PRINCIPIA PHYSICA UNIVERSI

BY
GEORGE P. STAVROPOULOS
B. Sc., M.Sc., D.I.C., Ph.D.

SECOND EDITION
RE-EDITED AND REVISED

ATHENS
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Συζύγῳ τε καὶ Γονεῦσιν,
᾽Αδελφοῖς τε καὶ Διδασκάλοις,
πρωτίστως δὲ
τῇ
Πρωταρχικῇ Οὐσίᾳ,
τῷ
Ἑνί,
ὄντως Ὄντι,
Μεγάλῳ,
Πανσόφῳ, Παντοδυνάμῳ, Παναγάθῳ, Δημιουργῷ,
Ζωοποιῷ καὶ Πατρὶ
Τριαδικῷ
Θεῷ,
ἐν φόβῳ τε θείῳ καὶ ὡς ἔξεστιν ἀνθρώπῳ,
τὸ παρὸν
ἀνατίθημι.

To
Wife and Parents
Brothers and Teachers,
but first and foremost
to the
First-Initial Essence,
the
One,
truly Being,
Great,
All-wise, Almighty, All-kind, Demiurge,
Life-bestowing and Father
Trinitarian
God,
in awe divine and as permitted to man,
this work
do I dedicate.

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FOREWORD

The main body of this work was completed on September 1, 1985. Since then and in my efforts to obtain reviews and see this work published, I was asked questions and obtained reactions in a way indicating a great need for an early preparation of the unsuspecting reader. This Foreword is intended to satisfy that need and will thus be different in content and extent from that of the usual form. The reader is requested to follow the particular layout employed, starting with this Foreword.

The scientific endeavor, the assumption upon which it is based, the method that it follows, its findings, their communication and dissemination, the way they affect the entire human enterprise and the feedback mechanisms that modify the subsequent scientific endeavor, all form a closed loop with no discernible beginning in sight. If there ever was a beginning, it is lost in the mists of uncharted history. To start arbitrarily from a particular point without adequate consideration of the wider field in which science operates, more simply, to isolate science is not to serve it or humanity well. Understanding will be immensely facilitated by the recognition that there are some areas that must remain separate and some other areas that that must be brought together: Despite unwitting confusion, despite even the current *deliberate* attempt to confuse Reality with its comprehension by us, there can be no doubt that the two remain logically separate. If they were not, physical science the object of which is the study of what is "outside" of ourselves, would be totally hopeless. Current attempts to "unite" the "sciences", specifically the physical sciences and psychology, at the expense of, and by deliberate blurring, the objective and the subjective is to add to the confusion, *not* to remove it, and to re-introduce, surreptitiously, Man to the center of the stage from which the Copernican revolution removed him, which center the subsequent development of the physical sciences to date has failed satisfactorily and sufficiently to fill. There remain, however, some supposed opposites, that must nevertheless be bridged. If one generally agrees that to bridge two supposed absolute extremes is to render any less extreme points of view easier to reconcile, I hereby request that the reader prepare for such a bold step. I do *not* ask of him to accept it as an immovable first principle. I *only* ask of him to accept it as a working hypothesis, despite all that he has been told in the last, say, two or three centuries, which seems to have been accepted without serious scrutiny. If what he has been told is true, it will be quite easy to find that the hypothesis leads nowhere and to reject it with a clear conscience. But if what he has been told is false, if the here proposed working hypothesis leads to no contradiction in the subsequent scrutiny, I will leave it to him to decide whether it pays to go back to the old (and now through our failure to find contradiction with the new shown to be *wrong*) way of viewing things, or whether it pays to adapt our position to the "new" reality. Because by its nature Reality *is one*, the bold step that I ask the reader to take is to

accept a connection between Science and Religion! I do *not* define the latter in the dogmatic manner of those who seek to impose upon others a way of life that they themselves do not or cannot easily practice. (In the narrow sense, such imposition has *not* been exclusively religious in origin, though the fervor with which it has been pursued by all its practitioners *is* fully religious in the wider sense. Besides, it has been the blatant attempt to such imposition that has brought upon us *all* man-made catastrophes throughout recorded history). Nor do I define it in the suffocatingly narrow context that characterizes the current "evolution vs. creationism" debate. As a scientist and as an engineer, I can and *must only* define it in the light of our *common* human experience that *nothing* that we know of, simple things like fresh flowers in a clear vase, or fresh coffee in a cup, happen by themselves! On seeing such things, we immediately and with perfect justification jump to the conclusion that a loving hand and behind that hand a loving spirit saw to them. Simple induction to the extreme, then, suggests that we consider it as a *distinct possibility*, our bold working hypothesis, that the entire Universe, the Κόσμος, namely, the all-inclusive, classically simple, perfect unto itself, unneeding of distracting superfluous ornamentation "Proper Arrangement" and Beauty of the Greeks has been placed there by a willing, living, loving Hand and an all-caring Spirit. That it *is* fully possible to do science, though seemingly "strange" on a first sight to the modern reader, yet *no less "scientific" and arguably much much more so*, based on such a hypothesis, which has gradually been rejected in the last few centuries, I will now proceed to show, and at the same time to explain why I reverted to a "dead" language to mold the seemingly ostentatious title of this work, which may well be the motive why the reader will pick up the book and leaf open the cover.

When one enters a dead-end alley, while he only intends to get across to the other side, he must retrace his steps, or in other words, to re-establish the historical and logical continuity of his attempt to get across; in our case, to resolve the mystery of the World. In 1687, Newton published his "*Philosophiae Naturalis Principia Mathematica*", which I. B. Hart in his "*Makers of Science*" has legitimately and without the slightest exaggeration characterized as "without exception the most important work in natural philosophy extant". Had it not been for that work, to the influence of which the three intervening centuries of scientific development attest, science would still be in the Dark Ages. Newton first and foremost bequeathed us the mathematical calculus. It is impossible for us today to imagine how science might have developed, had it not been for that singular contribution. He then bequeathed us his dynamics, the first and still fully current and rigorous theory of the objective world that (except for the "second order corrections" allowed by Einstein's relativity theory) constitutes the field of study of the physical sciences. He then gave us the first *universal* law, the law of gravitation. Einstein has justly remarked that, that law is in fact *appended* to the three dynamical laws of motion, because it is *not* logically derivable from them. Thus, through Newton not only did we acquire the mathematical tools to do rigorous science, we also and for the first time saw that *earthly as well as celestial* bodies, and by extension the *entire* Universe, all obey laws that are mathematically fully tractable by the inhabitants of a tiny planet seemingly "lost" in the vast expanse.

Newton's times were still times of deep faith in God, and he was and still is the preeminent example of a scientist of the very highest order who also was a

committed believer: To him, his own discoveries were not his own inventions. Rather, they were the first comprehending glimpses into a consciously conceived Plan, a Plan preexisting Man, to the existence of which the starry heavens attested. Much had already happened and much was still to follow that eventually permitted the statement to be made that science and religion were mutually independent, even mutually exclusive and inimical. As a result, few scientists still have the manly courage to declare their *full commitment to both*. Starting with Laplace's dictum that "God was a hypothesis of which he had no need", we in time conceived of biological evolution based on pure chance and "progress" driven by self-interest, yet in effect toward *no* goal! We then conceived of relativity as the negation of *everything intrinsically absolute*, whether physical[*], or, and as a consequence of the mood already on the march, metaphysical. We did not and still do not see in "relativity" the notion of "intrinsic brotherhood of all that is physical, thus attesting to the existence of a *common* Creator-Father"[**]. We then discovered quantum mechanics, but we interpreted it as a manifestation of pure blind chance being the basic function of Nature[***]. Under the great weight of this triple crown of modern "science", the last emaciated strands of faith in God broke away. Today, it takes a certified hypocrite fully to subscribe to these modern views and to contribute in any way to doing "Big Science" (that is almost exclusively funded by the military-commercial complexes of the world, East and West, or through other *only seemingly* "independent" branches of government whose ulterior motive remains on the whole none other than world domination, or at least not falling too far behind the two main contenders), and still claim a committed faith in a God who has pleaded with us to regard each other as brothers and to be ready to forgive and to turn the other cheek rather than to commit the sacrilege of inflicting the slap upon the face of our brother, whom we have long since ceased to regard as a living and sacred icon of God. To avoid the charge of hypocrisy, though not the consequences of psychopathy heaving under the surface, we have chosen the seemingly "easier" path of abandoning faith in God. Today, a scientist who claims a committed faith is looked upon by his peers with extreme suspicion, disbelief, thoughts of scientific or intellectual incompetence, even pity. And so, today, science, it is claimed in East and West, has "shown" us

[*] Except, of course, us! Because, appearances should not deceive. What the Copernican revolution supposedly overthrew has returned with vengeance under the cloak of relativistically introduced "physical Law": The Copernican revolution overthrew the Earth as the center of the Universe; relativity has re-introduced an infinity of observers, *all* "equal" to each other and *all* equally central as the one overthrown! The absolutes of relativity are there only in order to provide extra support for each observer's claim to equal centrality! This under the cloak of "physical law", which in reality is none other than man's arbitrary theoretical fiat!

[**] For *if the promises of relativity are logically binding*, not even God, whether he be defined as a Personal Creator or pantheistically in the Spinoza-Einstein fashion, can escape its implications and consequences. *If the theory is logically binding, nobody*, God included, can know more or decide, say, absolute simultaneity or the absolute order of events! Nobody needs a Creator-Father who cannot do better, nor even "Nature" that is just as constrained as every observer! Are the relativists prepared to accept this inescapable, yet *clearly metaphysical* consequence, because denying metaphysics *is metaphysics*? And if they are not, why are they chagrined when people are still sceptical of the overall logic of relativity?

[***] *If the indeterminacy principle is logically binding*, an argument analogous to ([**]) can be made here too.

to be truly lost in the vast expanse. All law, it is claimed, is relative and inhabits only in our minds; the order that science finds in Nature "somehow just happened" and in itself cannot claim objective existence independently of our own minds; to the extent that "somehow" it may exist on its own (which only demurely is allowed to creep in), all physical law is nothing more than the outcome of a blind purposeless quirk that also "just happened" to produce us, sole seers, definers, justifiers ex post facto; our presence here attests to no deep mystery at all and to believe otherwise is to believe in fairy tales! All this, the infamous anthropic (but in fact apanthropic, for it does not elevate us but only annihilates us) principle, the result of the most mature, sophisticated, advanced science the world has ever seen! This is what the "experts" teach nowadays.

This work will show that in the last three centuries we have gone astray philosophically, because physical Reality allows an *entirely different* scientific attack leading to a *different* conclusion that fully justifies Newton's belief in a Creator and thus re-establishes us on the age-old logical course.

Although it is true that closely examined, Newton's laws of motion require correction when referred to frames that are themselves in motion, the proposition to abolish altogether the notion of an absolute frame, in the simplest case an absolute point, in space, to which all motion ultimately refers is still a philosophical, *not* a scientific one based on physical Reality. This work will show that such a point does in fact exist, that Einstein therefore went too far in rejecting such reference. Since Newton's inverse square law does not, by Einstein's admission, follow logically from Newton's three other laws, logically, correction of the latter does not necessarily have to involve the former also. But Einstein disliked immensely the notion of "action at a distance" and sought to remove it through the introduction of the notion of a "geometrical continuum", "spacetime".That continuum was conceived to be such that to a first approximation motion in it reproduce the *results* of Newton's laws, including the results of the law of gravitation, though not the extreme mathematical simplicity of the latter law. This work will show that Einstein's special relativity mass-energy and mass-velocity relationships are derivable, without stipulating that theory, directly from Newton's law of gravitation and his second law. This immediately raises the question whether we are truly wise to abandon Newton's law of gravitation for Einstein's general relativity. Although the modern reader may find this question quaint, upon reflection, it is definitely shown not to be so at all. In the first place, to adopt Einstein's program is to abandon Newton's simplicity. The claim of relativists to the reverse is insupportable. Where Newton places one constant element, Einstein substitutes ten variable ones in order to explain the *same* phenomenon, gravity. In the second place, removal of the rather simple mystery of action at a distance throws us back to an even deeper, darker, much more elaborate mystery of "curved spacetime" that even mathematically is not at all clear and unambiguous. That general relativity has produced no comprehensive view if the World that it is unable in itself to give definite (not necessarily *the* correct) answers about the Universe as a whole and about the laws that make it tick is too well known to need further discussion. Suffice it to say that "ether", which the Michelson-Morley experiment rejected as non-existent, relativity re-introduced surreptitiously as spacetime. Only the rules of the game have been changed and become more complex, the mystery itself has thickened by far. In the third place, Einstein in effect ad-

mitted defeat, as the closing paragraph of his appendix to *"The Meaning of Relativity"* shows, in the face of the unambiguously real quantum effects that he was unable, as has anyone else been, to resolve on the basis of his "continuum". In other words, when we subdivide matter toward the anciently conceived "atom", to which a correct quantum theory philosophically *and* physically ultimately *must* refer, how exactly does spacetime suffer? Even worse, if ultimate reality is such a "continuum" of which all, us included, are parts, how exactly does that "continuum" act upon itself during our subdivision toward the "atom"? Neither are we aware of being externally forced to do so when, say, we break bread, nor were the babes, blissfully asleep in their cradles, at all disturbed as I tossed sleepless in my bed unable to suspend thoughts that cried out their need to be placed in order! How, then, does the "continuum" affect its parts, and they each other and the whole? To be more detached, what exactly can it possibly mean to speak of "parts" of a "continuum"? At least this point should be quite clear: It does not take too much philosophy to realize that something physical cannot cut itself to pieces and still continue to be a continuum!! Common sense demands that atomism and continuumism remain irreconcilable!!! If *not* all mystery can be removed, if in our efforts to remove all mystery, we find ourselves to be getting ever deeper in it, common sense demands that we retrace our steps to the point where the mystery is the thinnest!!! And a comparison of Newton's law of gravitation with Einstein's general relativity leaves no doubt as to where the physical as well as logical mystery are indeed thinner! The aesthetic attraction of the concisely expressed mathematics of general relativistic formalism is insufficient altogether to distract us from the obligation we have to face up to the need to obtain the *one* solution to which the singularity of this world attests, against which the differential calculus of relativity can only juxtapose an infinity of possible solutions but no way to help us pick the one we need!

This work will show that those who chose to accept the claimed inaccuracy of Newton's law of gravitation acted too quickly. For hidden in that claim are human assumptions that do not have to be the "principles of construction" of this World, and physical facts exist the effects of which have yet to be considered in evaluating the claimed failure of Newton's law. For hidden within that law is a world of science that "modern" science has not suspected. This work will show that within Newton's law of gravitation there lies the key that unlocks doors that have not been suspected to exist. "Modern" science has yet to ask whether Newton's law and. say, the constancy of the velocity of light are compatible, for if they are not, to the same "high degree" that the former holds, the latter fails!!!; it only assumes that they are, but has *not* demonstrated it as a fact. It has yet to ask whether the principle of conservation of energy is justified in light of Newton's law of gravitation. It has *yet* to answer how universal gravitation and universal expansion, those seemingly contradictory notions can reasonably coexist in the World. It has *yet* to realize that these are inextricably yet logically tied together as are the faces of the same coin!!! "Modern" science, having confused, as the "anthropic principle" demonstrates, the objective and the subjective, has been unable to see the objective *as a fully independent whole* and thus has *not* sought to find its laws. Because the objective exists as a whole, a *Universe*, harmoniously with itself, it necessarily obeys Laws that can hide *no* internal inconsistency; that depend upon *no* human supposition or *arbitrary* human principle; that provide a *unique* answer

to the above and *all* questions; that limit the whole within specified bounds, which *delimit* the parts of the whole to being different from what "modern" science makes them out; that *exclude* chance as intrinsic to the structure of the Cosmos as "modern" science has it. Modern usage simply employs terms of the Greek language without comprehension of their meaning. The Greeks thousands of years ago, when they somehow "constructed" their language, saw Cosmos as the very antithesis of Chaos. Without a formal statistical science, they *already knew* that chance relates to Chaos, not to Cosmos. We, today, in the name of "modern" science, seem to be demanding the exact opposite!—To soothe our pangs!

That a *unique* answer does exist as necessitated by the objective World, fully harmonious in itself, that can only be provided by Newton's law of gravitation, which is the exercise of this work, is the historical and logical continuation the title of this work was meant to herald. However, that answer can be obtained only when it is recognized at least as a working hypothesis that there is operating in Nature a Most Elegant Design based on a Least Set of Laws, within which Newton's law of gravitation is pivotal and that the universal gravitational constant is *not* a "mere" proportionality constant but a property (and when the analysis is complete, a *basic dimension*) of the entire Universe. That all this has been missed so far can only be due to the fact that the idea of the Most Elegant Design, the study of which falls in the realm of science, automatically introduces the idea of a Designer, which falls in the realm of Logic as a *necessity* and the realm of Religion as regards its *overall significance*! It has been our stubborn refusal to consider even the possibility of a Designer as a logical necessity that has pre vented us from realizing the findings of this work any earlier.

The bold statements of this Foreword will already have come as a surprise to a reader conversant in modern science. It is therefore necessary that he be forewarned that this is a prototypical work, written along lines that modern science has *not* investigated before, considering facts some of which are currently deemed to have no place in a scientific monograph, in which terms are used, specifically in the Introduction and the Preface, in a way that currently may seem strange, or alien. In the Introduction, the use of mathematical expressions was avoided *deliberately*. The reader will there be asked to think along lines that begin to loosen up from their current mold, with words rather than symbols, words that have striven to convey the essence without the rigidity. The time is there not yet come to introduce mathematical symbols from the current collection before they are adequately redefined. In short, the reader is asked to spend time in an intellectual adventure for which "modern" science has *not quite* prepared him. He is asked to persevere to the end and after he has done so to reflect, to go back to the text and to reflect again. Then, he can decide for himself as to where Truth lies. For it is incontrovertible that objectivity, the Objectivity of the World, requires the existence of Truth, beyond and independent of *every* human conception. And Truth *does lie somewhere*.

The reader already has some questions that deserve an early answer: "Why, if this is a prototypical work, did it not appear in the "peer reviewed" scientific journals? Why did I choose to wait until the whole thing was in place before submitting it for publication?" In the first place, I *knew* I was "talking revolution". But revolution for the sake of mere novelty is *not* a habit of mine; tradition has after all its rewards. Revolution in the way we see the world can only succeed if

the view it allows can stand logically together *without* discontinuities or conflict. I *had* to satisfy myself that this was indeed so, and so the work grew. When it was all done, should I break it up to conform to the current molds of presentation, or should I present it whole? For the absence of a suitable carrier, a very great deal would be lost, if I chose the first method. I would much rather have my reader with all my pertinent thoughts in his front than ask him to run through the reference libraries. Could this have been an excuse to avoid the revered "peer review process"? Hardly! I believe that a book of this nature must be reviewed far more closely than a mere journal article. For this reason, upon completion of the manuscript, I submitted publication proposals to *fourteen* top university presses, *two* scientific societies and *eight* top notch scientific publishers, each one of which have large teams of expert reviewers. I wrote to *three* professors requesting that they suggest Nobel laureates willing to review the manuscript. They did not. I wrote on my own to *six* Nobel laureates requesting that they review the work. One answered that he could not. Another hardly concealed his irritation and suggested that I was unaware of developments and should contact another professor to make sure. I did and found that I had not reinvented the wheel, which I knew all along. Three did not bother even with an acknowledgement of receipt. The last one replied that he read my requesting letter (admittedly more detailed than the other five) "with interest" and did offer to review the work, but expressed skepticism regarding the correctness of my view that chance does not rule the World and of my statement that I had succeeded in constructing a new physical model of the electron without the shortcomings of the old. I sent him the manuscript, but not this Foreword, nor the Addenda that were not then written. Two months later his reply arrived: It opened with the statement "I have now gone through your manuscript page by page. I have not found anything in it that seemed to me to be interesting … I may, of course, have missed some point. If you have made a discovery of this sort, …", and closed with the statement "I am sorry that my study of your manuscript has not led me to be able to mention one point that I consider to be a significant contribution to our understanding of the nature of the world. It may be, of course, that there is such a point, or even more than one, in the manuscript, but I did not find any". I replied indicating one by one at least twenty six points far more than simply "interesting", secretly hoping for a more detailed response. He replied, so far, with silence! In his "report", he nowhere indicated mistakes, not even in his own field of particular expertise! Just absence of interest! One would think that a scholarly work of *this* unique nature is either correct in its own terms and therefore at a minimum *ipso facto* most interesting, or faulty. In the latter case the author expects to be shown his errors. If after two months none is found, one may reasonably attribute the reply and the following silence to other reasons, perhaps relating to the subjects of already expressed skepticism which provide the justification of our current *philosophical* positions. Opposing arguments that cannot otherwise be refuted can only be evaded by those committed to the defense of those positions through some such ruse as reversal, equivocation, denigration or, silence.

I then wrote to two more professors and a prominent university president, requesting that they find reviewers able to pass judgment, either condemning the work if so deserving (but showing ample reason) or recommending its immediate publication given its obvious value if they could find nothing wrong with it.

To no avail. They did, or could, or would, find no one. When I rebutted fully the few, weak and generally irrelevant to the main thrust of the book comments that did get back to me through publishers, there was no further response. When I submitted to subsequent reviewers earlier comments and my rebuttals, they no longer made their comments in writing. (Fearing perhaps the same fate?) The publishers did not press them, either for written comments or to justify their negative recommendations. One publisher, realizing the incompetence of the first reviews he got and the potential significance of the manuscript, attempted to interest additional reviewers among the faculties (to whom he only disclosed the nature of the work and the overall synthesis it attempts) of three of the largest universities in the land and was amazed at his own failure!! He no longer could objectively justify his time, nor a publication proposal he had wanted to make to his corporate superiors! I decided to contact a seventh and elderly Nobel laureate. He offered to have an early look at the work. Two days later, he indicated that his correspondence kept him too busy to read the work in detail, though it appeared to be interesting and someone in his department might wish to get acquainted with it. A prominent European professor showed some interest but could only bring himself to commenting on a few and insignificant points of detail while, it looked as though, deliberately avoiding points of fundamental significance and exhibiting in the process an inability to distinguish between experimental science and its limitations and the experimentally insupportable generalizations of current theories. He suggested that I forget publication of the book, at least for the time being, and attempt to publish papers in the scientific journals, which could, and in all likelihood would, be rejected anonymously and safely behind closed doors for lack of "experimental verification" as had already been suggested in some reviews received. Since such a rule for rejection has never before been applied universally, or else no theory would ever have been published before it was experimentally verified, nor can or should be instituted for the future, one must consider it to be only a hypocritical though convenient ruse to screen material injurious to the established beliefs. When I indicated that I was prepared to finance publication of the book out of my own pocket if necessary, I was told that "I would be committing a still greater mistake because the experts would then not take the work seriously". So, the "experts" must be judging the quality of the work by the name of the publisher!!! But since the "experts" and the censors are essentially the same people who have or have had a hand in the development and spreading of the current theories, this also implies their unwillingness to consider any idea that is not theirs! This from someone who knows them intimately and well! I replied that I would leave it to this kind professor and the "experts" to decide whether their own studies could ever possibly claim exhaustiveness if they should deliberately choose to ignore the findings of this work and their profound implications.

The reception of this work in the hands of the reviewers revealed some extremely disturbing attitudes: it appears that a work today is no longer judged exclusively on its content and its own reasoning and reasons, but on the name of its author (is he one of "us"?) and on whether it does "us" harm! This humble author shall leave it to his readers to decide whether the issues raised in this work deserve to be dismissed, sight unseen, by "expert" professors no longer interested in these matters! He also shall leave it to them to meditate on the revealed be-

havior and frame of mind that are both incomprehensible and unforgivable among fellow workers searching for Truth and on the intellectual integrity of some of those in whose hands society has today entrusted its fate and the *very* expensive education of its young.

Other than that, what, then. may have been the cause of the negative reception by those who only saw the publication proposal? Apart from purely economical considerations, undoubtedly my professional titles which do not "qualify" me as an "expert" to handle the problem in hand. Of course, the qualifications that I do bring to this particular contribution to knowledge is the work itself, the invitation to challenge, scrutiny and falsification that it extends. That so many "experts" judged merely by the titles is perhaps only indicative of the narrowness of education provided nowadays in their own institutions! If possession of the Ph.D. degree is an indication of the intrinsic ability of the holder to think for himself, perhaps he may at some point decide to educate himself in a new field that the "experts" have unwittingly overlooked. In that case, by passing up the request to review a manuscript, or by not paying attention while they read it, the "experts" only expose themselves to the consequent judgment. As regards the essence of this work and its ultimate correctness or incorrectness, one must only remark that it cannot be decided on the basis of some such equivocations as already quoted, nor can its judgment be left in the hands of partisans whose impartiality is totally below reproach.

The details of the conflict of the old "paradigm" with the new, in which this work is thus already involved, has been dealt with admirably by Kuhn in *"The Structure of Scientific Revolutions"*. Perhaps, the reader will find it most advantageous to read that work most carefully before passing final judgment on this one. There (2nd Edition, p. 166), Kuhn states that the "scientific training is not well designed to produce the man who will easily discover a fresh approach". In that case, the slowness of discovery is *directly* due to the nature of training the institutions of learning provide to trusting young minds! What did *I* have to bring to that effort? Other than my own specialized training in three universities, an abiding curiosity to get to the root of things, in this specific case without even due regard to personal cost over more than twelve years of additional, patient, self-imposed, disciplined labor and a stubborn belief that nothing is here by chance, that all, together, do make perfect sense. A belief that there is a great "mystery" hidden in the human languages, specifically the one in which it was my good fortune to be born, which if protected from corruption can provide invaluable insight into the nature of things. Kuhn (pages 90, 144, 166), speaking of the "innovators", states that they are either young or new to the discipline, and thus not committed to the old "paradigm". Young, I no longer am. But youth lost was, I hope, experience gained and years of patience, that simply are not available to the young; it also was faith that in the young does not have the time to mature and illuminate in them a new no longer "mysterious" comprehensive vision.

If ultimate understanding is forever impossible without comprehensive vision, and if the latter is unattainable in the absence of time and mature consuming faith, we should not at all be surprised that the key hidden in Newton's law of gravitation lay there for three full centuries. Nor would I have found it had it not been for my own belief that the Creator made the World with nothing short of

absolute perfection and with nothing less than absolute simplicity and economy, yet fully capable of doing all that was expected of it and fully amenable to opening up its secrets to reveal all that we really *need* to know, if we only looked where the key lay. A pure theoretician can see "principles" and discover "laws", or construct models in imagination that may or may not exist in real life. An engineer, however, seeks more. He seeks in a finished work the organizing bond that allows it to stand together perfect to the eye and perfect to the hand, with nothing unneeded and nothing missing. Objective Reality compels the engineer seriously to marvel at the perfection of Design of what the Greeks *deliberately* called the Cosmos. Theoreticians can debate the probability of this or that being there by "chance". An engineer *knows* that no "building" and no "engine", no "structure" ever grows out of nothing, no materials, no laws, no plan, no willing living loving hand, *all these* set out to attain a *clearly preconceived* Purpose. An engineer *knows* the world is made of hard places upon which the foot can stumble and the knee wound itself. To him, Reality is truly painful and calls for our appreciation of itself in its ultimate detail, for nothing is placed there, unless it is place there by a "hand", for a *Purpose*. A theoretician may never leave his study and never have to face more than mere "concepts". But as everyone knows, concepts do not hurt, not at any rate enough to cause real pain and introspection! Here then, is not only a scientist's but also an engineer's, and a thinker's who has striven to understand the whole, conception of what we *must* pay attention to, if we truly strive to understand the World in which we live.

I am grateful to Professor John Ollom of Drew University for reading the main body of this work and the first three Addenda and for his valuable comments and the many hours of discussion.

Green Brook, N. J., July 1986

NOTE ADDED TO THIS FOREWORD

On preparing this work for electronic edition so many years later, I feel I *must* add the following: After publication of the Book and having come across a paper by a professor in a Southeastern US university, I sent him a copy of the book some time between 1987 and 1990. After his reading it, we had a long telephone conversation and he too assured me that he could find nothing wrong with the book, indicating further that my discussion of the problems of current quantum theory was the best he had ever seen. He also admitted having received a high ranking gentleman from the Institute for Advanced Study at Princeton, N.J., who wanted to "pump" his brains for his own and the Institute's use. Of course, that meeting could *not* have gone well. The result was that the Southeastern professor found, in his sixty third year, that his own university would not renew his tenure, thus jeopardizing his pension!

A second incident occurred to me: Soon after 1995, I handed over to a professor and close friend of mine visiting Athens complete early copies of my books "*Reality, Truth, Faith and Reason*" and "*Contra Philistines and Sycophants*". On his next trip, before visiting me he called to say "I have a very interesting book

to show you". On his coming, and sitting around the kitchen table, he handed me the copy I had given him of the second of the above two books! At my exclamation, he admitted that professors, too, are "constrained having second mortgages on their own homes"! He proceeded to suggest that I sent a paper on my re-examination of the Michelson-Morley experiment to "*Nature*". Upon expressing my skepticism of the wisdom of such an effort, he assured me that it *would* be published! I did *not* ask him how he knew! I only replied that if the "establishment" could only admit this little, it could only have been due to its unwillingness to admit the whole of my findings, but *I most certainly would not thus betray my own God*!

Reader! Please be not surprised! What I, an engineer, have with this work undertaken to bridge is the seemingly unbridgeable abyss that they have you believe as existing between "Science" and "Religion", over which *both* those sides want to keep you dangling in agony, so that they better exploit you, each side to its own best advantage! But enough is quite enough! My effort is *not* quixotic! The two sides are *not* as apart as *they* say (see below)! They both *are* dogmatic!

What the World's History of the Spirit has bequeathed us is the *true* meaning of the words Σύμπαν, meaning the *All*-inclusive; *Uni*verse, meaning the *Mo*νόστοιχον, the *All*-inclusive *in just one cogent verse*; and Κόσμος, meaning the *perfect arrangement of everything* that *only* thus κοσμεῖ and beautifies what otherwise would have remained Χάος = Chaos in both its senses of absolute emptiness and utter disorder! Be kind! *Do* think of these in *both* their material form, *and* their *spiritual and only thus true* substance! And for God, the name Δημιουργός, meaning public works Maker, submitting them to *our* examination! So, it is *not* the flesh that has moved me to write and you to read these words; but solely the Spirit's desire to get to the *true* meaning of It All! As of now, "Science" and "Religion" *have split the World asunder, in order to keep on exploiting It; and you from finding out their true intent and thus concerted effort*! Modern "Science" calls the World meaningless, purposeless; yet *both professors and Nobel laureates* keep on *taxing you and charging you their heavy fees for "educating" you* in the "proper" manner of meaninglessness and purposelessness! As for "Religion", its most high officials do *not* feel their hands literally to burn dipped as they are in the hot human blood *they* order shed in order that *they keep you* blindly obedient to the God-insulting profanities they sell *you* as "Piety"! Nor those on the other side do: In gloves are theirs perfecting the means of ever more effective killing! They have *not* told you: On this limited, tiny planet that can only support so few in untold luxury and only the *necessary* number of slaves, we have grown far too many! Shame is *not* a word those on either side even know how to spell! They, utter corrupters of Man's holy Spirit, still teach the largely ignorant populace to demand ever more, these from "society", those from God! And hoi polloi, thinking that we came to life simply to "have fun", in effect *squander* life living it prodigally, have arrogated to others to do the painful, yet necessary thinking that *is* expected from *each one* of us! So, here comes mine! They all ought to understand that the more they postponed accounting for their behavior, inevitably the greater would the volume of charges become!

We may *not* demand ever more for ever more people without stating *clearly* the *sufficient* source of the *endless* supply! Printing ever more paper money does *not* create wealth! It only *destroys* the *valuable* oxygen-regenerating woods that supply the pulp! In the process, we also *cheapen the honest savings* of those who

prudently save for a rainy day! Dr. Nobel laureate of economics, Mr. President of whatever, ask yourself, *is this honest*? Can it continue for ever? As it *cannot*, the End *does* come ever nearer!

As for you, Herr Professor, do you not feel that in a *Uni*verse, the differential calculus is *definitely not* quite enough unless it leads to the *one correct* integral answer? That your "somehow" is definitely *not* the answer? The analysis shows that, underneath the examined, there operates a Law that *cannot* and *may not* be ignored! *Is it not the universal experience of all human societies that ever existed that all Laws have their Lawgivers*? Can you suggest *any* Law that has been installed by a Mindless Lawgiver? We do *not* accuse our parliaments of mindlessness, but of cunning and dishonesty, of lack of courage to tell the Truth, live with It, and *thus* educate by their example! So, Herr Professor, do kindly tell us who the Lawgiver of the *Uni*versal Laws is! Have you forgotten the no longer divisible Democritean atoms? Do tell us *when they, if they* are the Lawgivers, convened in Congress and established the Laws that keep *their Uni*verse in order! Do you suggest that the Democritean atoms have each a mind? Kindly, *don't* stop there! Minds are *not* enough! To be enough they *must* be shown to be driven by Λόγος and He by a Spirit inspiring to Goodness! Or else, you Sir, *do* lead us to Evil! If you hate admitting the existence of the One Great Lord God, do be brave enough to admit that *you* have led yourself into the den of some about 10^{120} tiniest Gods, each of them wiser than yourself! Is then your "Science" the Ultimate Polytheism?

If all these be beyond you, Dear Professor, do be kind enough, learning from Aesop, no longer to call the *ripened* grapes "sour"! If you still insist on evading this crushing question, be informed that you only expose yourself *ex cathedra*! Your *pressing* present duty is to evaluate *honestly at long last* the findings of this work. *Show* the errors, if any, *improve* on the reasoning! *Only so* shall we progress! The abyss *must* be bridged!

If you, Herr Professor, still refuse, the Reader who now *can* understand what is truly here at stake, *shall* pass his final judgment on the *total faithlessness of the entire* world-ruling "establishment" in all its manifestations, of which *both* "Science" *and* "Religion" *are willful servants*! Lost in its incomprehension of Logic, "Science" may claim not to need God! But "Religion" (including unbelievably the Christian Churches *all the way to their very top*, *may not, foolishly,* tell the World that the Being of God "cannot" be proven! For that *is* blasphemy! An unprovable God *cannot*, if self-respecting, expect of us holiness! An unprovable God *cannot* confound and condemn His detractors! An unprovable God *demolishes Holy Justice*!!! Do they truly believe that an *unprovable* God established *them* to be the *sole* judges of our sinfulness? What sort of "faith" is that of theirs?

The *free* electronic presentation of this *set of seven books of which this is the first* to all who *can and are* willing to undertake the great pains of thinking for themselves, shall be the evidence, the proof and the charges in the open Court in which the matter of the origin and objective of the *Uni*verse shall at last be decided. This matter, *most important of all ever before us, and on account of the mounting heedless blasphemy and the rivers of hot blood still shed, is urgent*! The time *is* objectively running out! Each *shall* reap what each has wrought!

Athens, Greece, April 2009.

PREFACE

I

Man has a very highly developed consciousness of himself and of his environment, and of the objective reality of both. This is coupled, intensified, and recognized by his ability to examine critically both himself and the surrounding world. It is true that various philosophers have at times questioned the objectivity of Reality. There are two aspects to this question: The usual and more obvious one is based on the fact that all is ultimately judged in the mind, which alone is claimed to be sufficient reason for all conclusions about Reality to be "necessarily" subjective. Yet, that undisputed fact *does* not in the least vitiate the objectivity of Reality. Physical science shows quite conclusively the unique coupling of mind and Nature: they are intimately related, yet, they remain absolutely free of one another in all their essential objective nature. To say the least, when scientists independently think of an experiment and project an identical outcome, and proceed independently to design and perform the experiment, and independently verify their identical predictions, there is only one conclusion to be drawn: what is called Reality is objectively real, and by no means an identical figment of their independent imaginations. This is not meant to invalidate any and every instance of coincidence; but when well *designed,* multiple, independent experiments turn out identically without a single exception, coincidence has no place, and we may not doubt the objectivity of Reality.

The second aspect to the above question is much less obvious and only rarely alluded to, and then only by mystics, almost never by scientists, unless they are also mystics (the two are not incompatible). We shall defer all discussion of it until the end of this work.

Recognizing that his ability to examine himself and his environment critically is characteristically and uniquely his, Man, very early on, at least according to written history, gave himself the name "Ἄνθρωπος" (= ὁ ἀναθρῶν ἃ ὤπωπεν), meaning "he who examines what he *has seen*". He has not used this "has seen" lightly; for animals, too, examine mainly by smelling and touching what they are seeing, but only Man examines what he has *already* seen, necessarily involving in so doing his mental faculties, the inscrutable ἔσω λόγον or logos within. And only Man expresses by speech, namely by λόγου ἐκφραζομένου, or logos expressed, some of the processes of the logos within, his thoughts on what he has already thus examined. In contradistinction to himself, he called not only the animals, but also the in animate beings ἄλογα, for they lack both in speech and in what is expressed by it, namely, the logos within.

It is precisely because of his logos within that Man is constantly puzzled by the mystery of his own self and of the surrounding world. Perhaps nothing frustrates him more than his obvious inability to resolve this double mystery. Despite his recent great strides in *understanding scientifically* (though he is not really much closer today to *comprehending* what he claims so to understand) some of the principles and mechanisms of the phenomenon of Man and of the phenomenon of the Universe, he nevertheless continues to feel deeply frustrated, not only because he sees the final "how" to recede constantly from him with every new discovery, but also because he has never been able to provide an answer to the even more important "why". So much so, that he has practically abandoned all *conscious* efforts to provide an answer to that why, not only in the context of science (which is, probably, quite proper), but also in the context of philosophy.

As regards understanding of himself, he has developed psychology, yet, in his efforts to make an exact science out of modern psychology (he has not even examined whether or not doing this is logical), he has redefined Man to be "quite simply" a basically simple machine, since it, too, in common with all machines, he alleges, can in principle be broken down to its constituent parts. In so doing, he has basically rejected even the idea that there exist in the human character non-quantifiable qualities (for it is certainly not accidental, nor meaningless, that we speak of the qualities of man rather than of his quantities!), without which Man plainly ceases to be fully human, and, therefore, has thus forfeited the claim that he can provide all the basic answers about the true nature of Man based on measurement alone. It is true that in very recent times an effort is being made by many thoughtful scientists of various disciplines to emphasize once again the non-quantifiable, the truly human(istic) aspect of Man. However, acceptance of this view is generally feared and avoided because it is seen by many as a tacit admission of a serious limitation, if not failure, of science, as if there were an unassailable principle to the effect that human science necessarily covers *all* questions and cannot fail, given sufficient time, to answer them *all* correctly!

Probably for this reason alone, which of course has nothing to do with science but only with scientists, the return to a proper and truly humanistic conception of Man is still very far off.

As regards understanding of his environment, he has expanded the field of his investigations from the innermost recesses of the nucleus to the ends of the Universe. He acknowledges that he does not yet understand the processes at these two extremes, but he hopes to do so eventually. Can he reasonably expect that such a hope will ever be fulfilled? Can he reasonably expect, in view of his inescapable limitations and predicaments, that he will ever be able to know *all* there is to know about the vast Universe? We can safely state that as far as *all* details are concerned, this will be outside his reach forever, for he *cannot* be *in all places at once and at all times as he must, if he wants to study all the Universe and have the answers to all questions*. Accordingly, he must restrict his hope to establishing only the basic laws according to which the Universe functions—if there are such laws. But how can he possibly know that he has discovered *all* the basic laws without having mastered *all* the details? Evidently, he can-

not do so, in principle. Accordingly, he must restrict his hope further and be satisfied with discovering what we may call the most basic of the basic laws, which, perhaps, does not require knowledge of *all* the details. It is this, I shall call it, first hope, that encourages him to try to push back the frontiers of his ignorance. Yet, it must be admitted that this realization represents the acceptance of a very near and restrictive limit to what he so thoughtlessly has claimed to be within his reach to understand based on measurement alone.

There are many today who claim that the acquisition of knowledge in these and all areas is good in itself. But to say that Man has developed his scientific horizons for the sake of knowledge alone is definitely wrong, because knowledge for its own sake is arid and it leads nowhere, and today we (to his credit, the common man leading in this respect the specialist) begin to rediscover this basic truth with much greater clarity than at any other recent time. The sole legitimate purpose of knowledge, other than the satisfaction of basic human needs, is wisdom itself, which has yet to become again our obsession, preoccupied as we are with the materialistic view of the world. Not only is knowledge a tool, and as such a very poor substitute for the true good that is wisdom, but because it is a tool, it can and has been conceived in tight non-communicating compartments. In juxtaposition, wisdom is unique and whole and universal and therefore it covers not only the environment but also the human self, not only what can be quantified, but also what cannot. Lest there be a doubt on this crucial subject, let me hasten to add that knowledge can be, as it *has been,* misapplied and abused with terrifying results. Wisdom can *never be* misapplied or abused.

Yet, though he appears to have thoughtlessly, but supposedly consciously abandoned the effort to understand the full Man, he subconsciously and fundamentally still recognizes that he has not given up all hope to earn somehow the proper wages of his labor: through realization of the first hope to attain the second and much more important one: wisdom. If only he could return part of the way finally to conquer himself!

II

It is conceivable, indeed, it is very probable that both how and why, as they regard both Man and the World, will be answered at about the same time, because the entire Universe, including Man himself, is basically very much simpler than it looks. The ultimate perfection and beauty must also be the ultimate simplicity. Certainly, it is not for nothing that we have called it “universe”, meaning single-simple, orderly sequence, line, turn, and “κόσμος”, meaning jewel, ornament, beautiful arrangement. And so, in order to penetrate that simplicity, and in order to answer all answerable questions about Man and about the Universe correctly, we must see it all in a unified context, with a totally fresh look as never before, forgetting the piecemeal approach that has failed to provide us with the ultimate answers. But much more important, Man must see himself in a new light (not *really* new to be exact), not as an object, or as another curiosity in this vast collection of “curiosities” that is the Universe, but as a κύριον, that is as a

free, independent entity, separate from and potentially superior to the rest of the Universe, for he can think and it cannot! Only then will he be able to ask what is certainly the most penetrating question that a scientist or engineer can ask of himself: *If I could, how would I build the World?* Obviously, he recognizes that he is not wise enough to answer such a question to any reasonable depth; but at the same time, he *is* wise enough to recognize that if he could, he would build it with the greatest possible economy of effort and means, the greatest possible simplicity (the simplest possible design based on the fewest possible fundamental laws and principles), so that it be a σύμπαν, single and singular and whole, with all its parts organically cooperating in the most harmonious manner possible*, for only then would he be able to rest and call his creation truly elegant, or much better still, καλὸν – good ("... saw that it was good"). And he *is* wise enough to recognize that it takes the greatest possible wisdom to build something as vast and as beautiful, yet as elegantly simple as the entire World. This is what we briefly shall call the Most Elegant Design Hypothesis.

But this line of thought allows, at least in principle, the possibility that there may be Someone who did make it all, just as Man would if he could; Someone whom modern science and philosophy are so desperately trying to do without, because it is felt, perhaps sincerely, but probably not, that He is of hindrance rather than of help.

It has widely for a few centuries now been held that science and religion are incompatible, that science is by its very nature antireligious, religion likewise anti-scientific. In truth, there can be no conflict, no question of incompatibility, because by definition each of the two belongs exclusively to its own world. The world of science is the world of the senses, which is instrumentally measurable and miraculously (though taken for granted and never investigated as to the true reasons why it should be so) mathematically quantifiable. The mistake of certain scientists is the mistake of the blind and of the deaf who have never seen the colors or heard of music, yet, in all seriousness and thoughtlessness maintain that they sense *all* there is to be sensed! For the world of religion is none of the above, for it begins precisely where the other world ends, and tries to express what, as a result of necessity and limitation, the senses recognize as inexpressible, to secure what the mind recognizes as mathematically insecurable. The world of religion is the world of joy and of sorrow; of justice and of love; of beauty and of perfection; of wisdom and of good for their own sake. It is not correct to say that these are adequately covered by conventional (that is, agreed upon) ethics, or legalistics, or psychology, or esthetics, or art, or philosophy, because they are not adequately covered by any and all of these activities. Much more than any other, religion crowns them all, and brings balance and an inner organic bond between and among everything else, and makes, in the final analysis, life worth living, for it gives it purpose in a way that neither psychology, nor art, nor science, nor philosophy can ever do. It is held that all this is glorious nonsense. The fact remains

* It is in this sense that we shall try later in this work to find that combination of least principles, *Least Set of Laws of Nature* that *suffices to* make the Universe fully consistent both logically and physically.

that *religion is a very human activity and a very human experience, more accessible to the average man than is science*. It is arrogance to dismiss *this reality* as due to the ignorance of the "common man". It is the duty of science to examine it and explain its causes, just as it professes to be doing for all phenomena of reality, even if this involves, as in fact is does, a critical self-examination of science itself. For it is high time that science become the subject of its own investigation. Only thus can it possibly cleanse itself and proceed to new conquests of terrae incognitae.

Once and for all, it must be understood that religion is the world of belief, *any* belief. It is religion to believe in the *existence* of God. It is religion to believe in the *non-existence* of God also! Because, religion is an activity, and as such it refers to the type of the particular activity involved, *the act of believing*, not to the object of that belief.

It is unscientific of science to take sides in what in fact is an inter-religious dispute: the existence or non-existence of God, before it itself has examined the merits of the arguments of either side. Because in centuries past, practitioners of religion, deep in their ignorance, thought they saw an implacable enemy of religion in the face of the then rising science; because *it happened* that those practitioners advocated a particular branch of theistic religion, the full implications of which they had yet to comprehend, as they still do, it will be just as ignorant, if not in fact worse, of science to respond in kind and recognize an enemy in the face of theistic religion. The only conceivable enemy of science is unTruth, *not* what others say in ignorance.

It is being held that theistic religion, by advancing the idea of a created world, is antithetical to science, that it is restricting the scope of scientific search for the origins of the world. It can easily be shown that this opinion is wrong. Because, it is the professed objective of both science and theistic religion to establish the Truth: Since the world is one, the truth about it can only be *one and the same* also, no matter how it is arrived at. If both science and religion are sincere in their self-confessed objective, they should rather collaborate, the faster to see Truth finally established. To quarrel on stage, not unlike two prima donnas, as to whose interpretation of the shrew is the more likely to draw greater applause from a largely uncritical audience is, at least, to postpone arrival at that noble objective. If God exists and has created everything, He also has created science, and thus science is by no means a way inferior to religion of searching for God. On the other hand, "if God created the world" is an assumption that science should not allow itself to leave without thorough investigation as to its testable scientific implications. Moreover, if the physical world of existence and of science necessitates the preexistence of Λόγου (= Mind), denying that necessity is patently unscientific and downright dishonest. And thus, if religious people are to be blamed for discounting science, scientific people are to be blamed much more for ignoring the scientific necessity of finding out once and for all whether or not Λόγος is the precondition for all that forms the purview of science. Therefore, rather than restricting the scope of scientific search, the proposition that God exists opens up the most exciting by far way of looking for the origins of

the World: For whether or not Mind is the precondition of everything is not only scientifically imperative to determine beyond any scientific doubt; it is also by far and away the noblest of all scientific pursuits.

It is wise indeed to learn from one's own mistakes, but it certainly is wiser by far to learn from the mistakes of others. Neither the religious, nor the scientific communities seem to have learned much from past mistakes. The former have yet to admit and confess that atheism appeared in the face of civilization as a backlash to *their* misbehavior, to *their* abuse of the Religion of the Spirit, for purely secular gain. It was *exclusively* for such gain that they resorted to torture, to the drawing of blood, even to human sacrifice: Truth has *absolutely nothing* to fear, and thus it *can* tolerate, yet *expose* untruth in others, secure in the Truth of itself. The latter should never permit themselves to respond even remotely in kind, thus resurrecting a most ugly past. Nor should they treat with equal contempt those "uncritical masses", at whose expense they find "solutions" to non-existing problems, or supposedly solve a legitimate problem by replacing it with a score of worse ones, to the point of readying to incinerate the Planet in order to solve, once and for all, all those self-inflicted problems. It is thus that we have brought upon ourselves the anti-scientific backlash of the "common man". The human cause cannot be served by replacing an old arrogant priesthood with a new equally arrogant one. Priesthood is nothing if not servanthood. It is because of this dual withdrawal of the common man, from both theistic religion and science, both of which have failed him in his all too human aspirations, that he falls victim to such pitiful fads or follows the first charlatan on the scene, and having found no solace, turns into being indifferent, self-centered, cynical, disorderly, terroristic, nihilistic.

From this dual catastrophe, the "morality of the expediency of the moment", which is the current nom-de-plume of the religion of atheism as it is officially being practiced, is no salvation at all, as it is evident to all but the practitioners of the momentarily expedient. It should be considered as being suicidal for science to throw its lot with this "new" morality: Science is nothing if not the study of order in Nature, presupposing the existence of laws seeing to that order. As any gambler can tell, pure chance does not bring steady gains! Nor does the absence of laws *in Nature* bring about the order, the study of which is the objective of science. The morality of the momentarily expedient recognizes no laws, far less laws capable of establishing anything akin to the order recognized by science. Nor, *of course,* does this new morality have anything at all to do with the Truth, the ultimate objective of science. It follows that, science cannot gain anything by marrying itself off to the momentarily expedient.

If there is a lesson to be learned from all of this, and there certainly is a huge lesson to be learned, it is that science, for its own sake, must recognize its own true interests: And those are not simply "doing science ad infinitum". Science is *not* the study of infinite reflections of itself, for if so, there is no truth in it, only, perhaps, the *appearance* of truth. Thus if science believes in itself enough to go after the Truth, if it believes itself secure in the belief that it does not deceive it self into pursuing self-produced phantasmata, it must recognize that there is in-

deed an end to all studying, and that end cannot be at the infinity of self-reflected images. The study of Nature must thus eventually come to face up to the "Problem of First Cause". This may sound overly religious, and in fact it is! Yet, it is no less at the very core of science finally free of delusions! It is the essence of Truth to be one and whole and the same forever, no matter how it is arrived at. In this, then, there is a clear and present need that we change our attitude.

But not only must our attitude change; we must also take a very long and a very hard look at the record *without* preconceptions or bias, and *without* the philosophical and ostensibly scientific, yet in truth, (anti)-(crypto)-religious prejudices of centuries past. To give an example, what hard proof is really there that the Laplacian view, the hypothesis that the entire world started with a tenuous gas filling the void, which we now call "the primordial soup" is the correct view? If we are to be honest with ourselves, as we *must*, we *must* recognize that no such proof has ever been offered, and that our adherence to such belief is only based upon the senseless and indiscriminate repetition of the notion, repetition that somewhere along the way dropped all qualifiers and suppositions and thus made a "proven fact" out of a mere hypothesis, without ever bothering with a proof, and buried it under successive layers of similarly "proven facts".

If the examination of the record shows that it did indeed take Wisdom to make the world, science must do two things: First, accept the finding as an integral part of the scientific Truth, for neither hiding it, however careful and secure such hiding may be, nor the vehemence of obstinate rejection, however concerted such rejection may be, can change by one iota the nature of the World or the body of the objective Truth; and second, proclaim the finding as the absolutely greatest scientific finding of all time, for no other finding can in principle be greater.

At a time when much gray matter, effort and expense have already been spent on communicating with other galactic, or even extra-galactic intelligence, by shooting towards the stars our latest hieroglyphics, only hoping to receive an equally undecipherable answer in several thousands (or tens of thousands? or maybe millions?) of years, it is only natural to submit that science has grievously failed to do the obvious: examine the record to obtain once and for all the answers to some much more important questions: whether this world is the child of Intelligence or of chance, whether Intelligence is with God and, therefore, primary and the cause of all that exists, or secondary and the effect of the purest and most senseless and purposeless chance imaginable; whether Wisdom is an objective that really exists and is attainable by Man, or whether he is forever lost without a compass in the abyss of absolute nonsense, chasing after his own utopian dreams.

Twenty four centuries ago, the two greatest intellects that ever lined, Socrates and Plato, had no difficulty siding with God, for they saw Λόγον namely Reason (Cause, as well as, Purpose) everywhere about them, despite the absence in their day of "hard scientific facts". Much later, Man sank into the Dark Ages, tried to lighten his darkness in the light of human torches, and re-emerged during the pseudo-Renaissance deficient in the most crucial respect. Without realizing his deficiency, he proceeded into the Age of Reason and of Science, though nei-

ther Socrates and Plato, nor, indeed, Aristotle, as the reputed "father" of logic, would have recognized much Reason or Science, pegged as they became to, and prisoner of, the information (whether real or illusory does not seem to be bothering him very much!) fed by the sensory organs to the brain. In our time, sensory experience is ruling the way of general thinking. And because of this, and despite the accumulation of "hard scientific data", Man still is not quite conscious of the nature of his deficiency, though he never for a moment ceases to feel it. For from the time Greek ceased to be the language of the learned, Man lost his Λόγον and with it his Spirit. "Reason" now could become quite illogical, and "logics" could be discovered that were totally unreasonable. "Causes" could be claimed that had no purpose, and "purposes" that were never willed. The natural flow from cause to purpose (effect) was allowed to lose totally its orientation. Having lost his Λόγον, he has truly lost his Reason despite all counter claims, and thus he has been left totally and abysmally alone. And being without Reason himself, he does not recognize it anywhere else either! Never before did he become so preoccupied with the many aspects of "Law and Order", as he is doing at the present time; and yet, never before did he accept the absolute supremacy of chance over Reason, as much as he does today allegedly on scientific grounds! As if chance alone can ever beget sustained Law and Order! And like Thomas the Disciple, he wants to put his finger upon the mark of the nails, to be persuaded that there is indeed Reason everywhere about him! (And so he shall be!).

III

The ideas outlined above, though finally crystallized in the particular form in which they were just presented after the main body of this work was practically complete, were nevertheless a small part of the much wider concept of "Faith and Reason", on which I had resolved many years ago to write a monograph. It soon became evident that the advantages and disadvantages of the scientific method and of science itself had to be tackled extensively within that context. It was for this reason that I, a "non-expert" in the matters that I am about to discuss, decided to brush up yet *critically*, starting in the Spring of 1974, on a few subjects of general physics, gravitation, cosmology, etc. Very soon I stumbled upon "the stone that the builders had rejected", though it was the very cornerstone of the entire edifice and had been known to us all since Newton announced his famous findings to the Royal Society in 1683.

Slowly and painfully did I start to build upon that cornerstone, casting and recasting in the mind and on the paper the ideas, trying to obtain the solution that would answer the greatest number of questions with the greatest economy of first principles, and resolving in the process my personal misgivings that I had had for many years regarding the current interpretation of raw scientific findings. How well I succeeded, it is now to be judged. Only the findings of my personal pursuit of wisdom through the exact sciences will be recounted in this volume; the much wider concept of "Faith and Reason" will have to wait.

About the obvious errors contained in this work, I have no fear. But I trem-

ble at the thought that despite my efforts, serious hidden errors may have entered the pages of this work, errors that will hinder rather than facilitate the human pursuit of wisdom by obscuring rather than clarifying the truth about reality. But unless all my findings are totally wrong, which should be obvious rather than hidden, I feel that further progress in the pursuit of wisdom through the exact sciences *cannot* be made without *full* use of what is basically correct from among my findings. It is for this reason that I make this work public. That, in the process, I expose myself to the criticisms of the "experts", it cannot be helped; the prospect of gain for Man is a much greater consideration for me than a possible personal rebuke by the "experts". I only wish that all others, rather than avoiding to face the issues, had been and shall be just as circumspect, stopping to hide in silence behind unjustly respected titles.

Yet, this volume is not addressed only to them, but to all those who can build concretely upon logical premises and arguments, for we all expert and non-expert alike have this in common: logic, on the basis of which we can communicate at all. Although some knowledge of the current scientific status is necessary, that knowledge need not be that of the experts. I have tried to establish on all occasions the premises and the arguments as clearly as I could, so that it be clear how I arrived at my conclusions. In many cases, this approach may appear to be quite unnecessary. I will be the first to rejoice on learning that this will have been really unnecessary to *all* my readers. It has not been always unnecessary to me!

As this work was performed in "free" time, my deepest appreciation belongs to my wife, who bore with me patiently during the endless silent evenings, the silent dinners, the late nights, and suffered, worst of all, the bursts of my irritability, when the work was stalling as it so very often did. Her patience, encouragement and expectation have been especially heavy liabilities. Without her, this work may well have never been possible.

PART ONE

INTRODUCTION

1.1

ON THE THERMODYNAMICS OF THE EXPANDING UNIVERSE*

Thermodynamics is probably the empirical science of most sweeping generality, and has already been used (whether correctly or not is another matter) to make general statements about the state of the Universe, past and future. The formulation of its first and second "laws" has with time shifted towards the more general, perhaps in an attempt to show how generally applicable thermodynamics is. This may already have gone too far, but at any rate there is no question that thermodynamics offers an excellent tool for handling some of the basic questions about the Universe. Perhaps, when the Universe was still believed to be static and infinite, one might have had no reason to question whether or not the premises of classical thermodynamics held to the "entire" Universe. No longer! The Universe is now believed to be finite and expanding. The question of whether or not those premises still apply to this "new" Universe is no longer closed, or if it is, we *must* reopen it. No other justification need be given than simply drawing attention to the fact that basic to classical thermodynamics is the notion of equilibrium which is a state an expanding universe is generally very far from.

Among the physical laws, the so-called "laws" of thermodynamics hold a very special place: They are totally *empirical* in nature and no exceptions from them have so far been found. Also, they have not so far been attributed to some other even more fundamental laws of Nature. These statements need some clarification.

To start from the last statement, one may well wonder as to the exact nature and number of the truly fundamental and mutually independent (of each other, as logical statements, in the sense that one such statement in no way implies another such statement) laws of Nature, which together comprise the Least Set of such laws, and to which all other known laws can be demonstrated to be adducible as special cases, theorems, corollaries etc. Study of this important scientific and philosophical issue has not even begun. With regard to such a set, where do the "laws" of thermodynamics stand? Are they members of the Set, or are they derivative *from laws of* the Set? At the presently accepted stage of our knowledge, no certain answer can be given.

Now, exactly because the "laws" of thermodynamics are totally empirical (that is, conclusions based on "experience") one may *not* assume that they apply to the Universe as a whole. Such an assumption is a risky one that deserves to be

* In this work, an effort will be made to distinguish between the actual Universe and the concept. Only the former will be capitalized.

investigated in its own right, before it can be used as a basis for further argumentation. The reason, obviously has to do with the indisputable fact that we have never in "any way, shape or form" "experienced" the Universe as a whole in any sense compatible with the empirical premises of thermodynamics. The statement that shall be made below to the effect that an expanding Universe does not conserve its energy and the analysis of that statement must be seen in light of our present inability to make sweeping generalizations of *applicability* of the "laws" of thermodynamics to the entire Universe. An earlier version of this text omitted discussion of the details discussed here and drew the fire of reviewers. As their identities are mostly unknown to the author, he can only say that they could not have been thermodynamicists and have misunderstood the significance of the totally empirical basis of thermodynamics as a discipline. Because, it is no accident that the first studies and principles of thermodynamics were, respectively, conducted and developed by engineers. The roots of thermodynamics in the engineering disciplines must not be permitted to be overshadowed by the later development of thermodynamics as a theory. This has already happened in certain quarters, if one can judge from the reviewers' comments, where the "laws" of thermodynamics have already been accepted as truly basic and forever unalterable verities! The fact that conclusions based on experience are subject to revision in light of later experience, specifically in view of the rapid advance of technology and the inexorable though slower advance of physical theory, seems to have been lost.

Strictly, the "laws" of thermodynamics are part of classical or equilibrium thermodynamics. Non-equilibrium thermodynamics is the extension of thermodynamical theory to situations away from equilibrium, in which extension, the "laws" of equilibrium thermodynamics continue to be fundamental premises. So, basic in all of thermodynamics is the notion of equilibrium. But equilibrium, which is understood to mean the state of absolute "rest" of a system at which none of its properties undergoes temporal variation, *is only an abstraction and an assumption*. *It is* an abstraction because nobody has ever been able to observe a system in true equilibrium. The quantum-mechanical concept of disturbance resulting even from the act of "observation" is certainly correct. Even the most "innocuous" observation involves the transition between two states, at best two equilibrium states: direct observation of a single equilibrium state is not possible. In light of this consideration, the notion of equilibrium for macroscopic systems, which constitute the realm of classical thermodynamics, has been softened to allow variation of the microscopic quantities comprising the macroscopic system, as long as such variation fluctuates more or less evenly about a statistical average value that itself remains time-invariant. And *it is* an assumption because nobody has observed any system with sufficient sensitivity and for a sufficiently long period of time to say with some legitimacy that long-term time-invariance is a fact. As specifically applies to the first "law", the conservation of energy, its unqualified formulation extends far beyond the sensitivity of measurement, because even today we do not have sufficient sensitivity to demonstrate true time-invariance. Under the notions of relativity, conservation of energy is tied to the invari-

ability of the velocity of light, but even that is not known to better than ±100 m/sec. True time-invariance means a relative variation of $\pm 10^{-\infty}$, clearly beyond our ability ever to observe! So, the notion of "law" must only be understood in the sense that no exceptions have *yet* been found, under our present experimental capabilities, but in light of our inability to demonstrate true time-invariance, the "law" is definitely a soft one and as a general statement it must never be construed to imply more than the term "principle", the absolute verity or falsity of which is never at issue in a subsequent discussion *premised upon it*. Even the entire system of thought, as we have constructed upon the *principle* of conservation of energy, cannot strengthen the basic weakness of the premise itself.

In writing their specifications or reporting their experimental findings, engineers and experimental scientists are careful to include a statement regarding the maximum permissible error or the estimate of uncertainty in measurement, because they know that errors and uncertainty in measurement are unavoidable facts of life in the world of experience. Their central statement is not strengthened but weakened by the absence of the qualifying statement, because in that world, absence of the latter is rightly regarded as a good indication of careless or inadequate work. Thus, as a statement of experience, the statement of the "law" of conservation of energy *must* include a statement of the estimate of uncertainty, for *only within the limits of certainty* has it been experimentally established as true. Without such a statement, the simple general statement that energy is conserved ceases to be a hard fact of experience and becomes more a hypothesis upon which theoreticians may built an entire theory. But the world of reality, the physical Universe, does not have to obey the human theory, but only its own preestablished laws, from the reality of which the facts of experience have been extracted. So great has the distance between experimental and theoretical thermodynamics become, that it is entirely possible to make statements in full accord with the former and full discord with the latter. In fact, this work will show that the laws of Nature fall inside the gap!

Now, on to the main subject: For our purposes, the Universe is defined to contain *all* existing matter and energy at any given time. It shall be shown below that if it expands and obeys the second law of thermodynamics, it expands unendingly and does not obey the first law, it does not conserve its energy.

The definition of the Universe just given implies that the Universe is perfectly closed in the sense that there is nothing physical outside it. Its total energy consists only of its internal energy. Its expansion is performed against its own gravitational self-attraction, totally adiabatically, at the expense of its internal energy, which is thus gradually reduced. If the Universe expands *unendingly,* ipso facto, its expansion *is* a basic law. In such a case, the Universe consumes unendingly its internal energy, which it shall never regain: After infinite time, its gravitational self-attraction will have been reduced to zero, its internal energy will have been brought to zero, the Universe will have cooled to 0°K. In an unendingly expanding Universe, the state of infinite expansion, the state of zero internal energy and the state of zero absolute temperature are identical. Now that the Universe is widely believed to be expanding, the important question has al-

ready become: "is our Universe expanding unendingly?" In light of the statements just made, the question acquires additional importance.

In cosmological circles, it is believed today that the question of unending or reversing expansion depends only on the value of the average density, in the sense that if it exceeds a certain critical value, the Universe will re-collapse upon itself. Careful consideration of the facts shows that this is an *insufficient* criterion. The question of radial distribution of matter and the dependence of the velocity of expansion on time may *not* be overlooked in this regard. As regards the distribution of matter, it is believed today that it is uniform throughout. But in reality, this is only a remnant of the old conception of the Universe as static and infinite. An expanding finite Universe need not have a uniform distribution, and as it shall be shown later in this work, a non-uniform distribution of matter can still result in a picture of near-uniform distribution for a not-too-far-off-central observer. The question of a uniform distribution may *not* be accepted aprioristically as is done today; it has to be considered in full view of its causes and effects. The question of the "present" velocity of expansion and its dependence on time is also undecided. True, the most distant objects in the Universe are "seen" to flee away from us at a very large fraction of the velocity of light, but this statement is deceptively simple: Hidden in it are assumptions the validity of which is by no means certain. Most telling of all is the question of whether or not light itself is an integral part of the Universe. For if it is, and the Universe eventually re-collapses, it too must eventually come to a halt and then begin to retrace its steps backwards, in full contravention of the fundamental premise of special relatively that the velocity of light is constant. To speak of re-collapse in terms only of galaxies, to the total neglect of light itself, is too simplistic a picture of the Universe to be regarded as serious. If the above premise of relativity is to be adhered to, and light is regarded as an integral part of the Universe, the theory itself has already decided the issue: the Universe is expanding forever! So, one cannot adhere to the theory and also regard the question of re-collapse as still open. A choice has to be made: If one chooses to regard the question of re-collapse as still open, one in effect tables the issue of the validity of relativity as a proposition of universal significance; without realizing it, one in effect asks for the time-dependence of the velocity of light! Our definition of the Universe as given above, on which the present discussion and the present work in its entirety are based, *includes* light, since the latter is correctly regarded as energy. *Only such* all-inclusiveness is logically valid.

To the questions, therefore, being asked here, in the way they are being asked, current theory, including thermodynamic theory, cannot be regarded already to have provided any satisfactory answers. The question of re-collapse may no longer be examined solely under the *assumption* of the universal validity of the first law. It must also be examined in light of the second law that alone deals with the fundamental issue of reversibility, fundamental both as a thermodynamic issue, practical and theoretical, and as the *central* issue of re-collapse.

According to the second law, whereas all "higher" forms of energy can be converted to heat with a 100% efficiency, the reverse is not true. Conversion of

heat to "higher" forms of energy is only partial. The difference is rejected as a *still* "*lower*" form of heat into the low temperature heat reservoir. As handled by the second law, the "system" is totally separate from the reservoirs. If the second law is to apply to the Universe as a whole, the latter can only correspond to the "system". The notion of system and reservoirs comprising a single system is foreign to the second law. It is immediately obvious that the second law is not well adapted to handle the question of the Universe as a whole, where the reservoirs of heat must somehow be included in it. Because the reservoirs as used in the context of the second law are only reservoirs of heat, it is possible to regard the internal energy as the high reservoir, in the sense that the conversion of internal energy supplies the heat at a near-constant (as a first approximation, for a not-too-long period of time) rate, thereby maintaining a near-constant (under the assumptions) high temperature. The question of the low temperature reservoir is a great deal more difficult. The discharge of heat into it cannot be "internal", because there only higher forms of energy, not heat per se, are stored, and such transfer must involve an additional engine to do this extra work, and so on in an infinite regression, which is *not* implicit in the second law. The only other alternative is to regard the low reservoir as "external" to the Universe! The obvious contradiction can only be avoided if the latter is accepted as expanding, thereby itself providing the "external" reservoir. Regardless of the exact resolution of these difficult issues, there is no question that universal expansion converts higher energy to heat and a complete reversal of the expansion must involve a 100% conversion of all the heat generated and spread out during the phase of expansion back to work. Under the second law, this is impossible for *two* reasons: (a) The law forbids the existence of naturally reversible systems. (b) Even theoretical reversibility, essentially very close to equilibrium, is less than 100% efficient. In the very least, if, (as seems reasonable, indeed obligatory under our definition of the Universe as including light), the Universe (its front for sure) expands with the velocity of light, it is certainly nowhere near equilibrium. Thus, there can be no question that a universe, expanding as our Universe must be doing under the definition we gave for it, to which the second law applies as already understood, is not a place where universal expansion can be reversed. If its expansion cannot be reversed, the Universe is expanding unendingly and its internal energy is not conserved, as already shown above. If the Universe proved to be reversible, that would be a first, in the sense that the Universe as a whole would be the only natural process that would be reversible to 100% in *double* contravention to the second law. Thus, either the Universe expands unendingly and the second law holds while the first law collapses, or the Universe will effect its own re-collapse collapsing the second law but holding up the first. Fundamental in this whole argumentation is the realization that the notions developed under the abstraction-assumption of equilibrium are not transferable intact to the farthest extreme from equilibrium, where the Universe, as defined, must be regarded as located at any one moment.

How far from equilibrium as used in thermodynamics the Universe really is can easily be seen by the following: In strict thermodynamical terms, a process is said to be reversible if it can be reversed by an infinitesimal change in the op-

posite direction. Applied to the whole Universe, this implies that a man's walking up rather than down the street is sufficient to initiate universal re-collapse!

The above discussion is doubtless shocking in light of the general acceptance of the two unqualified laws of thermodynamics as physical facts. To satisfy oneself that things are not as above concluded, one must look for processes that can show the preservation of the two laws in the universal scale. The processes of the pendulum and of the vibrating spring come to mind. To maintain the first process, an outside attracting-reference mass is required. The Universe under our definition cannot have an outside reference. The process of the spring avoids this problem: the restoring force is its own internal tension. It must be realized, however, that in *all* physical pendula and springs, conversion of kinetic energy to potential and vice versa is not eternal: a penalty is always paid as "higher" energy degrades to heat, which becomes unavailable to the subsequent spontaneous maintenance of the process. The processes of a not-too-powerful explosion producing fragments that eventually re-collapse and of hyperbolic flight have been advanced as examples supposedly proving the conservation of energy. Implicit in the former process is the gravitational field of the Earth, an outside body. In that sense, that process is no different from the process of the pendulum. The process would indeed be a valid demonstration of the validity of the first law if it could result in the re-collapse of the explosion fragments to their exact original state, in the absence of *all* external fields! Either a hand-grenade or an atomic bomb or anything in between or beyond must on its own reform after the explosion its original state, light and heat included! We, have no experience of such event! The process of hyperbolic flight, either natural or man-made as an injected motion, to be truly hyperbolic, must include the ultimate points at infinity, whence it should on its own bounce back. A hyperbolic flight excluding infinity must somehow be reflected on "mirrors" and not lose energy to them! We know of no such flights! The quadratic equations of motion can indeed be written under energy conservation, but in themselves they do not prove the existence of exact reversible motion in the real world. The question of whether the trajectories predicted under energy conservation are being periodically retraced exactly, and not approximately for some period of time, in the real world *cannot* be settled by argument premised on the first law, but only by *meticulous* measurement, still beyond our present capabilities. The recently verified increase in the Earth-Moon distance proves that the orbit of the Moon as referenced to the Earth is *not* an exact ellipse, not even in the short-term. So, not even the most accurately known "elliptical" natural motion can be produced as an example of natural motion tracing the quadratic path predicted under energy conservation.

To return to the consideration of the Universe and to the question of the sufficiency of the value of density to effect closure, one may remark that an observer of a sufficiently remote past, when the expanding Universe had a density higher than the so-called critical value, which according to current opinion suffices to effect closure, should have had no difficulty concluding that the Universe *will* some day re-collapse, *if* that were a sufficient criterion. But such density has *not* been observed! One may thus ask: why is the issue still open? This issue is tightly con-

nected to the even more serious problem of how precisely (a question of *exact mechanism*) and why (a question of *cause*) could the Universe ever have exploded, if it contains sufficient mass as eventually to re-collapse. These questions have found no answers in the context of present theory, but unless they too are answered, neither an eternal expansion-contraction nor a single cycle of such a process can be accepted as being the fate of the Universe.

To avoid a conflict, as presented above, between the first and the second laws of thermodynamics, it is necessary for the Universe to possess reserves of energy that it cannot consume in the process of expansion, reserves that are not subject to the second law, reserves that it eventually can draw upon to regain precisely the energy lost in the expansion, and not a bit more or a bit less. Such energy reserves are neither known nor suspected to exist. Nor does the Universe demonstrate in any way that it possesses some memory of the precise amount of the energy lost in the expansion.

It thus appears unavoidable that, as regards the entire expanding Universe, the first and second laws of thermodynamics are mutually exclusive. Application of the second law vitiates the first, and acceptance of the first negates the second. If the Universe is governed by the same set of laws from end to end and this conflict is true, it must carry through to all processes in the Universe, including the ordinary processes. If so, the two laws, assumed to apply with equal force to ordinary processes at least, *cannot* both be true. Thermodynamic theory will have to be amended and returned to its experimentally defined bounds.

The question of whether or not the Universe can ultimately re-collapse must be considered in conjunction with the *entire* set of universal laws now in effect, and with the possibility of their own reversibility. Universal contraction may well, and perhaps must, require an altogether different set of universal laws. Take, for example, the spontaneous expansion of gases. It is inconceivable that the expansion of the Universe and the expansion of gases are two totally different and totally unlinked processes, that they are not in effect but one process. One can conceive of two different bodies tied up gravitationally to form a "stable" binary system. Even ignoring the question of increasing separation between them due to the universal expansion, each of the two bodies can and does also attempt to establish equilibrium with its own vapor. A sufficiently high vacuum will ultimately cause either one or both bodies to evaporate or sublime, no matter what its (their) temperature may be, even if only slightly above 0°K, thereby loosening and ultimately destroying the bond of the binary. The solar wind is sufficient evidence of evaporation of a stellar body, and it can, and it certainly is more accurate to, be interpreted as due to the vapor pressure of the Sun. Just as the spon taneous expansion of gases in the above case of the binary is instrumental in its ultimate destruction, so the solar wind, in its widest sense, may continue to "blow" until the entire Sun evaporates and diffuses totally into space. The case of universal expansion may well be fundamentally similar. If so, reversal of the expansion must entail a spontaneous contraction of ordinary gases, a process impossible even to conceive under the universal laws now in effect! We must conclude that the present laws do not allow universal contraction.

The arguments presented above, if correct, *are* very upsetting. Perhaps, no theory is regarded today as more secure than thermodynamic theory. If the latter is *in fact* shown to be premised on physically erroneous assumptions, no other theory, presently subscribed to, will manage to avoid revision. The issues raised here are sufficiently momentous to warrant a closer look. In the very least, they have succeeded in drawing attention to the need to begin thinking in terms of a minimal set of universal laws from which all other physical laws flow in a logically and physically consistent manner. That minimal set not only must set the qualitative "tone" of the Universe, it must also include *sufficient* quantitative information to decide *in the fullest* the course of *all* physical events. The "laws" of thermodynamics are more of a qualitative nature, and if also truly in conflict, *they cannot both in their present form* be members of the minimal set.

Arguments premised upon untested hypotheses and principles accepted a priori, *may not* be used to refute the conclusions already reached. A proper answer, affirming or refuting, can only be given in the context of a minimal set of physical laws *already operating in the real world.* Before proceeding further in search of such a set, it is necessary to stop and examine some other currently accepted principles.

1.2

CONCEPTION AND OBJECTIVITY OF PHYSICAL REALITY

So far, the great efforts made to understand the workings of the Universe as a whole have been based on understanding the workings of its parts, from elementary particles to clusters of galaxies. These efforts have resulted in theories of which none, however, has overwhelmingly been accepted or in any way proven to the satisfaction of all experts. Included in such theories are statements regarding the properties and geometry of the Universe, statements which are more philosophical in nature than scientific. For example, one such statement is the cosmological principle, namely, that "the Universe has the same general characteristics as observed from any point at any given time". Another states that the Universe is both finite and unbounded. A third statement holds that the Universe is of the same infinite size at all times. It is not clear at all whether such, and which, statements are logically compatible with each other and with established knowledge (to be distinguished from theory-laden "facts"), or whether they facilitate rather than inhibit a complete understanding of the universal processes. For example, if the Universe were non-expanding and started with a gas which occupied all the universal space evenly, its density should have been so small (see below) as to render the very idea of the big bang incomprehensible, even ignoring the fact that the gas under those conditions should have been at equilibrium, out of which it could not come by itself. On the other hand, if the primordial gas occupied the universal space unevenly, its tendency should have been to disperse evenly everywhere according to the laws of gases, and not to produce a big bang, which is seen as the generator of gravitational instability in the gas, and not as the result of a preexisting instability.

Statements such as those mentioned above (which, above, were treated only indicatively) are designed to extricate us from some such questions as to what lies beyond the limits of a limited universe. The steady-state theory, in addition, would extricate us from having to answer questions as to the before or after the present day Universe, and possibly from conflicts arising from fundamental statements such as those indicated in the previous paragraph. We appear to have been committed to the philosophical belief that there is no beyond, before or after and that questions about these are meaningless, and we forget that such a priori commitment is patently unscientific. In fact, questions as to the beyond, before or after any physical quantity are neither philosophically, nor intellectually meaningless; they are eminently meaningful, though perhaps premature. On

the contrary, it is intellectually and scientifically unacceptable to define such questions as meaningless and to restrict thereby the scope of our search. Science cannot arrive at its proclaimed purpose, the Truth, by limiting itself and by incorporating in its logic possibly unjustified answers to premature questions, questions and answers that had already been formulated within the framework of philosophies of centuries past. In this chapter, we shall see how science has been and still is compromised by poor philosophy.

Until the end of the nineteenth century, the physical Universe was believed to be certain, unambiguous, predictable, and that the remaining uncertainties were all due to the imperfections of the measuring technique used. But by then, the refinement of measurements had been improved and certain effects, undetected before, made themselves apparent. This led to the development of the theory of relativity and the quantum theory of matter. The double effect of these two theories on the scientist's conception of the physical world was that, the Universe was (a) no longer to be regarded as simple as it had been before, for according to the special theory of relativity, space and time were neither fundamentally different nor in principle separable from each other, and according to the general theory, not even separable from matter; and (b) not quite as determinate as it had been before, because according to Heisenberg's uncertainty principle, even the simplest act of observation changes the state of the system observed thereby establishing a limit beyond which nothing logical can be said or even conceived. As a result, what had been considered before to be simple physical laws were no longer as simple, as more and more effects had to be accounted for in any single observation and included in the same single mathematical expression. The great development of physics, both theoretical and experimental, that followed, produced theories and theory-laden "data" and "facts" that appear to be too many and too intricate for their own good. It is asked seriously whether one can avoid "proving" any theory at all, or whether any theory at all can ever be disproven when "data" can always be produced in its support.

For the reasons discussed in the first chapter of this introduction, the most disconcerting piece of additional information about the physical Universe is that it expands. Yet, the universal expansion is still so exoteric that no formal theory has yet been developed to account for it. That an unendingly expanding universe seems to drive a wedge between the two laws of thermodynamics does not seem to have been publicly acknowledged. That under a law of expansion of sweeping generality, no length and no velocity (including, say, the diameters of the proton and the electron, and even the velocity of light itself*) can possibly remain time-invariable does not seem to have been publicly acknowledged either. It is said that under the principle of general relativity, universal expansion is indeed permitted. A sweeping law of universal expansion should not have failed to be included even in the equations of special relativity. The reduction from the general to the special case does not allow a sweeping law of expansion to be ignored. Nor can, of course, the quantum theory of matter escape the consequences of such a law.

* If this point is not quite clear to the reader, it is only because I must run somewhat ahead of myself. He is asked to be patient for a while.

Despite concerted efforts to bridge the two great theories of modern physics, and hopefully all other theories in between, and all phenomena of some importance, if not *all* physical phenomena, a satisfactory union is not yet in sight, nor even, it is believed, just under the horizon. It now seems to be the right time to enquire as to the probable reasons why this should be so. It seems to be obvious that we are faced here with a dilemma: either the two theories are not *really physical* (as opposed to mathematical and as applicable to Nature) and are, as a result, either both or at least one of them fundamentally incorrect, despite their (its) great success; or the unity of Nature, required to allow the union of the two theories, is not really there. The latter option is one that no scientist can tolerate to entertain. The reason for it is that despite everything, scientists have no reason to doubt in the slightest the absolute concreteness, wholesomeness and rationality of Nature. We are thus forced to pursue the first option of the dilemma.

Heisenberg's uncertainty principle, at the root of current quantum theory, seems to violate the belief of scientists in the concreteness and rationality of Nature, for the indeterminacy involved is seen to be a basic characteristic weakness of Nature rather than a limitation of the human observational and conceptual powers, and as such it presents a fundamental break in the connection between cause and effect. Curiously, this has not retarded at all the pace with which scientists forge ahead towards their goal of ultimate understanding. There is no doubt that the principle involves a logical and philosophical thorn; however, in view of the successes of the theory we so far have preferred not to think about it, hoping that the problem will somehow be resolved when we know more about Nature. Yet, if a choice were demanded of us at this time, what should we choose, the uncertainty principle and the quantum theory *as currently formulated,* or the inviolateness of the connection of cause and effect, meaning that particular actions can *only* produce particular, certain and exact results? There is no doubt that the second would be the better choice. Because, not only does that connection form the very basis upon which all other branches of physics and science in general are based, but also because it was that connection that formed the basis upon which the experiments were designed and the measurements made, upon which the quantum theory was established in the first place! Above all, we must preserve the rationality of our minds, or there can be no science at all.

As a result of a combination of quantum theory and relativity, at least two other points have been confused. The one is the push of particle physics towards the discovery of the ultimate fundamental particle(s). In the process, parts are found that singly or collectively are heavier than the whole of which they are supposed to be parts! Nor is there an end to this kind of "discovery" discernible. If allowed to proceed with bigger and bigger energies, even more glaring absurdities can be expected, for there is no theoretical limit, and ultimately even the entire Universe may be discovered to constitute part of a proton, say: Such "discoveries" are in sharp violation of the rationality of the human mind and have drawn some serious attention. For example, Heisenberg ("The Nature of Elementary Particles", *Physics Today,* March 1976, p. 32-39) in an effort to resolve this obvious antinomy placed the blame squarely on our demand for pictures, on our notion that "pictures are the preconditions of understanding", and on the language

itself that is no longer capable of verbally describing the experimental data. He wrote: "we will have to accept the fact that experimental data on a very large or a very small scale do not necessarily produce pictures, and we must learn to do without them. We then come to recognize that the antinomy... is solved... in a very subtle manner...: The word 'dividing' loses its meaning". And again: "The phrase 'consist of' has a tolerably clear meaning only if the particle can be divided into pieces with a small amount of energy, much smaller than the rest mass of the particle itself". Such pitching of theory against language suggests a grave misunderstanding of the function of language, for the fact remains that language does *nothing* more than communicate the way in which the mind works, and we cannot call the language absurd any more than we can call absurd the regular operational mode of the human mind, in which science itself in its entirety was worked out! Nor can we call the demand for pictures unnecessary or even bothersome. Pictures may not always be preconditions of understanding, but the fact remains that objective reality, by virtue of its very objectivity, *is picturable*. If the particle is objectively real, if its behavior suggests a real internal structure for the particle, then both the particle and its structure (including its component parts) *are picturable*. For the Universe to be ultimately understandable as an objective reality, it is necessary that it be picturable in its ultimate detail. That we cannot come up with a suitable picture can only be due to the fact that we do not really understand the science we perform and create! Here again, we must opt for the rationality of our minds and dismiss the current interpretation of these supposed "facts" that do not seem to be associated with pictures.

The other point of confusion is the duality of the photon. We are told that the photon is both a particle and a wave, that it behaves as if it had mass though it has no mass, that it is a wave though no means of transmission for the wave has been found. We are told that this is the nature of the electromagnetic radiation and that we should not ask any more silly questions*. Here again, the fact remains that if the photon is a natural object containing one or more quanta of energy, by virtue of its very objectivity, *it does have an independent objective nature;* and, therefore, questions about its nature are not silly at all. The effort made to silence the questioners by calling them silly can only be taken as proof of ignorance. In view of our ignorance of the nature of the photon and of how that nature affects its behavior, and in view of our inability to discover a process or even develop a concept by means of which the *perfect* vacuum can transmit radiation (for to call light radiation, to find that it is transmitted in vacuum, and to conclude on the basis of these two that radiation is indeed transmitted in vacuum, is nothing more than a futile game in tautology), it is only logical to revert to Newton's view of the corpuscular nature of light. We have not yet discovered the mass of the photon only because we have no means of detecting masses down to $10^{-\infty}$ grams. Therefore, we may not insist that the photon or any other real particles is or are truly massless. We do not know how a true particle can behave as a wave only because we do not know its nature and its internal structure.

* The use of personal pronouns here (and elsewhere in this work) is only meant to increase the vividness of the discussion and to force home the arguments that would lose much of their power if an impersonal construction were used.

We are told that the photon should not be viewed as anything more than a concept, but we are not told also how concepts (that is human mental constructs) transmit light *in reality*, for light is certainly not a figment of the human imagination! Calling the photon a concept is perhaps excusable; but certainly calling the electron also a concept is not, for we have measured its mass and carried physical experiments upon it. Concepts *cannot* be experimented upon, at least *not* in the fashion of physics! The electron is a real particle and it also behaves like a wave. Why can the photon not do the same? Moreover, a massive projectile *needs no means of transmission*; the vacuum is just the *perfect* medium of delivery for a projectile!

We are told that mass and energy are fundamentally the "same", or rather two different aspects of the same natural reality. The fact remains that they are not the same at all, especially in an expanding universe. Because under a universal law of expansion, the velocity of light *cannot* remain constant, and as a result, the same mass is associated with different energies as the velocity of light changes, as we shall see later.

Certainly, Nature does not consist of concepts, nor are natural operations mere rearrangements and interactions of concepts. We *must* see the particles, the photon, the electron, etc., as *true* particles, and as such necessarily as being massive, or we simply contradict the rationality of the human mind upon which rationality we try to build our sciences.

What prompted Einstein to the development of his general theory were also the cosmological difficulties which others before him, but he most of all, believed to derive from Newtonian mechanics. Newton's law of gravitation is considered to be part of his system of mechanics, though it (the law) does not follow directly from the system but rather is appended to it as an additional hypothesis* (A. Einstein: "*Relativity*", Crown Publishers, New York, 1961, p. 102). In discussing those difficulties, Einstein (loc. cit. 105-107) rejected the introduction of ad hoc laws designed especially in such a way as to overcome those difficulties, for, in his words, "we purchase our emancipation from the fundamental difficulties at the cost of a modification and complication of Newton's law which has neither empirical nor theoretical foundation. We can imagine innumerable laws which would serve the same purpose, without our being able to state a reason why one of them is to be preferred to the others; for any one of these laws would be founded just as little on more general theoretical principles as is the law of Newton". Evidently, Einstein did not consider his own theory of relativity to be just another such law! This, no doubt, must have been so, because he believed the cosmological difficulties of Newton's law to be real, and his own theory to be intrinsically superior to all other theories, as well as capable of overcoming all cosmological difficulties.

And here, we come to a point of great confusion that we must try to clear before proceeding further. It is evident from the above excerpt, as well as from the writings of many other contemporary scientists (undoubtedly, as a result of the revolution in physics brought about by relativity and quantum mechanics), that

* If only all hypotheses were as concrete as Newton's Law of Gravitation!

the "law" is considered widely as a human mental construct, especially when it appears to be derivable from certain more or less arbitrary mathematical principles, on the basis of which, a theory, such as Newton's theory of classical mechanics, containing the law in question, is developed. But, if the law is just another human mental construct not unlike Hamlet or Oedipus Rex, a view that Bronowski ("A *Sense of the Future*", MIT Press, 1977, p. 16-21 etc.) took many pains to put forth; if all such "laws in turn are held together by such mental concepts, such creations of the human mind as gravitation", and the facts of Nature are "endless chaos" without the organizational faculty of the human mind; and if the order in which such facts are arranged in the human mind is only due to its conceived laws and theories (J. Bronowski: loc. cit. p. 255) and is nowhere else to be found but only in the human mind; one is perfectly justified in wondering why it is the laws and theories of the scientists rather than the creations of the playwrights that explain Nature better. It is evident that for this to be so, there must be some *real connection* between the scientific mental constructs and the objective reality which scientists study; it is necessary for Nature to be organized and be ultimately understandable in terms of rules and laws that exist in it *objectively,* to which the human mental constructs strive to approximate; it is necessary that the "law" be not only a human mental construct but also a *Physical (natural) Law* totally distinct and separate from all human activity. (Nature has after all existed long before Man and is considered by scientists to have behaved "*uniformly*", meaning that there were laws governing its behavior before the human organizational faculties came along). The human construct is indeed a human creation, but even if it is ultimately adjusted to coincide exactly, one to one, with the natural law, the latter does not become a human creation nor does it lose any on its inalienable objectivity. In promulgating a scientific law (meaning a concept), should man indeed allow himself to be guided by personal values, philosophical views, or even aesthetic preferences just as he does in writing a theatrical play? In so doing, can he really expect agreement between such a law and the objective natural Law to which his own tries to approximate to be any more than fortuitous? Can he really claim discovery, when despite his efforts to dilute the natural Law with his own personal values, the former still shines through? Should he not be humble enough to declare rediscovery very much in the (for lack of a better word) archaeological sense? Einstein, for example, proceeded to construct his theory of relativity because he found it *unacceptable* that there may indeed exist in Nature a certain frame or frames that is or are intrinsically different from the vast majority of other frames. Is Nature obliged to obey a mere human?

Consider the following excerpts from his writings: In his original 1916 paper (see English translation in: Einstein et al., *"The Principle of Relativity"* — A Collection of Original Papers, Dover Publications, 1952, p. 113), Einstein emphatically insisted that "the laws of physics must be of such a nature that they apply to reference systems in any kind of motion". We must note that his 'must' makes sense if the 'laws of physics' are only human mental constructs, of which we can demand whatever we may please. If, on the contrary, by 'laws of physics' we mean the objective natural Laws that we try to approximate and ultimately comprehend, to demand that they do this or that is logically inadmissible to say

the least, for who are we to make such demands upon the laws of Nature? Earlier on the same page, Einstein connected the law of causality to the "world of experience" and he stated that that law has validity only "when *observable facts* ultimately appear as causes and effects" (the stress is his). Elsewhere (A. Einstein: *"Relativity",* Crown Publishers, 1961, p. 60), in explaining his principle of relativity, he stressed the importance of experience. He stated that the principle asserts that "if we formulate the general laws of nature as they are obtained from experience, by making use of .... (two reference bodies), then these general laws of nature … have exactly the same form in both cases. This can also be expressed as follows: For the *physical* description of natural processes, neither of the reference bodies K, K´ is... specially marked out as compared with the other. Unlike the first, this latter statement need not of necessity hold a priori; it is not contained in the conceptions of 'motion' and 'reference body' and derivable from them; only *experience* can decide as to its correctness or incorrectness". Note again his stress on 'physical' and 'experience'. The comments made above on his 'must' have equal validity for his 'general laws of nature' and his 'physical'. But very much more important is the fact that Einstein based his postulate of relativity upon the ultimate test and validity of experience; he never for a moment seems to have doubted that experience (as it applies specifically to the study of Nature) may indeed, to some extent, small or large, be illusory. And thus he never made any allowances, nor did he provide any means, for the elimination of the illusory effects of experience upon his own postulate of relativity. It is, therefore, important to realize that to insist on the validity of the theory of relativity is to insist on the objective correctness and truthfulness of experience as usually perceived and as interpreted by Einstein.

It is known to photographers that film images of the vertical lines of high buildings photographed with an ordinary lens tilted upward are themselves converging upward. To avoid this, special lenses have been developed that allow long vertical lines to be imaged parallel to each other. Einstein's demand that Nature obey the same laws as expressed in (that is, viewed from and experienced in) any frame is precisely equivalent to demanding that a set of mathematical expressions be found that allow the use of vertical parallel and non-parallel lines on the film interchangeably! In the case of a high building, we are lucky to know that its vertical lines do not converge upward, that they are not even parallel, but rather that they converge downward, as in reality they do. But what if the object observed is inaccessible and, one would say, objectively unknowable, exactly like a distant galaxy or a photon, and we have to rely entirely and *solely* upon our experience of it as imaged on "films" obtained under overall conditions (including the conditions of the reference frames and of the process of "picture"-taking) that, unbeknownst to us, *are nevertheless different,* such as necessarily to yield *basically different* images and not different just in appearance? What if two distinct and inaccessible objects are imaged one with parallel vertical lines and the other with converging vertical lines? Are we to assume that they are identical but photographed in different frames? But let us assume that a set of mathematical expressions, like that mentioned above, were finally obtained over the protestations of both Euclid and Riemann, and incorporated in a more encompassing "phys-

ical" theory. Application of that theory would only be good (and even then *questionably* so) for *seeing* the images of reality, and *not* for reality itself; if it did have anything to do with reality, it would almost certainly be fortuitous. For what fundamental assurance can we have that whatever demands we make of the film images will yield the *correct* natural law applicable to the real distant object? If the application of the theory to the two images on the film were to make the Pyramid of Cheops identical to the Parthenon how could that affect the reality of the two objects themselves? Would an architect be able to deliver a thing that *at* one and *the same time was both, the Parthenon and the Pyramid*? Or would he be able to deliver two identical things, one in Athens and the other in Egypt, that would *become* the Parthenon the first, and the Pyramid the second, *simply because of their location?*

On the other hand, the cosmological difficulties that Einstein found in Newton's law of gravitation (loc. cit.) are just nothing more than a matter of personal choice and taste, for there is no reason known to Man why the Universe should be infinite rather than finite, or why the Universe ought not to possess something of the nature of a center, simply because this is a "distasteful conception" (expression of Einstein, *"Relativity",* Crown, p. 107). Knowing the transitoriness of a (any) man's tastes, we may not build a "physical" (meaning here: about Nature) theory based on our tastes.

There is no doubt that Einstein's general theory as a human conception is a creation of great profundity and beauty, but it most certainly is *not* a natural law; if it were to be considered as such, it should certainly have to be judged by Einstein's own criteria (as given in the excerpt given above), and it should have to be rejected on account of the arbitrariness of its assumptions and its extreme generality, on which its beauty as a human creation is based. For if Newton's inverse square law holds to the ends of the Universe (with only minor adjustments, of which later), and is nothing more than a special case of Einstein's theory, there is no doubt that the latter as a theory is greatly over-designed and it possesses neither the simplicity nor the elegance of Newton's law, and as a natural law, is quite unnecessary since it becomes specific to the entire Universe *only* in the special case.

When our present advanced laws and theories, being a mixture of human constructs and natural laws, become incapable of further elucidating the physical world, it is obvious that we must try to remove from them as much as possible of the human arbitrariness. In the case of Newton's and Einstein's mechanics, and in view of the above discussion, this does not mean that Einstein's mechanics must be rejected in favor of Newton's, ostensibly on the grounds that Newton's mechanics is less arbitrary. For even within the framework of classical mechanics there are tacit assumptions that are by no means self-evident as to their correctness. Specifically, standard lengths and time intervals are assumed to be time-invariable. But how are we to compare a rod to itself through time to determine whether or not it is truly time-invariable? It is even more difficult by far, if not impossible in principle, to compare a time interval to itself through time! Nor does the theory of relativity provide an answer to these questions. The possibility of illusion affecting our experience necessarily includes this aspect also,

though it has nothing to do with the limitations of our senses but rather is a basic problem having to do with the ultimate fundamentality of time itself. *Only a concrete and explicit theory, or much better yet, a comprehensive natural Law can provide the answers to* these *questions*.

But if both Newton's and Einstein's mechanics are found to be wanting in this area and are to be set aside as a result, what is to take their place? What, most basic of all, is to become of gravitation? Here, we remember that Newton's law of gravitation was appended to his mechanics as an additional "hypothesis". The question is thus asked: Beyond the limitations of an observer and of his instruments, beyond even the fundamentality of time itself, given two physical bodies is there, or is there not an instantaneous force acting between them, and if there is, how is it to be expressed? To the first question, there is no doubt that the answer must be affirmative. The apple or the Olympic shot falls, precipitates, gravitates. The spring balance testifies as to the force of gravity acting upon the apple or the shot. We now remove the shot from the end of the spring balance, we try to extend the spring to the same length, and we find that it takes force to do so. We conclude that an equal force is necessarily acting upon the ball too. There is nothing mentally constructual about this observation; we *feel* the reality of the force that we apply with our own muscles; the feeling may be inexact quantitatively, but there is absolutely no mistaking its qualitative significance and reality. As to the second question, there is no doubt that *irrespective* of our capability to measure *exactly* the masses or the instantaneous separation of the two bodies, these quantities (masses and separation) are exact. What then is the instantaneous force acting between the two bodies? Newton determined that force to be given by F in

$$F = \frac{Gm_1m_2}{r^2}, \qquad (1)$$

where m_1 and m_2 are their masses, r their instantaneous separation, and G a proportionality constant. Since then, measurement has shown this equation to be correct to a high degree of approximation. Newton indicated that "the cause of gravity is what I do not pretend to know" (R. Besançon: "*Encyclopedia of Physics*" 2nd Edition, Van Nostrand, 1974, p. 558), and since his time, nobody has found the natural cause of gravity. Einstein's attempt to link gravitation to the geometry of spacetime remains a purely theoretical statement. No experiment has been proposed to verify *explicitly* the physical dependence of gravitation upon that geometry. If, according to general relativity, matter itself is inseparable from, and affects spacetime, no such experiment is possible in principle, because gravitation cannot then be separated as the effect and spacetime as the cause of it, and therefore, the verification of the statement is impossible in principle. By Einstein's criterion, we cannot accept his own explanation of gravitation as a statement of reality, but only as an unprovable principle, very much like Euclid's principle of the parallels that is not itself verifiable within the context of Euclidean geometry and is meaningless outside that geometry.

But is Eq. 1 exact? If it is exact, to what is the tiny disagreement with mea-

surement due? Why is the perihelion of Mercury precessing so much? At the present time we cannot state with absolute certainty that all forces acting upon Mercury have been accounted for* nor that they have been accounted for *correctly*. But much more important, it must be realized that *Newton's Law is incomplete, for it says nothing as to the path along which the separation of the two bodies is to be measured. How this is to be done can only be the subject of an additional law*. Newton *assumed,* and we continue to do the same, surely quite *arbitrarily,* that the separation is to be measured along the Euclidean straight line joining the centers of the two bodies. If the entire Universe consisted of only those two bodies, there would be very little doubt indeed that their separation was to be measured along that Euclidean straight line; that path would then automatically suggest itself, and any other path would of necessity be totally arbitrary. But in the *presence* of other bodies this is neither self-evident, nor necessarily correct. Indeed, it is very probable that it is not. If Mercury were somehow stopped on its trajectory around the Sun, it would then be free to fall towards the Sun, but its path would be influenced by the attraction of *all* other celestial bodies and it would not be straight in the Euclidean sense. We know now that even light does not "fall" along a Euclidean straight line, despite the principles and "laws" of geometrical optics. This is so not because it is demanded by the theory of relativity (which as such, that is, as a human mental construct is totally powerless to have an effect upon reality), but because *there is a* natural law to that effect. The possibility thus suggests itself that it is along the actual path of fall that the instantaneous separation of the two bodies "must" be measured. Indeed, in a universe in which Newton's law of gravitation finds *universal application, any path (including a Euclidean straight line path) other than the actual path of fall loses totally its natural significance*. This "must" is not a matter of convention, nor of theoretical speculation. Rather, it is the essence of an additional and distinct natural law that is required to determine *how* Newton's Law is to be applied. As a result of this law, separations introduced into Newton's Law remain naturally meaningful in every case, regardless, that is, of the number of bodies in the Universe. This additional law (we can call it the Law of Separations or the Gravitational Path** Law) fully complements Newton's Law and elevates it from being a simple relationship between any two bodies that *ignores* the rest of the Universe, to being a truly universal law in the sense also that it determines the relationship of the two bodies *in full consideration of the rest of the Universe*. In essence, this is the Mach principle rediscovered. So introduced, however, it is seen as basic, yet, in no way affecting Newton's Law or its consequences. Under this new law, Newton's Law of Gravitation bonds together, and uniquely, the entire Universe: No body in it, however small or large, is left out. Gravitation thus becomes the bond that holds the Universe together and need no longer be considered to depend upon the curvature of spacetime as theorized by Einstein.

* For example, the matter of the oblateness of the Sun is still open, despite early claims of its absence; in view of the oblateness of the Earth, it would be very curious indeed, if the Sun truly had no oblateness at all.

** It would be very surprising indeed if this path were proven to be different from the path of least action. Ultimate elegance and economy demand that the two paths be identical.

Three bodies, in a three-body universe, for the purposes of Euclidean Geometry (which is only an axiomatic mathematical construction without necessary counterpart in Nature), may still be regarded as forming a Euclidean triangle. But for the purposes of Physics, namely, their interactions, natural separations, relative motions and trajectories *in accordance with these two natural laws,* they must be regarded as forming a plane curve-sided triangle (inscribing the Euclidean triangle), the angles of which sum up to less than 180°. As a result, the Sun-Mercury distance in the present Universe is larger than assumed so far, and F (in Eq. 1) is smaller, thereby necessitating an amount of precession in excess of what has been considered so far, under the assumption of straight-lined separations.

In addition, planetary orbits must decay, though certainly very slowly: the kinetic energy is not forever. On the other hand, under a general law of expansion, planetary orbits are not closed but spiraling outwards, and this effect must also be included, specifically because it implies that (a) the gravitational force between *any* two bodies grows weaker as their separation increases and (b) the years of the planets grow longer! Thus, additional corrections must be made, beyond those already carried out, before it can be shown that Newton's Law of Gravitation is incorrect. The current agreement between general relativity and observation on the precession of the perihelion of Mercury is so good that only one additional appreciable effect will be enough to prove the theory wrong: in the very least, the effect of universal expansion has not yet been included. Planetary astronomy will be decisive in showing whether or not the law of the path of gravitation discussed above is objectively there and affects the motions of the planets in essential agreement with observation.

The existence in Nature of the Law of Separations is not only logically necessary as discussed above. Its effects must be seen in the light of Einstein's own discussion of modification of Newton's Law: The Law of Separations modifies *only the value* of separation entering Newton's Law, but leaves Newton's Law itself intact. Without the Law of Separations, agreement between Newton's law and observation can only be obtained by modification of Newton's Law itself. *Any such modification,* regardless of whether it is introduced directly and overtly or indirectly and covertly (as is done by general relativity theory), in effect results in replacing Newton's Law with something like $F = G^{\alpha} m_1^{\beta} m_2^{\gamma}/r^{\delta} + f(?)$. Now, faced with the incontrovertible fact that Newton's original law is obeyed so very nearly, one is constrained to admit that the exponents in the first term of the modified form vary little from their original values, while the second term (whether a constant or a function of unknown parameters) varies little from zero. Using some such modified expression, one could obtain agreement between "law" and observation to any desired degree. However, the cost in simplicity lost would be enormous:

It is not quite enough to obtain a numerical agreement between "law" and observation. We also need to understand the Universe, and this we cannot do unless we *also* understand the full physical significance of all terms and parameters entering Newton's Law or a modification thereof. Presently, we know nothing about the exact form of the term f(?). Even general relativity is not explicit in

this regard, doubtless because an explicit expression of the "force of attraction" is by no means simple. (The issue is only evaded by dismissing the notion of the "force of attraction". The net result of a modification can only be made clear if all "laws" are expressed in the same "language". So, even if we dismiss the notion of the "force of attraction" on the grounds that it is not real, we are still permitted to write, or request writing, the relativistic result in the "unreal" language of the "force of attraction", if only for the sake of direct comparison). On the other hand, modification, however slight, of the exponents changes drastically the nature of interaction of the physical quantities entering the first term, and with it the meaning of all notions entering the science of mechanics. Introducing values for α, β, γ, and δ other than those used in Newton's original law requires corresponding modifications of the expressions relating mass, acceleration, velocity, force, momentum and energy! Thus, no matter how Newton's Law is modified, the result cannot be simple nor our understanding of the Universe facilitated. The alleged simplicity of general relativity relates only to the conciseness of the equations involving second-order differentials. Is this enough? Since the Universe is integral (or else, it could not be "universe") simplicity must relate to the integral and not to the differential equations! The fact remains that general relativity permits an infinity of solutions of its equations and provides no rules as to how to go about choosing the one solution corresponding to *this* Universe. This, we do only through *arbitrary meaning-giving to, and arbitrary normalization* of physical quantities. On the other hand, Newton's Law could hardly be improved upon as to its explicitness and simplicity.

The comparison can only suggest that before abandoning Newton's Law, we will be well advised to exhaust our understanding of how it is to be applied, its scope, its implications. The present discussion has addressed only the first two items: How Newton's Law is to be applied is the subject of the Law of Separations. Under this complementary law, the scope of Newton's Law is indeed universal in the broadest sense possible. The full implications of Newton's Law and its awesome elegance have yet to be appreciated, as the rest of this work will show. If after the whole subject is fully presented and studied, we still decide to reject Newton's Law, we will at least do so with the clear conscience that we gave the simplest possible expression of universal natural law the greatest possible benefit of doubt.

Until then we can regard, if we so desire, Newton's Law and its supporting Law of Separations as a mere working hypothesis. We shall see that it will present us with a great multitude of explicit challenges to disprove it. No more can be asked of a scientific hypothesis.

To summarize then, in this Introduction, we have dealt with some of the most serious problems that modern science is facing, or must bring itself to face and we have tried to uncover some of its logically unwarranted philosophical underpinnings. In the main body of this work, we shall continue to make every effort to steer clear of all human bias and to indicate explicitly all assumptions that we may still have to make in order to bridge the gaps of our ignorance of the operation of the Natural Law. We shall assume that, as written, Eq. 1 represents

the exact natural law of gravitation and we shall search for the overall Design that is the simplest possible and results in a natural and unbiased way in implications totally free of internal contradiction. Examination of those implications will be based primarily on reason and secondarily on observation, warned as we now are that, the latter is not necessarily free of illusions or of the effects of as yet unknown causes, nor its present interpretation free of potentially erroneous theory-laden "facts".

In the end, if all goes well, both the fundamentality of the natural law of gravitation and the elegance of the Design will doubtless become apparent. The profound scientific, cosmological and philosophical significance of the findings of this work will also become obvious and shall be discussed as and when needed.

NOTE ON NEWTON'S LAW

(Not only for the non-mathematically trained Readers!)

In considering the standard expression of Newton's law of gravitation written in the form

$$F = G(m_1 \times m_2)r^{-2},$$

where F represents the force of attraction acting between masses m_1 and m_2 located at a distance r between them and G the universal gravitational constant, we must well understand that we already have a *physical-tactile* knowledge of *force* as the product of the mass (that we can touch and weigh) of a body, subjected to acceleration (defined as the rate of change of its velocity per unit of time), as well as of the distance (that we can "walk" and measure) between the two bodies; whereas on the contrary, we have *absolutely no such* knowledge of the quantity G! The knowledge of G is obtained *mentally-intellectually* by dividing the force on the left-side by the fraction on the right-side of the above equation; and only thus is it found that it has dimensions of force times distance squared divided by mass squared, that simplifies to

$$|G| = |MLT^{-2}| \times |L^2| \times |M^{-2}| = |M^{-1}L^3T^{-2}| = |D^{-1}T^{-2}|,$$

on the basis of which we write $G = \alpha/DT^2$, where α is an arithmetical (i.e. dimensionless) constant yet to be determined, and D and T *cannot* be other than the *average mass density* (at T) and T the *age* of the universe *both at (or for) the time it is being studied*!

Nothing other does more clearly introduce the idea that the universe out there is ***not*** built solely of tangible materials! We cannot touch, feel, physically-as-we-do-an-object examine the quantity G, without which the universe ***cannot*** be put together! As the universe has existed and developed under the law of gravitation long before intelligence appeared *in* it to understand even this undeniable fact about it, it quite simply ***cannot*** be avoided that some ***Other Intelligence*** *did get involved in thus designing, organizing, building it under Law and setting it to function for a most clearly foreseen and desired to be obtained Purpose*!!! No scientist can honor his breeches, both physical and intellectual, unless finally, he acknowledges this inescapable, hardest than anything else physical fact!

(Note added to this text on May 5, 2012, re-edited Aug.19, 2014.)

(See also Page 235 added to this text on Aug.30, 2014.)

PART TWO

A NEW UNIVERSAL LAW AND ITS IMMEDIATE CONSEQUENCES

2. 1

THE FUNDAMENTALITY OF G*

Among the recognized forces acting in Nature, gravitation is unique: it is the most obvious; it has elicited more thought than any other; it is the weakest of all forces; it is mysterious. Einstein attempted to remove the mystery. His general theory of relativity in reality is such an attempt. But in a very real sense, he did not succeed, despite statements to the contrary. Because, if lifting a mystery really means making it finally comprehensible to all, or in the very least to more people, general relativity by being less comprehensible to more people than Newtonian gravitation cannot objectively be said to have lifted the mystery, it has only made it thicker! Galilei was the first to recognize and prove that gravitation acts identically on all bodies, causing them to fall towards the Earth identically, regardless of their mass, great or small. Newton was the first to describe gravitation formally (Eq. 1) and show its "universal" application. The term "universal" at present must be understood in the following two restricted senses: (a) Whether gravitation acts between any two bodies on the Earth, or between the Earth or its seas and the Moon, or between the Sun and the Planets, it is always the same, in the sense that G, in Eq. 1, has been found to have the *same* constant value. (b) Gravitation is seen to apply to all scales within which the present sensitivity of measurements allows us to detect its effects. Beyond those scales, determination of the value of G is very difficult, yet, we have absolutely no reason to suspect that gravitation ceases to apply identically to any scale, smaller or larger. The great difficulty of the determination is shown by the fact that the value of G is not known to an accuracy better than about four significant figures. The value of G in the cgs system, used in this work, upon which numerical calculations are based is 6.6720×10^{-8} and the associated relative standard deviation 615 ppm (parts per million), or 6.15×10^{-2}%.

Our understanding of the constancy of G at the practical level must be understood in this restricted context. Recent laser ranging measurements suggest a systematic increase of the Earth-Moon distance and this has been interpreted to indicate a systematic decrease in the value of G as a function of time. The possibility that $G \approx t^{-1}$ has already been a conclusion based on the Large Number Hypothesis of Dirac. Because of the limited accuracy with which we know the

* In an earlier version of the text, the material presented in the next several pages was absent and the reader was introduced very quickly and perhaps abruptly into the consideration of the "second" universality of G, and from there into the analysis of Eq. 2. This created considerable conceptual problems with some reviewers. Because consideration of the hard facts discussed here is the foundation for most of what follows, it is important to avoid all such problems. The author requests the indulgence of all who will find the discussion of detail unnecessary.

value of G, and the much smaller effect of its possible variation with time, the issue has not been decided at the experimental level.

The study of the constancy of G at the theoretical level is totally another matter. To carry it out requires knowledge of the *actual* formal connection of G with other physical constants, or other physical quantities. Such knowledge is not yet available. The formulation of models, the analysis of model parameter variation and the comparison of model predictions to the findings in the real world in the final analysis depend upon the limited accuracy of the experiment. Plato made the point that experiment ("experience") should not be given undue weight, that one must not suspend one's critical faculties and blindly depend upon experiment. One does not heed this wise advice when one accepts experiment as the final arbiter. To clear this important point, one only has to consider that experiment suggests that G is constant within about 6×10^{-2} %, while a true constant is constant to within $10^{-\infty}$ %! The more important but intimately related point having to do with the inner logical and physical consistency of the premises themselves upon which models are being built and their predictions compared to the real world has not so far been sufficiently appreciated. For example, one may ask "Is it internally logically consistent to assume that both G and c, the velocity of light, are constant?" Also, Dirac's conclusion that $G \approx t^{-1}$ depends heavily upon the premises implicit in his Large Number Hypothesis. So, not everything consistent within the experimental uncertainty (about 6×10^{-2} % for G) is necessarily truly logically or physically consistent. There is an infinite difference between 10^{-2} % and $10^{-\infty}$ %! So, unless we increase the sensitivity of our experiments to $10^{-\infty}$ % a clear impossibility, nothing of a concrete epistemological nature is really gained (in this case, knowledge of the true constancy or variability of G) by holding experiment as the final arbiter! Yet, without experiment how does one decide the inner consistency of the premises used in modelmaking? If that were possible, perhaps most of the models studied would have been eliminated from the start and progress would have been much faster. This discussion points up the difference between, and great problems existing in, giving ultimate authority to experimental verification, on the one hand, on the basis of which one can never be absolutely sure of anything, and the clear impossibility, on the other, of a priori deciding, by pure reason alone, what premises are internally logically and physically consistent. It is obvious that progress can only be made by a *measured* combination of the best features of both approaches. That such a strategy is possible *and* fruitful as well as avoiding *all* bias inherent in modelmaking will be shown in this work.

The most solid and safest of all foundations upon which one can begin building is dimensional analysis. Because it builds upon the dimensionality of the physical quantities themselves, it *alone* can eliminate *all* bias hiding in the premises of theory and modelmaking. However far-reaching, findings based on dimensional analysis can be trusted as logically and physically absolutely secure. The findings of this work, far-reaching though they are, are based on dimensional analysis, beginning with the analysis of G. The reason that such analysis has not been undertaken already is perhaps due to our discarding propor-

tionality constants as "basically uninteresting". Some of them are. G most definitely is not. Perhaps also, the neglect of G has been due to the formal similarity between Newton's and Coulomb's laws. In the latter,

$$F = f\frac{q_1 \cdot q_2}{r^2}, \tag{1a}$$

F and r have the same significance as in the former, but q_1 and q_2 express two electric charges. In the case of Coulomb's law, the proportionality constant f ("analogous", it is generally assumed, to G) can be given any value depending on the choice of units of F, q and r. In the cgs-electrostatic system, f = 1, a pure numeral. So, nothing is gained by studying f. But the "analogy" between f and G is not at all real. The reason is that we have no *direct* understanding of the physical quantity we call electric charge, except only by means of its effects on other electric charges, effects that are manifested *through* Coulomb's law. The analo gy with G would be proper if we could understand mass only through its gravitational effects, the fact that it exhibits weight when placed on a balance. Of course, one need not lift or weigh a body to realize the presence in it of mass. (How *much* mass, is another matter!). We have, it seems, an intrinsic and *direct* appreciation of the "quality" of mass that we do not have for electric charges. This is a *fundamental* difference.

Given our intrinsic and direct appreciation of mass, as well as of force and length, and their physical distinctness, it is *impossible* to employ units for F, m and r such as to reduce G to a pure numeral. So, there is more to G than what has to do simply with the units, such as dynes, grams and centimeters. This inner irreducible essence of G we comprehend through its physical dimensionality, which points to its objectivity as something physically real and distinct. Based on Newton's law, the dimensionality of G is expressed as (Force) × (Mass)$^{-2}$ × (Distance)^2. Because force has the dimensions of (Mass) × (Distance) × (Time)$^{-2}$, it is immediately obvious that G has the dimensions of (Mass)$^{-1}$ × (Distance)^3 × (Time)$^{-2}$, namely, the dimensions of (Density)$^{-1}$ × (Time)$^{-2}$. Given a quantity d expressing only density, and a quantity t expressing only time, G can be expressed as

$$G = \frac{\alpha}{d \cdot t^2}, \tag{1b}$$

where α is *necessarily* a pure numerical constant, because *all* physical dimensions involved are already expressed by the other three quantities G, d and t. In this case, if one were free to choose, a suitable choice of units would indeed result in α = 1, a pure numeral. Several years after this realization and completion of the work contained in Part Two, this author learned that R. H. Dicke ("*Evidence for Gravitational Theories*", Academic Press, London, 1962) had already pointed out that the above expression can be derived from simple dimensional arguments but he had gone no further.

But progress *can* be made at this very point: The universality of G, namely, the fact that as far as we can tell it enters with an identical and invariable value

all two-body gravitational interactions regardless of which and where the two bodies are, suggests that a deep-seated secret hides in G: It is obvious at once that α, d and t cannot be any quantities but necessarily only such that the *composite* quantity $\alpha/d{\cdot}t^2$ have the value entering universally all gravitational interactions as that value is determined through Newton's law. This is the traditionally recognized universality of G, which in light of what is to follow must be called the "first" universality. Still, its deep true significance as presented here appears to have escaped us so far: Because, however obscure its inner workings, which we are forced to say in the face of the fact that α, d and t remain at this stage unspecified, there can be *no* doubt whatever that we are faced here with a most important, possibly fundamental Law of Nature. The first universality of G, the fact that with an identical value it enters all gravitational interactions, when "there is no obvious reason for this to happen", one will doubtless say after a cursory view, points to the *existence* of a Law that universally *specifies* that value. Seen in this light, the subject calls for further study, because our understanding of the workings of the Universe *cannot* be complete without *full* knowledge of the Law that specifies so uniquely and universally the value of G. (Obviously, in the case of a variable G, things are not better but are in fact worse, since the specification must include the moment-by-moment variation of a quantity the value of which applies identically everywhere at any one moment). In other words, our knowledge shall be complete only when we *identify* the quantities α, d and t.

Such study so far has not been attempted. Current science, with its religiously pious adherence to the basic notions underlying relativity on the one hand and current quantum mechanics on the other, has no room for such study. Relativity has in effect abolished G and has replaced it with ten lesser quantities, none of which it regards as a universal constant. Current quantum mechanics, the science of "law without law", is too far removed to provide any help. In reality, these two *theories* both having become "the law" unto themselves recognize no law outside their own bounds, which is where the law discussed here, obscure for the moment though it be, seems to be lying.

The first universality of G already discussed begs consideration of the second: Because, the term "universal" signifies preeminently a quality characteristic of the Universe *as a whole*. Conception of this universality is totally beyond the currently preeminent theories and so, it has not been recognize that it *is* possible that G relates fundamentally to the structure of the Universe *as a whole,* or more precisely that the Universe *as a whole* depends explicitly on G. The most Elegant Design Hypothesis calls for unification of the two universalities. Under such unification, the Universe is not simply a "dump", or more charitably a conglomeration of some strange, incongruous, mysterious materials that happen to be together, nor a place where gravitation is a most peculiar property of all that matter thrown together that for some "strange" reason "simply" seems to be using an inexplicably singular constant in its mathematical expression, but a place where the whole and the parts unite uniquely to produce not only a Σύμπαν-Universe but also a Κόσμος, a meaningfully organized Whole, in other words, precisely a place where the simplicity and elegance of the Design, if it truly exists, is most likely to show up.

There is a fundamental difference between ordinary world-modelmaking and a Design already exhibited out there that incorporates the two universalities unified: Modelmakers can only produce symbols on the blackboard or paper. None of them has ever succeeded in explaining *how* a model, or even *his* model, can come into existence, or *what* symbols and coming into existence really mean *in their ultimate detail*! No one should be offended if an analogy is drawn here to indicate the world of difference this makes: A prekindergarten child draws the picture of an automobile. In so doing, it has at least already captured in gross outline the whole picture of the automobile and no one doubts what the drawing represents. But what direct, "organic" relationship does the drawing have to the real automobile out there? Does the child by simply specifying the gross outline of the automobile also specify, describe or at least remotely intimate the activities of mining, metallurgy, metalworking, enginemaking, tiremaking, fuelling, road building, that all together in their great complexity make it possible for the automobile to come into existence *and* to function in the real world? Does the child, by simply drawing a crude circle specify the components of the wheel-tire down to their ultimate detail of the fundamental particles involved and how these came about and function? But at least the child has captured the gross total picture! Do we yet possess of a single world-model that can legitimately claim to represent the gross "outline" of the real world, as legitimately as we all recognize the child's drawing to represent the outline of the real automobile? Whoever designed the World, He not only designed the fundamental particles the World is made up of down to their ultimate detail, but also had the power to bring them into existence and cause them to interact as they actually do in the *real* World. Do modelmakers know what their, say, "photinos" or "gravitinos", if they truly exist, *really* are beyond their being empty symbols on the blackboard? It will not at this stage do to say that "nobody made the World", because *nobody* can with a straight face say that "nobody made the automobile!"! If a *simpler* entity cannot come into being by itself, it is far more improbable that a *more complex* entity could have done so! This is *not* a matter of religious belief or aprioristic philosophy, but a matter of mathematical probability! So, *before* such a statement can legitimately be made, the World must be k*nown* in its ultimate detail, or in the very least *in sufficient* detail to guarantee it for all time, in the sense that no matter how much more detail we come to know later, we shall never have to reverse our conclusion. *Only thus* can it be decided whether Somebody made the World or not! When not even as crude as a child's outline of the World can be produced, some humility is definitely in order.

The above discussion should make it therefore clear that if a design, specifically the Most Elegant Design, is found to be exhibited by the real World, such a Design is no longer a blackboard exercise empty of substantive content, and no world-modeler can honestly turn his back on it, if he still retains a minimal self-respect. It will not do to deny the significance of all this, or the need for searching a little deeper to determine once and for all whether or not this is so, on the grounds that this is no longer science but religion, because of the glaringly obvious religious implications of a *possibly positive* outcome of such a search. Be-

cause, it is now crystal clear that such a search *can* be conducted fully within the strictest scientific context. On the contrary, it is *not* science to deny physical reality as it exists or a priori to dismiss the possibility that it may exhibit itself to be organized under such a Design and thus to excuse ourselves for not looking for it, for the fear of finding it if we look! By denying the Truth of it, *whatever it may be,* only ourselves do we make the poorer.

Having thus now cleared out of the way the twin huge roadblocks of fear to face up to the facts arising one from our total commitment to, and unwillingness to violate, the current theories, and on the other from the basically silly terms in which the science versus religion controversy has so far been cast, which roadblocks have prevented further progress in properly reading the physical evidence, we are finally ready to proceed.

The second universality of G clearly suggests that what had before been written in totally unspecified terms as $G = \alpha/d \cdot t^2$ can now be written in the partially *specified* terms of

$$G = \frac{\alpha}{D \cdot T^2}, \tag{2}$$

where D and T represent respectively quantities of density and time as they apply to *the whole* Universe. For if the left-hand side of Eq. 2 is a property of the Universe *as a whole, so is its right-hand side and each of the physically meaningful quantities* (namely, D and T) present in it! The statement of the last period is NOT an assumption, but a *logical and mathematical necessity*! Because, it is a basic rule of both logic and arithmetic that ONLY quantities *similar* in nature may be equated. So, it is *not* that each one of the quantities themselves entering Eq. 2 may be questioned as supposedly being assumptive, but whether or not Eq. 2 *as a whole* represents an *objective and thus real* relationship exhibited by the Universe *as a whole*! Before we proceed further to answer this question, we must stop to specify *fully* D and T. A quantity of density D, applying to the whole Universe, *cannot* be any other than the *average* density of matter, ALL matter, in it. The question of homogeneity *need not* be addressed here, aprioristically as is currently done, but only later in full consideration of its causes and effects. Similarly, a quantity of time T, applying to the whole Universe *cannot* be anything other than its age. The specification of the dimensionless proportionality constant, the pure numeral α, must be left for later. At present, we need some assurance that Eq. 2 truly represents a universal law. How do we obtain that? We argue as follows: Unless it is absolutely necessary to obtaining the simplest solution possible for the entire Universe in all its "complexity", a value of α other than unity certainly reduces the elegance of the Design because it requires the introduction and use of an arbitrary and fundamentally useless constant. For this reason, and for our immediate purposes, we may set $\alpha = 1$ and write:

$$G = \frac{1}{D \cdot T^2} \tag{2a}$$

Choosing the value of the age of the Universe to be 12 billion years ($= 12 \times 10^9$

$\times$ 365.2422 $\times$ 24 $\times$ 3600 = 12 $\times$ $3.1557 \cdot 10^{16} = 3.786 \times 10^{17}$ sec), an approximate but valid figure, produces the value

$$D = 1.045 \times 10^{-28}\ \mathrm{gcm}^{-3}$$

for the average density of matter, which is *within range* (10^{-27} to $10^{-30}\ \mathrm{gcm}^{-3}$) of the present estimates. This is already an extremely heartening outcome: Because, there is absolutely no reason why such a density value should be produced, unless of course Eq. 2 or 2a truly represents a universal law (an improved value for α notwithstanding) and our present estimate of the age of the Universe is essentially correct. The value of D already produced cannot be dismissed as a mere coincidence when, absent such a universal Law, any value at all could have been produced! Science is specifically in the business of the exhaustive examination of such "apparent" physical coincidences. Suffice it here to say that an *improved* value for the average density of matter will be produced later, and in agreement with it, a value for the total mass in the Universe (the calculation of which involves the velocity of light!), each value being within one order of magnitude of our best estimates. In this light, there can be no question at all that our procedure is indeed on the correct track.

In comparing these values the following points must be borne in mind. (a) the present average density of matter in the Universe need not be equal to the average density in our *immediate vicinity,* which alone is also observed at the present universal age. (b) The *presently observed average* density must necessarily be higher than the *present average* density, if G is not a function of the universal age, because the presently observed average density is in fact averaged over the period T_1 to T_2 during which the light has been in transit that is just now reaching us from the farthest-presently-observed regions of the Universe. (c) Due to the great difficulties of measurement and the uncertainty of the assumptions involved in them, the range of the present estimates can only be taken indicatively.

These remarks notwithstanding, it is truly remarkable that such values as produced in this work can be obtained so easily and from so few, non arbitrary, basic assumptions as those employed here. One may perhaps be inclined to take the density value generated above as a peculiar coincidence. But when later the value is further improved and the value of the total mass is also obtained, one can no longer continue to consider them *both* as coincidences. There can be no question at all that Eq. 2, subject to the correct specification of α, is indeed a universal Law of the very highest significance that substantiates *in fact* the unification of the two universalities of G. It is very important to realize that Eq. 2, having been obtained by dimensional analysis, is *not* a conceptual law, a mere human mental construct potentially having a "counterpart" in Nature, as can only be claimed for a world model, but a natural Law *already applying* to Nature that derives exclusively from the double universality of G and the exactitude of Eq. 1, as the latter has been written. For if the exponents of the quantities entering Eq. 1 were even slightly different, Eq. 2 could *not* have been written. Conversely, the values of density and mass produced on the basis of Eqs. 1 and 2 suggest that these equations as written are exact and universally meaningful. The logicality (whatever it is that makes them conceptually comprehensive as well as compre-

hensible in our minds) and naturalness (that derives from their being derived from the objective reality out there, one directly as Newton's law, the other indirectly through dimensional analysis) of Eqs. 1 and 2 are at the same time distinct (as separate activities: one mental, the other physical) yet indistinguishable (in that they both apply as a natural Law to the entire Universe)! The wonderment, due to the comprehensibility of such universal Laws, in the face of the totally mysterious connection between the human mind and the entire Universe, can only be justified as long as one insists on ignoring the Most Elegant Design Hypothesis. Under this hypothesis, now beginning to be proven right, a Mind was already at work before the World came into being: This is implicit in "Design". So, the direct connection of Mind and matter is already present in the hypothesis and thus in itself it should no longer produce wonderment. The connection of the human mind to matter is totally another matter that *cannot* be understood on the basis of this hypothesis alone. Only through an additional connection between our minds and the Mind can the connection between the human mind and the physical Universe out there be understood. But this is a matter that must await a fuller discussion in Part Four. Mention of the subject is made here only to show that we do not do our homework properly as long as we evade this whole issue under various excuses, or choose to ignore the existence of universal physical Laws that inescapably contain within themselves "information" beyond the merely physical, and thus pass up in silence even their purely physical-scientific import.

In light of the findings of this section and those promised for later, it is obvious that, the universal gravitational constant is strategically placed to regulate not only the gravitational behavior of all individual parts of the Universe according to Newton's law, but also the behavior of the Universe as a whole under Eq. 2. It is thus entirely legitimate to regard this latter equation, subject to the correct specification of α, as the equation of state of the Universe. If Eq. 2 is truly such, a thorough analysis of it *must* lead to important new knowledge and conclusions that on account of their derivation will be impossible to dispute. Moreover, if such analysis points to some conclusions that are in agreement with indisputable independent findings (such as those already mentioned) and to other conclusions that require revision of some of our biases and principles, yet conclusions that all together produce, without *any* breakdown in logical or observational consistency, a unified conception of the World, there will then be no argument against the total thesis thereby having been produced. At the basis of the total structure, there will be the fact that Eqs. 1 and 2 *in combination* represent exact Laws fundamental to the construction, structure and operation of the Universe. If, in view of the importance of the issues involved, one still harbors reservations pending the results of the complete analysis, this is certainly understandable. A cautious investigator may for the time being only wish to grant to Eq. 2 no more than the status of a working hypothesis. For as it will be shown immediately below, Eq. 2 permits several possibilities. Of these, *only one* can possibly apply to the objective physical reality understood as the Universe. The real objective of the analysis of Eq. 2 thus is to determine *that one* possibility, and show that all claims made above are indeed permitted under it.

TABLE 1. Constancy—Variability Combinations of the three Universal Quantities in Equation $D \cdot G \cdot T^2 = \alpha$.

Case	T	D	G	REMARKS
1	C	C	C	Non-physical
2	C	C	V	Non-physical, impossible
3	C	V	C	Non-physical, impossible
4	C	V	V	Non-physical
5	V	C	C	Impossible
6	V	C	V	Possible
7	V	V	C	Possible
8	V	V	V	Possible

C = Constant
V = Variable

TABLE 2. Constancy—Variability Combinations of the three Universal Quantities in Equation D = M/V.

Subcase	D	V	M	REMARKS
a	C	C	C	Possible
b	C	C	V	Impossible
c	C	V	C	Impossible
d	C	V	V	Possible
e	V	C	C	Impossible
f	V	C	V	Possible
g	V	V	C	Possible
h	V	V	V	Possible

TABLE 3. Constancy—Variability of the five Universal Quantities T, G, D, M and V. Permitted Combinations only.

Sub-case	T G D M V	Defining Equations Required	Section	REMARKS
6a	V V C C C	1	2.2	Disproven
6d	V V C V V	2	2.2	Disproven
7f	V C V V C	1	2.3.1	Disproven
7g	V C V C V	1	2.3.2	Proven
7h	V C V V V	2	2.3.3	Disproven
8f	V V V V C	2	2.4.1	Disproven
8g	V V V C V	2	2.4.2	Disproven
8h	V V V V V	3	2.4.3	Disproven

The analysis of Eq. 2 proceeds with the realization that there are eight possible ways in which G, D and T can be brought together depending on their constancy or variability, and these are shown in Table 1. Since it cannot be denied that time flows, the Universe necessarily ages, and its age necessarily is a true variable. As a result, the first four cases shown in Table I represent non-physical situations that can be ignored. Moreover, since Eq. 2 requires at least two variables, Case 5 is impossible. Thus only three Cases (6, 7 and 8) remain that are logically possible.

Since the universal density is a derived quantity, namely, the ratio D = M/V of the universal mass and volume, there are similar restrictions imposed by the constancy or variability of these quantities. Here again, there are only eight ways in which D, M and V may be combined and they are shown in Table 2. It is immediately obvious that Subcases b, c and e must be dismissed as impossible. The three possible cases of Table I must be examined in light of the permissible subcases of Table 2. There are only eight ways in which the three cases and five subcases may be combined and they are shown in Table 3. The Universe can only satisfy one of these eight sets of conditions. Our duty is to find out which that particular set is.

Subcase 6a is the closest the Universe can come to a steady state, whereas Subcase 6d, in which M and V are dependently variable, is in essence a case of a compromised steady-state universe, in which only the universal density is held constant. Other compromised steady-state cases are 7f and 8f, in which the universal volume is held constant. Also shown in Table 3 is the number of equations required to define each subcase completely. Subcases 6a, 7f and 7g require only one such equation each, so that Eq. 2 or 2a by itself is sufficient. Subcases 6d, 7h, 8f and 8g require two defining equations each, and Subcase 8h requires three defining equations. The particular Section of this work where each subcase is discussed is also shown in Table 3. Subcases 6a and 6d shall be discussed together in Section 2.2; Eq. 2a applied under constant D leads to conclusions that are quite contrary to our best knowledge of the universal processes that cannot but be affected by the two basic conditions of variable G and constant D, so that neither of these two cases can possibly be describing the Universe. The search for a second defining equation for Subcase 6d is therefore unnecessary. Subcases 7f and 7g shall be examined separately in Section 2.3, where it shall be shown that the former subcase cannot possibly be describing the Universe, whereas the latter leads indeed to conclusions in basic agreement with our knowledge of the Universe and at the same time sheds new light on some of the most basic questions of physical science. The last four subcases shall be examined briefly later and shown to be at least inelegant combinations, due to the additional equations required for their complete definition.

2.2

THE CASE OF A UNIVERSE OF CONSTANT D AND VARIABLE G AND T

The constancy of density can be effected in either of two ways: (a) The universal mass and volume are both constant (Subcase 6a). (b) The universal mass and volume are both identically dependent upon the universal age and the effects of the latter completely cancel out (Subcase 6d). In either case, the universal gravitational constant becomes a function of the universal age only. The values G_1 and G_2 of G in the corresponding universal ages T_1 and T_2 stand in the ratio:

$$G_1 \cdot G_2^{-1} = T_1^{-2} \cdot T_2^{2} \tag{3}$$

What are the effects of these conditions? How far do they carry? Can they be detected in our locality of the Universe? What does the universality of the applicability of the universal laws imply? It looks as though the best answer to these questions must be given in approximately reverse order: The brief discussion of these questions immediately following does not apply only to the analysis of the present conditions, but to the analysis of all conditions examined in this work and thus it is worth keeping in mind.

At any universal age, the universal laws can be expected to apply universally, simply and uniformly. Unless they do so, their local effects vary haphazardly with location and local conditions, and their integrated effects are more in the nature of unrelated statistical averages. Without a deeper substratum of law to which the local conditions are due, the statistical averages thus obtained do not relate logically to each other; they simply stand each one alone, without any inner connection among them. If so, no universal law exists and science is impossible. But we know enough already to suspect, correctly, that science is not impossible, that the local conditions in reality do reflect a deeper substratum of law and that the statistical averages are not meaningless but reveal something of the nature of that deeper substratum. Thus, although local variation exists, it has and can have no effect upon the Universe as a whole. For example, the existence of winds shows that the density of air is not uniform from place to place, but this in no significant way affects phenomena in the larger scale. The more universal the local storms become, the more the universal laws can be expected to become more intractable. But we find that storms are in reality very local. Atmospheric storms quiet down very quickly with height and pretty soon the heavens acquire the serenity the night sky reveals. In the planetary regime, local effects are only minor perturbations in an otherwise already well established order, which demonstrates the converse, namely, that the universality of the laws of the Universe carries through to our regime and can therefore be expected to be discoverable down to the closest astronomical distances such as those between the

Earth and the Sun or the Moon. The title conditions examined here do have an effect in the solar system and here on Earth.

Assume for simplicity a circular trajectory for the Earth, held in place by the balance of gravitational and centrifugal forces acting upon it:

$$G \cdot M_E \cdot M_S \cdot r^{-2} = M_E \cdot \omega^2 \cdot r, \tag{4}$$

resulting in

$$G \cdot M_S = \omega^2 \cdot r^3. \tag{4a}$$

Assume also conservation of angular momentum:

$$M_E \cdot r^2 \cdot \omega = \text{constant}. \tag{5}$$

Here, M_E, r and ω are respectively the mass, distance from the Sun and angular velocity of the Earth, and M_S is the mass of the Sun. We shall examine the applicability of Equation (3) for each of the two cases (a) and (b) of the first paragraph.

(a) Universal Mass and Volume Constant.

At two different universal ages T_1 and T_2, the Sun-Earth system is affected as follows: From Eq. 4,

$$G_1 \cdot G_2^{-1} = r_1^3 \cdot r_2^{-3} = \omega_1^2 \cdot \omega_2^{-2}, \tag{4b}$$

and from Eq. 5,

$$r_1^2 \cdot r_2^{-2} \times \omega_1 \cdot \omega_2^{-1} = 1. \tag{5a}$$

Thus,

$$G_1 \cdot G_2^{-1} = r_1^{-1} \cdot r_2^1, \tag{6}$$

and by Eq. 3,

$$r_1^1 \cdot r_2^{-1} = T_1^2 \cdot T_2^{-2}, \tag{6a}$$

and by Eq. 5a,

$$\omega_1 \cdot \omega_2^{-1} = T_1^{-4} \cdot T_2^4. \tag{6b}$$

The immediate conclusion reached from Eq. 6a is that the Sun-Earth distance increases with the square of the universal age. The solar energy received on Earth is inversely proportional to the square of their distance. On the other hand, if to a good first-order approximation we ignore the outward energy flow from the interior of the Earth and assume a practical short-term steady state, the energy balance on the surface of the Earth is determined by the Stefan-Boltzmann law: the Earth radiates away as much energy as it receives and this energy is proportional to the fourth power of its absolute surface temperature. Thus,

$$E_1 \cdot E_2^{-1} = r_1^{-2} \cdot r_2^2 = \Theta_1^4 \cdot \Theta_2^{-4} \tag{7}$$

It follows that,

$$\Theta_1 \Theta_2^{-1} = T_1^{-1} T_2 \tag{7a}$$

The surface temperature of the Earth is inversely proportional to the universal age. We assume the present age of the Universe to be T_2 = 12 billion years. The

present black-body, day and night temperatures are respectively 394°K, 295°K and 275°K. Accordingly, the black-body, day and night temperatures 3.5 billion years ago, at the presumed dawn of life on Earth, should have been respectively 556°K (=283°C), 416°K (= 143°C) and 388°K(= 115°C), all much too high and prohibitive of life. At later ages, the temperatures would have been more conducive to life, but the time available for evolution would then be severely restricted. Alternatively, one may argue that the estimate of the universal age is too low. If one accepts 333°K(= 60°C) as a more reasonable (still perhaps on the high side) average temperature for the initiation of life and the estimate of 3.5 billion years as correct, one may write

$$(333^\circ\mathrm{K}) \cdot (285^\circ\mathrm{K})^{-1} = T_2 \cdot (T_2 - 3.5)^{-1}$$

and find that $T_2 = 24.3$ billion years, which is on the high side of the present estimates. Lower values for the average temperature 3.5 billion years ago result in still higher estimates of the present universal age. Thus, the evidence of life on Earth and the present estimates of the present universal age do not support the title conditions here examined.

Even more damaging to the potential validity of these conditions is the evidence adduced from Eq. 6b. This equation suggests that the period of revolution is proportional to the fourth power of the universal age! This is logically impossible.

Also logically impossible is the conclusion arrived at on the basis of Eq. 6a. Universal applicability of this equation requires that the Universe expand, which is contrary to the title conditions here studied. If the Sun-Earth distance is allowed to increase as per Eq. 6a in a universe of constant volume, other distances must perforce decrease and it is impossible to see how the same universal laws can have opposite effects.

(b) Universal Mass and Volume not Constant.

The constancy of density now requires that

$$M_1 \cdot M_2^{-1} = r_1^3 \cdot r_2^{-3}. \tag{8}$$

Applying this relationship to Eqs. 4 and 5 results respectively in

$$G_1 \cdot G_2^{-1} = r_1^3 \cdot r_2^{-3} \times \omega_1^2 \cdot \omega_2^{-2} \times M_{S,1}^{-1} \cdot M_{S,2}^{1} = \omega_1^2 \cdot \omega_2^{-2} \tag{8a}$$

and

$$M_{E,1} \cdot M_{E,2}^{-1} \times r_1^2 \cdot r_2^{-2} \times \omega_1 \cdot \omega_2^{-1} = 1, \tag{8b}$$

yielding

$$\omega_1 \cdot \omega_2^{-1} = r_1^{-5} \cdot r_2^5.$$

It follows that

$$G \approx r^{-10},$$
$$G \approx T^{-2},$$

$$
\begin{aligned}
r &\approx T^{1/5}, \\
M &\approx T^{3/5}, \\
\omega &\approx T^{-1}, \\
\Theta_E &\approx T^{-1/10}, \\
E &\approx T^{-2/5}.
\end{aligned}
$$

According to these relationships, the Universe must expand slowly, the masses of bodies and of the entire Universe must increase, the clocks must behave properly but slow down, the energy received on Earth and its surface temperature must decrease very slowly. Under the present conditions, the universal energy being proportional to (mass) × (velocity)^2 becomes proportional to T^{-1}; in the beginning, immediately after the appearance of the first infinitesimal amount of mass, the Universe must have had an essentially infinite amount of energy! It is inconceivable that the continuous creation of mass could have escaped our notice, that bodies acquire more mass, yet lose weight (the gravitational forces become proportional to $T^{-6/5}$). There can be no question that our Universe does not behave in this manner.

If the non-conservation of mass does not affect existing bodies, the Sun Earth system must behave according to Case (a) above. The universal mass can then be expected to increase exceedingly fast with the sixth power of the universal age (from Eq. 6a and 8) and appear where no mass existed before. No evidence whatever exists of this really happening anywhere.

For a universe of constant density, the rate of change of G with universal age can be obtained from Eq. 2a:

$$dG/dT = -2/DT^3 = -2G/T, \qquad (9)$$

the present rate being 5.28×10^{-18} G/sec or 1.67×10^{-10} G/year. The yearly change thus is about 3.7×10^4 times smaller than the uncertainty the value of G (615 ppm), and therefore much too small to be detected by present methods. The constant density universe requires just the above rate of change in the value of G (assuming the universal age to be 12 billion years), and unless such a change can be demonstrated, the objections against such a universe must be considered.

A value of α other than unity would make the value of density larger by the factor α, but would leave the rate of change of G and the basic structure of the universe unchanged and thus would not affect the above discussion.

The Steady-State Universe

There has been a great deal of debate in the past on whether or not the Universe is at a steady state. Given the infinity of time, even an oscillating universe of finite period, however long it may be, is a steady-state universe. Tables 1 and 2 allow us to determine and analyze *all possible* conditions under which a steady-state universe may obtain. Table 2 shows that a steady state may obtain only in

Subcases a and f. Table 1 shows that a steady state may obtain in Cases 1 and 7 (constant G) and in Cases 4, 6 and 8 (variable G) Under constant D, a steady state is possible in Subcases 1a and 6a.

Subcases 1a and 4f can only obtain if the universe is ageless. In such a universe, no process is possible or indeed permissible in which the product can in any way be distinguished from the reactants. Regardless of the scale of such a process, the ability to distinguish between products and reactants *is sufficient to* define *past* and future, in other words, time, even if the latter is not defined in a more fundamental way. A universe obeying Subcases 1a and 4f is always in absolute equilibrium in all scales. Our Universe is not in absolute equilibrium and thus it disproves the possibility of Subcases 1a and 4f.

Subcase 6a has already been discussed and disproved. The discussion was based on the exactitude of Eqs. 1 and 2a and on the principles of conservation of mass and angular momentum, which require that the Universe expand. Under these conditions, the universal density of matter cannot remain constant.

There remain only two possibilities for a steady-state universe, Subcases 7f and 8f. They both compromise to some degree the notion of steadiness because they demand a variable density. They shall be discussed later.

2.3

THE CASE OF A UNIVERSE OF CONSTANT G AND VARIABLE D AND T

Under these title conditions, the universal density becomes a function of the universal age only. By replacing D with its equivalent M/V, Eq. 2 becomes

$$V = \alpha^{-1}GMT^2, \tag{10}$$

which can be satisfied under: (I) constant V and variable M (Subcase f); (II) variable V and constant M (Subcase g); and (III) variable V and variable M (Subcase h). We shall examine each of these cases.

2.3.1

THE SUBCASE OF CONSTANT VOLUME AND VARIABLE MASS

Under constant volume, all distances remain absolutely constant through time, or remain constant on aggregate. In the latter case, increase in some distances must be compensated by decrease in other distances. Although this appears inconsequential and trivial for ordinary phenomena, in the scale of the Universe as a whole, it requires additional universal laws to regulate the relative motions of the galaxies, clusters of galaxies etc.; the universe in such a case cannot be the simplest possible. In the absence of such additional laws, the relative motions must be totally random. In either case, gravitational attraction decreases between bodies moving away from each other, and increases between bodies moving closer together; in the latter case, nothing can stop gravitational collapse: The universe will eventually develop into being clumpy, the clumps possibly being black holes. Nothing that we know for certain about the present Universe directly contradicts the picture just presented. The observed recession of the galaxies under the Hubble Law must only be apparent, the spectral red-shifting due to some other cause.

In the present Subcase, the universal mass is a function of the universal age:

$$M = \alpha VG^{-1}T^{-2} = (4/3)\alpha\pi R^3G^{-1}T^{-2}, \tag{10´}$$

if, in addition, it is assumed that the universe is spherical, R being the constant

radius of the universe. The beginning of the universe, $T = 0$, is understood to be the moment of infinite mass and infinite mass density at which a universal law of continual mass annihilation took effect: ever since, the universal mass is decreasing monotonically. The rate of annihilation is

$$dM/dT = -2\alpha VG^{-1}T^{-3} = -2MT^{-1} \qquad (11)$$

At the present universal age (12 billion years), this rate is -1.67×10^{-10} M/year. Given the present estimate of the universal mass, $M \cong 10^{56}$ g, this rate is very great indeed, being equivalent to about 10^{13} solar masses vanishing per year. More important yet, since the mass of the Universe is necessarily observed through time, the above rate of annihilation is applicable only to our immediate vicinity: at greater distances and past ages, it was necessarily greater.

Mass annihilation must not be confused with spontaneous radioactive decay. In the latter, mass simply converts to photons, as we shall see in the next Section. In the present case, no such conversion is permitted: mass simply vanishes without a trace. The rate of -1.67×10^{-10} parts/part/year is, at any rate, too great to be satisfied only by the known radioactive elements; ordinary elements must also be involved.

Decrease in mass is either proportional to mass already present, in which case it affects all masses, including the masses of the fundamental particles; or selective, meaning that some fundamental particles continue to exist with undiminished mass, while other particles abruptly pass out of existence. It is obvious that proportional mass annihilation is simpler as far as the universal law regulating it is concerned. Selective mass annihilation requires additional laws, or else it is random. It is totally inconceivable that we have failed to notice selective mass annihilation, if it be present in our vicinity, so that we may safely discount this possibility.

Under proportional mass annihilation, two different masses balanced on a two-pan balance remain balanced through time. Spring balances, however, cannot possibly fail to detect the effect, if present: Loss of mass from a mass suspended from a spring in the gravitational field of the Earth, which itself loses mass, results in relaxation of spring tension, contraction of the spring from, say, x to $x - dx$ and increase in the distance between weight and base from y to $y + dy$. In order to miss the effect, it is necessary that

$$x/y = (x - dx)(y + dy)^{-1},$$

A measuring rod held parallel to the spring must find its upper portion shrunk and its lower portion elongated in the same proportion, or the effect cannot be missed. It is impossible to give reasons why a measuring rod should suffer such changes, nor indeed can it, as can immediately be demonstrated by suspending a second spring with a different rating: the measuring rod cannot satisfy the needs of both springs at once. Thus, we can safely discount the possibility of proportional mass annihilation also.

Before dismissing this case altogether, it is worthwhile to discuss it a little further. Under proportional mass annihilation, the force of gravity between

masses at fixed distances is proportional to the inverse fourth power of the universal age; and so is energy. As a result, mass annihilation implies energy annihilation as well. On the other hand, velocities and accelerations are proportional, respectively, to the inverse first and second power of the universal age. Far enough back in universal age, velocities could be found that exceeded by far any set value, including that of the present velocity of light. In order that the velocity of light remain, at least, limiting, it is necessary that it be of the form

$$c = \beta T^{-1}, \tag{12}$$

where β is time-invariable. For T= 12 billion years, $\beta = 1.135 \times 10^{28}$ cm. In a universe of constant volume, this quantity is an absolute constant measure of length that must be related to the universal radius. Since the instantaneous distance covered by light is

$$dr = c \cdot dT = \beta d\ln T, \tag{12´}$$

the distance covered between ages T_1 and T_2 is

$$r = \beta \ln(T_2 / T_1). \tag{13}$$

Light, then, has covered an infinite distance since $T_0 = 0$. In view of the finite measure of length just given, we must conclude that light traveling outward must eventually bend and get trapped in a Keplerian orbit just inside the edge of the universe, such that the relationship

$$Rc^2 \leq 2GM = (^8/_3)\alpha\pi R^3/T^{-2} \tag{14}$$

must hold very closely but not exactly, since in the case of $Rc^2 = 2GM$, the photon would have equal kinetic and potential energies and thus sufficient velocity to escape, which is absurd for a universe of constant volume (and radius). In other words, the following must hold very closely:

$$c \cong (8\alpha\pi/3)^{1/2} RT^{-1} \tag{12a}$$

$$dc/dT \cong -(8\alpha\pi/3)^{1/2} RT^{-2}. \tag{12a´}$$

The deceleration of the velocity of light can have no cause other than the decrease in the gravitational field of the universe caused by the annihilation of mass. (Why the gravitational field affects only the tangential velocity of light at the edge of the universe but not the radius also is not clear. This lack of clarity must be regarded as a shortcoming of the present case). We write:

$$\mathcal{G} = -GM/R^2 = -(^4/_3)\alpha\pi RT^{-2} \tag{15}$$

and equating

$$dc/dT = \mathcal{G}, \tag{15´}$$

we find

$$\alpha = {}^3/_{2\pi} \tag{15´´}$$

and

$$c \cong 2RT^{-1}, \tag{12b}$$

so that $\beta = 2R$ is the diameter of the universe. (Why the gravitational field must be taken to be negative other than solely in order to avoid a negative value for α that would be absurd cannot be given).
Light covers the distance R in time T_1 to T_2, such that

$$2R\ln(T_2/T_1) = R,$$

resulting for now in $T_1 = 7.28$ and $T_2 - T_1 = 4.72$ billion years. If one assumes that light travels back to the center along a straight line, one can obtain an estimate of the mass seen through time. (Again, why light must travel back along a straight line, while on its outward journey it must bend around to conform to the constraint of constant radius, is not clear. Without such an assumption, the following calculations are not possible). One needs the additional assumption that the velocity of light is constant everywhere at constant time. Now, if light at the edge of the universe is decelerated by the gravitational field, so is everywhere, and one must write

$$GM/R^2 = GM(r)/r^2, \tag{15a}$$

where M(r) is the mass inside radius r. It follows that

$$M(r) = (r^2/R^2)M = (2R/GT^2)r^2.$$

The element of mass in the shell dr at r at T is

$$dM(r) = (4R/GT^2)\, rdr. \tag{16}$$

The mass dM(r) observed by a central observer at time T_2 is obtained when the values for r and dr from Eq. 13 and 12´ are introduced, so that

$$dM(r) = (4R/GT^2)\beta^2 \ln (T_2/T)dlnT. \tag{16´}$$

Upon integration, between T_1 and T_2, one finds

$$M_{obs} = (16R^3/G)\left[(-1/2)\,(\ln T_2)(T_2^{-2} - T_1^{-2}) + (1/2T_2^2)(\ln T_2 + 1/2)\right.$$
$$\left. - (1/2T_1^2)(\ln T_1 + 1/2)\right] =$$
$$= 7.64 \times 10^{55} \text{ grams},$$

which is of the order of magnitude of the mass observed in the Universe! This, despite the fact that our Universe cannot possibly be one of variable mass as was shown earlier. The calculation of observed mass shows that astronomical observation ("experience") alone (laden with multiple consecutive assumptions) is not sufficient to decide the cosmological questions. One has to look for agreement *amongst all consequences* of the title constraints.

The energy received on Earth from the Sun is proportional only to the energy emitted (since their distance remains constant in a constant-volume universe), namely, proportional to T^{-4}. The temperature on Earth thus is inversely proportional to the universal age, so that

$$\Theta \approx T^{-1}$$

For $\Theta_2 = 394°K$, the present black body temperature, we thus find that 3.5 billion

years ago, $\Theta_1 = 556°K$, which is between the present equilibrium temperatures on Venus and Mercury, certainly much too hot for the initiation of life. (Using the same expression for the average day-night temperatures, one finds that 3.5 billion years ago, the average day-night temperature was 129°C). It is thus quite obvious that despite astronomical observation, which appears to be corroborated by the above assumption-laden calculation of observed universal mass, there can be no doubt at all that our Universe does *not* fit the title conditions examined here.

2.3.2

THE SUBCASE OF CONSTANT MASS AND VARIABLE VOLUME

2.3.2.1. GENERAL REMARKS.

The study of the effects of the present title conditions upon the structure and behavior of the Universe* begins with the consideration of Eq. 10:

$$V = \alpha^{-1}GMT^2. \tag{10}$$

The dimensionless constant α will be determined later; it does not have the value found in Section 2.3.1. As *is immediately obvious, under constant G and M, Eq. 10 expresses the Law of (monotonic) Universal Expansion, deriving remarkably from Newton's law of Gravitation*!!!

The simplest way in which this law of expansion can be obeyed is by requiring that all distances and all sizes in the universe also expand monotonically in agreement with Eq. 10, in proportion to the universal length related to $V^{1/3}$. This is at once the most general, strictest and simplest law of expansion possible. This generality and simplicity cannot hold if distances and sizes are to change in some other way, or not at all; for then, additional laws are required to determine how each distance or size is to behave and when. Let us distinguish these two modes of expansion as the grander and the lesser, respectively.

The currently accepted notion of universal expansion, deriving from Hubble's law, is generally regarded to apply only to intergalactic distances. The logical extension backwards to a zero initial volume, entailing a determination of the behavior of all distances and sizes, and not only of the intergalactic ones, is only vaguely and reluctantly discussed, precisely because we prefer to regard the so-called "rigid rods" as time-invariable. There can be no question then, that the currently accepted notion of universal expansion refers to the lesser mode of

* For the purposes of the present analysis, the conditions of constant G and M will be regarded to apply to a model universe. When the analysis of all cases is completed, it will be seen that the present case is the only one that does not lead to internal contradiction or physical impossibility and therefore that it is the only way in which the actual Universe can possibly have been made up.

expansion distinguished above. This leaves the multitude of additional laws required to regulate the expansion of all sub-intergalactic distances and sizes, or to fix the moment at which each such distance or size was fixed at a certain value from that moment on, still to be determined. Which mode of universal expansion must we accept as universally applicable, especially bearing in mind that the grander mode of expansion totally dispenses with the notion of "rigid rods"? The possibility of the lesser mode of expansion cannot be denied, despite the additional complexity required and the loss of elegance that such additional complexity entails, as a product either of pure unadulterated chance or as a conscious decision of a Creator. Yet, it must be admitted that *it is incalculably improbable that in the total absence of any laws whatever, the particles of matter arranged themselves, purely by chance, in such a way as to create and perpetuate the appearance even of the one complex set of laws required to regulate all distances and sizes in the universe and to conform to the general law of universal expansion expressed by Eq. 10*. On the other hand, a conscious establishment of such a complex set of laws can only be justified as a basic precondition for the attainment of a particular objective that otherwise would be impossible. At present, no such objective is known, nor can it be discovered by physics alone! On these grounds, the *truly sensible* thing to do is to reject the lesser mode of universal expansion and to accept the grander mode and *all* that it entails.

In this grander sense, Eq. 10 expresses mathematically the simplest possible law of a "big bang" creation, but even more importantly, *it shows that such creation and subsequent expansion is both the logical counterpart and physical consequence of Newtonian gravitation* expressed by Eq. 1. As we have seen, Eq. 1 requires that Eq. 2 also apply. Under the constraints of constant G and M, Eq. 2 becomes the law of universal expansion expressed in the form of Eq. 10. Thus, *Newtonian gravitation requires as its inseparable counterpart the big bang creation and expansion represented by Eq. 10*! It is the most important implications of this dual law, expressed by Eqs. 1 and 10, that we shall study in this Section (2.3.2.).

To start off from something fundamental, *Eq. 10 makes it necessary to distinguish and separate the concept of the volume of the universe from the concept of space. Eq. 10 refers only to the former and says nothing about the latter*. There is no scientific evidence indicating that the volume of the universe and space are one and the same thing, and that the latter increases identically to the former. Eq. 10 demands that we see the entire universe as the ultimate finite body, the volume of which is determined strictly at any universal age. Its expansion, like that of any lesser body, presupposes the existence of space within which it is possible at all. We shall return to the study of this problem later in this work. Here, it should suffice to state that to equate the volume of the Universe to space is to make a *philosophical statement, not a scientific one*! Science alone *does not permit confusing the notions of universal volume and space*!

In agreement with the definition of the Universe already given in Section 1.1, it is reasonable to state that the Universe encompasses all physical quantities. Eq. 10 implies the existence of a front of expansion, the *entire* Universe (for simpli-

city only, dropping the adjective "physical" which we *must always* understand) being within this front. In the absence of any outside influence, since nothing physical exists outside the Universe, it is reasonable to state that the Universe expands as a perfect sphere. This needs some explanation: In the absence of external influences, the momentum of a fraction of the universal mass moving in one direction can, and must, only be balanced by the equal momentum of another piece of universal mass moving in the exact opposite direction. It follows that the center of the Universe represents, at a minimum, the center of momentum of all masses in the Universe. In other words, the *center of the Universe remains totally motionless in space through time*! *It is the absolute point of reference for all distances and motions in the universe*! *As such, it stands totally alone*!!! The distribution of masses in the Universe *must* meet this law at a minimum. Whether or not higher symmetry is required in that distribution will be discussed later (Section 2.3.2.3.). If the first act of the expanding Universe was to shed off copious numbers of some kind of particles (see next section) in all directions, then, these particles at any one moment represent the front of the expanding universe. For the reasons just described, that front comprises the surface of a perfect sphere. Its radius is also the radius of the Universe, R, and is obtained directly from Eq. 10 as:

$$R = (3GMT^2/4\pi\alpha)^{1/3}. \tag{17}$$

Differentiation yields the velocity of expansion relative to the center of the Universe:

$$dR/dT = (2/3)(3GMT^{-1}/4\pi\alpha)^{1/3} = 2R/3T, \tag{18}$$

and the deceleration of that velocity as:

$$d^2R/dT^2 = -(2/9)(3GMT^{-4}/4\pi\alpha)^{1/3} = -(3T)^{-1}(dR/dT) = -2R/9T^2. \tag{19}$$

According to Eqs. 18 and 19, both the velocity of expansion and the deceleration of that velocity were infinite at $T = 0$ and will be zero at $T = \infty$. In other words, under the conditions studied here, the universe is 'open' and its expansion can never be halted. This, too, must be seen as a consequence of Newtonian gravitation under constant G and M.

According to Newtonian gravitation, the gravitational field at a distance r from the center of mass M distributed within a radius R uniformly (the mass density distribution being constant everywhere in the universe at a constant universal age T), or at least, radially uniformly (the mass density distribution being a function only of r and T), is given by $-Gm/r^2$, where m is the mass inside radius r. Accordingly, the field of gravity at the universal front is given by

$$\mathcal{G} = -GM/R^2. \tag{20}$$

Introduction of Eq. 17 shows that $\mathcal{G}$ is proportional to the $-4/3$ power of the universal age, as is the deceleration of the universal expansion. This identical dependence suggests, as we might logically surmise, that it is the field of universal gravitation, and it alone, that causes the deceleration of the expansion of the uni-

versal front. Equating (19) and (20) yields:

$$\alpha = 1/6\pi^*, \tag{21}$$

$$R = (9\,GMT^2/2)^{1/3} = \left[2GM(3T/2)^2\right]^{1/3}, \tag{17´}$$

$$dR/dT = (4GMT^{-1}/3)^{1/3} = \left[2GM(3T/2)^{-1}\right]^{1/3} = 2R/3T, \tag{18´}$$

$$\mathcal{G} = d^2R/dT^2 = -(4GMT^{-4}/81)^{1/3} = -\left[(1/4)GM(3T/2)^{-4}\right]^{1/3}$$
$$= -(1/3T)(dR/dT) = -(2R/9T^2), \tag{19´}$$

Accordingly, the average universal density is quite simply expressed by

$$D = (6\pi GT^2)^{-1}, \tag{22}$$

being 6π times smaller than the value given in Section 2.1. The present value at (T_2 = 12 billion years) thus is

$$D_2 = 5.45 \times 10^{-30}\ gcm^{-3}. \tag{22´}$$

2.3.2.2. THE NATURE OF LIGHT AND ITS RELATIONSHIP TO THE UNIVERSAL CONSTANTS.

2.3.2.2.1. Rejection of the Constancy of the Velocity of Light.

Modern physics is founded partly upon two principles: (a) The velocity of light is time-invariable; (b) the velocity of light is limiting, the maximum possible velocity in the universe. These two principles cannot both be correct in a universe obeying Newtonian gravitation under constant G and M: According to Eq. 18´, such a universe, in the course of ageing, expands with velocities as-suming all values from infinite to zero. For such a universe, our understanding of the velocity of light must be modified, for if it is to remain time-invariable, given the presently observed spread of galaxies, there necessarily was a sufficiently remote past, during which massive and even ultramassive objects sped with super-

* Some time ago but subsequently to the above derivation, this author came across a paper by I.W. Roxburgh ("*Encyclopedia of Ignorance"*, R. Duncan & M. Weston-Smith, Editors, Wallaby Books, New York) in which Equation (2), written in the form $6\pi Gd\cdot t^2 = 1$, was associated with the de Sitter solution of Einstein's equations of general relativity. It appears, however, to be widely agreed (see e.g. "*Encyclopedia of Physics*", R.M. Besançon, Ed., Van Nostrand Reinhold Co., 2nd Edition, page 178), that deSitter's solution represents a universe of vanishingly small mass expanding with an ever increasing velocity. It is not at all clear to this author how such conclusions can be based on the last equation mentioned above. Be that as it may, it is incontrovertible to conclude that the significance of Equations (2) and (21) as deriving directly from Equation (1) and the rich implications of this fact, as are here being demonstrated, have till now been totally missed. For example, Roxburgh (loc. cit.) goes only as far as to state that $6\pi Gd\cdot t^2 = 1$ expresses the dependence of G upon "the cosmological distribution of matter". Also, this author has found that R.H. Dicke ("*Evidence for Gravitational Theories*" Academic Press, London, 1962) pointed out that $Gd\cdot t^2 = 1$ can be obtained from simple dimensional considerations, but he went no further. (See also discussion p. 39).

luminal velocities! On the other hand, because of the variability of the velocity of universal expansion, the velocity of light can only remain constant and limiting, if it is pegged at $c = \infty$ for all time, which is clearly not observed. The above two principles are, therefore, mutually exclusive. *Universal expansion and observation compel us to reject the principle of the constancy of the velocity of light*. The velocity of light can thus remain limiting, but its value *must* be given as a function of the universal age, regardless of all that this entails!

In order to proceed, it is necessary to decide whether or not light constitutes a fundamental and inseparable part of the universe. The Compton effect demonstrated that the scattering of light can only be understood if light is regarded as a stream of particles exchanging upon collision energy and momentum in the way of ordinary massive particles. Pound and Rebka demonstrated that light gains energy as it falls down towards the Earth similarly to ordinary massive particles. While both phenomena have been interpreted in terms of the theory of relativity, they are also compatible with the theory of the ponderability of the photon first proposed by Newton. This work is based upon Newtonian gravitation. If Eq. 1 is a fundamental law, then surely it must be obeyed universally by *all* particles in the Universe. In other words, *all particles, including the photon, are* ponderable, namely, have mass. Under these conditions, *all* wave properties of light must be seen as derivative properties due to the intrinsic nature of the *massive* photon. We must go one step further and *proclaim the fundamental photon as the best candidate to be the single fundamental particle out of which all other particles in the Universe are made up,* and thereby give the most affirmative answer to the question posed in the opening of this paragraph: *Where light is, there too is the Universe; the Universe extends only as far as the First Light of Creation*. Before proceeding with the study of this last statement, we must stop to give reasons for making the earlier italicized statement.

It follows directly from the last statement above that the front of the expanding universe is none other than the front of the First Light emitted at the moment of Creation. The following question arises: How does the *present* velocity of First Light relate to the velocity of the photon here and now? If the momentary velocity of light were independently *fixed* on the momentary age of the Universe (as the velocity of First Light obviously is, based on Eq. 18´), *and* on the universal age at each subsequent emission (during, e.g., a nuclear reaction), the study and understanding of physical phenomena would become extremely complicated, if at all tractable. If this were the case, astronomical distances, in particular, would be essentially indeterminate. Such indeterminacy disappears if the velocity of light is *universally dependent only upon the age of the universe*: *Photons everywhere in the universe have the same velocity at the same universal age*. The following question arises: How do all photons in the universe "communicate" and "agree" to adjust their velocity to the same absolute value, relative to the center of the universe (see section 2.3.2.2.4), at any given moment? This question takes us directly into the fundamental nature of the natural Law, which we shall study later in this work. However, it must be recognized that regardless of the problem of the Law, a great simplification can be obtained if we *understand all photons*

to have a common age: the age of the universe. In other words, when a photon is emitted, or absorbed, it is not created, nor destroyed, at that very moment; it is only released to, or absorbed from, the free state. Before its release, or after its absorption, the photon is a constituent part of the particular body in question. *Ordinary bodies are thus nothing other than fully organized coagulations of photons existing in a bound state*.

This last one, is a most general statement. Obviously, the recognized particles of matter are themselves coagulations of photons also, so that photons in a body *must be seen in the full complexity of the constitution of matter* to which they give rise. The principles of the constancy of mass in the universe, of the ponderability of the photon (see next section) and of its indestructibility lead directly to the *principle of the constancy of the number of fundamental photons in the universe*. The fundamental photon thus emerges as the ultimate fundamental particle. The characters of Creation and of the Universe are thus greatly simplified: Creation involved *only* photons! The Universe in the most fundamental sense contains *only* photons—*fully organized under explicit exact Law*!

2.3.2.2.2. The Ponderability of the Photon.

The Pound-Rebka experiment deserves special attention: Using the Mössbauer effect (phenomenon of recoilless resonance fluorescence), they measured an increase in the energy of photons falling down a 22-meter tower. This increase in energy was measured as an increase in the frequency of light received at the bottom of the tower relative to the frequency of the light emitted. The following explanation of this phenomenon has been given: According to quantum theory, a photon of frequency ν, has energy $h\nu$, h being the Planck constant. As a result, $\delta\nu/\nu = (\nu' - \nu)/\nu = \delta E/E$. According to Einstein, a photon of energy E has an "apparent" mass $m = E/c^2$. Combination of these two statements yields $m = h\nu/c^2$. When a particle of mass m falls a distance δH down a gravitational field of approximately constant intensity g, it acquires an extra energy $\delta E = mg(\delta H)$. For the photon this becomes $\delta E = h\nu g(\delta H)/c^2$, the relative increase in its energy thus being $\delta E/E = g(\delta H)/c^2$. For $g = 980.7$ cm/sec^2, this fraction measures 1.091×10^{-16}/meter. Pound and Rebka's result was in good agreement with this value.

The Pound-Rebka measurement can be interpreted along more traditional lines without reference to the theory of relativity, by assuming a variable velocity of light relative to the Earth and considering the relationship $E = mc^2$ to hold (which shall be shown later in this work, without reference to the theory of relativity), among the instantaneous quantities of energy and velocity for a photon of fixed mass. A photon, upon emission from the top of the Pound-Rebka tower, has energy $E=mc^2$. As it "falls down" it accelerates slightly. As a result, upon reception at the bottom of the tower, it has energy $m(c + \delta c)^2 = mc^2(1 + \delta c/c)^2$. Because of the very small change in velocity, this is sensibly equal to $mc^2(1 + 2\delta c/c)$. The net increase in energy per photon thus is $\delta E = mc^2(2\delta c/c)$. This can only be due to the acceleration of the photon afforded by expending potential energy of the field. If at the top, the potential energy relative to the Earth is mgH

and at the bottom, $mg(H - \delta H)$, the potential energy difference is $-mg(\delta H)$. By the principle of conservation of energy, then, it follows that $mc^2(2\delta c/c) - mg(\delta H) = 0$, or that $(2dc/c) = g(dH)/c^2$. It follows that $\delta E/E = g(\delta H)/c^2$. This, however, is an oversimplified and basically incorrect explanation that only matches the earlier relativistic one. Both explanations are in error, at least as far as they assume g to be constant. But $\delta g/g = -2\delta H/H$, or 6.91×10^{-6} over the height of the tower, and is far too large not to be properly considered in a study of a far more minute an effect. The correct explanation will be given in Addendum VII. Even so, the objective here is to indicate a phenomenon involving light that can be interpreted, equally well as by relativity, on the basis of a variable relative velocity, which suggests that the photon, at least in this respect, may be regarded to behave similarly to other bodies.

Despite current opinion, from a purely relativistic viewpoint, the currently accepted interpretation of the Pound-Rebka experiment is most peculiar: The question must be asked and answered: What exactly happens to the photon as it falls down? When it acquires some extra energy, how exactly does the photon change? According to the theory of relativity, the kinetic energy of a body increases both directly, with an increase of its velocity, and indirectly, due to increase of its effective mass. Thus, a body of rest mass m_o moving with velocity v has an effective mass m and kinetic energy $E_{kin} = (^1/2)\cdot mv^2 = (^1/2)\cdot m_o v^2\cdot\times (1-v^2/c^2)^{-1/2}$, where c is the velocity of light. If the body is a photon, to which the theory assigns zero rest mass, we are forced to conclude that its kinetic energy is 0/0, that is, completely indeterminate! The theory makes no statement as regards the potential energy of bodies. Thus the theory of relativity can provide absolutely no answer to the question just posed. Nor can the quantum theory do any better! Other than mathematically manipulating some expressions, both theories seem in fact effectively to prohibit study into the nature of the photon, which may explain why nothing has been added to our knowledge of it since 1905! This is highly unsatisfactory, because ultimate knowledge of the universe must perforce include knowledge of the nature of the photon. Nor can we continue to appear to be satisfied with a theory that depends upon an "apparency", (not unlike a deus ex machina) in order to be saved from internal inconsistency.

This work is based upon the strict applicability of Newtonian gravitation as discussed in Section 1.2. It is necessary, therefore that we now return to the Newtonian notion of the ponderability of the photon: This is essential if we are to continue to regard mass and energy as physically "equivalent" (about which more later). Physical equivalence requires that the mass of the photon be physically real and not only mathematically apparent and totally devoid of precise physical meaning. The notion of ponderability requires that the photon be treated like any other physical body. The universe will be simplest if no special exemptions are made regarding the behavior of bodies according to laws universally applicable. Exemptions can only be accepted if they are absolutely necessary to explain unassailable experimental findings that are impossible to reconcile on the basis of the simplest set of universally applicable Laws; they *cannot* be accepted as a priori theoretical postulates that necessarily complicate such a set of Laws.

Acceptance of the ponderability of the photon is required on the following grounds also: We do not know what pure energy, totally disembodied of mass, really is. From the all-important dimensional viewpoint, to speak of "pure" energy is nonsense, because energy is defined in terms of mass, length and time. Just as energy *cannot* be defined without reference at all to some length and time interval having to do with the activities of the body in question, so too, it *cannot* be defined without reference to the mass of that body, or, in the very least, to the mass of *some particular* body. It follows that energy, by the very nature of the physical world, is *eternally bound to mass* and can only be understood, if at all, in terms of the latter*. In other words, it is totally nonsensical to say that a body possesses energy yet is massless. For then, to what mass is the energy possessed by such a body related to, if not to the very mass of the body itself? *To this question there can be no precise answer*. A fully meaningful universe is precisely one in which all correct and sensible questions have exact, correct, sensible answers. Thus either the universe is not and can never be fully meaningful, or the question was incorrect. Nobody can possibly choose the first option and still adhere to physical science, which is predicated precisely on the notion that the Universe is indeed meaningful (meaning, admitting of an exact, correct and fully logical explanation). The resolution of the dilemma lies with the question, not the Universe! In the present case, the question was predicated upon the separability of the energy from the mass of a (any) body. This predicate must be rejected. Such rejection leads directly to the acceptance of the ponderability of the photon, that alone can preserve the "equivalence" (seen in the light of the last footnote) of mass and energy, and to the rejection of the notion that the mass of the photon is not real and only apparent. There is nothing "apparent" about the mass of a body that behaves gravitationally entirely like the mass of the so-called corporeal, or ponderable, bodies, the objective reality of the masses of which has never been questioned. In the final analysis, we are compelled to conclude that there are no incorporeal particles, that all particles barring none are corporeal, that they incorporate an innate and fundamentally irreducible intrinsic mass, which constitutes the basis of their objective existence and entire essence.

If we are to accept the photon as ponderable, what is to become of the wave-like nature of light, upon which most of modern physics is based? If the above conclusions are logical, and can hardly be otherwise, especially in view of the all-important dimensional argument discussed above, the wave-like nature of light must be attributed to the internal structure and interactive properties of the photon, and our failure to recognize this to the fact that so far we have examined light only in beams (meaning bundles of photons) travelling together. We have not yet isolated single photons, nor have we given an exact answer to the following question: Given a photon of energy $\epsilon = h\nu$ and a photon of energy $\epsilon_o = h\nu_o$, where $\epsilon = j\epsilon_o$, j being a whole number, is the first photon a packet of j photons

* The opposite is however *not* true; mass is *not* eternally bound to energy; because, mass is a *fundamental* dimension and is, therefore, capable of independent existence, at least in principle. Simply put, a body does not become massless when it becomes motionless; yet, when it is motionless, it also is "energyless".

of the second kind, or is it a totally distinct singular entity of equivalent energy content? For if we should choose the second option, we must admit that there are *at least* as many kinds of fundamental particles in the universe as there are photons of distinct energy levels. This option, therefore, does *not* allow the simplicity that physical science presumes to exist in the physical world, a simplicity that requires the *fewest possible distinct kinds of fundamental particles*, out of which the universe has been built. Again, if we should choose the first option, we must admit that there is a basic or fundamental photon out of which all greater (meaning now heavier, also) photons are composed. In this way, the number of the distinct kinds of fundamental particles in the universe is kept at the absolute minimum, but we are required to recognize and study the internal interactions of the packets of fundamental photons, with which we have so far played, to which interactions the wave-like nature of light must ultimately be due. It is this first option for which we must opt. For, not only does it still preserve the possibility of a fundamentally very simple universe, it also finally resolves at least two very important questions.

The first question refers to what exactly happens to a "photon" as it gains or loses energy. If the photon is a fundamental particle of eternally fixed mass and temporally fixed velocity, its energy is fixed at any universal age, T. A fundamental photon can neither gain nor lose energy at fixed T. However, as it travels through a field, it may acquire companions, thereby forming a bundle or packet. Such bundles "gain" or "lose" energy, meaning that they acquire additional members, or lose some, and in the process they appear to blueshift or redshift, respectively.

The second question refers to the nature of the medium through which light-like (electromagnetic) waves travel. This question certainly was *not* resolved with the advent and ascendancy of the theory of relativity. It was only confused by, and hidden from view behind, the new concept of spacetime, which has still to be given a physical and not only a mathematical existence. Looked at dimensionally, the physical picture of spacetime (dimensionally composed of length and time, only) in which "massless" particles, i.e. photons, travel in a wave-like pattern (which is the physical picture of the special theory of relativity), totally fails to account for the corporeal properties of light. In view of this failure, mass, which lies at the core of all corporeal phenomena, has been made to enter the special relativistic view of the world only indirectly, through its "equivalence" to a supposedly "pure" (i.e., massless) energy. As a result, the mass-energy equivalence is not at all, as is usually claimed, an outcome of special relativity, but rather an additional and independent premise of it, on the basis of which alone may the theory claim to be at all physical. On the contrary, the notion of corporeal (i.e., massive) bullet-like particles (photons), travelling individually, or in groups (bundles or packets) within, between and among which, these particles interact with each other, presents a dimensionally complete picture of the entity we call light or "radiation". Even the otherwise emptiest intergalactic space is not at all empty, but rather a three-dimensional conglomeration (sea) of such particles travelling in all directions. It is inevitable that their interaction should give rise to "wave" phenomena, essentially similar to those encountered in acoustics. Such "radiation" does indeed provide a dimensionally complete explana-

nation of the dual, mass-like and wave-like, nature of light. It also travels best in perfect vacuum and needs no "ether" as a medium of transmission (see Addendum V).

2.3.2.2.3. Re-Examination of the Michelson-Morley Experiment.

The last sentence brings to mind the null result of the Michelson-Morley (MM) experiment. Although that experiment proved the absence of ether, the presumed medium of transmission of electromagnetic radiation, it nevertheless failed to bring about the required re-examination of the notion of electromagnetism. As a result, to this day, all "light" remains a radiation without a medium, yet, nobody seems to be duly concerned. Re-examination was effectively prevented by the advent of the theory of special relativity, which purported to provide a theoretical explanation of the null result of the MM experiment. But, in fact, the theory only succeeded in substituting one notion for another: "spacetime" for ether. Radiation, instead of being regarded as undulations of the "ether", was henceforth seen as "undulations" of "spacetime". In a fundamental sense, *only* the names have been changed: spacetime was advanced as the "physical" substitute of the "non-physical" ether, *but no deeper understanding has been produced*; spacetime still remains a purely theoretical notion and has yet to become a physical quantity upon which experiments can be performed. Because, as we saw in the last paragraph, spacetime lacks the dimensional completeness of ether: mass is introduced arbitrarily as the equivalent of energy, which is introduced, also arbitrarily, as the "fluid" transferred by the "undulations" of the physically two-dimensional (composed only of length and time) spacetime! Compared to all this, the ballistic-interactive view of light proposed here rids us completely of the physical as well as of the philosophical shortcomings and limitations of both ether and spacetime. Moreover, *it is this ballistic-interactive nature of light that receives the full support of the null result of the MM experiment and not the classical wave-like nature of light or the theory of relativity*. This, however, can only be understood after a recounting and a critical re-examination of the classical analysis of that experiment.

Michelson and Morley increased the sensitivity of their instrument by increasing the effective length of both light paths to 11 meters, through the use of multiple reflections. It is theoretically immaterial whether a single or multiple reflections is or are used, yet, it was probably due to the use of the latter that the analysis of the experiment has been confused in a very significant way. Let us first consider the simplified schematic representation of the experiment as given in the literature, reproduced here in Fig. 1. According to accepted interpretation, when the principal axis of the interferometer is oriented parallel to the direction of motion (velocity v) of the Earth relative to ether, the times required for the forward to and backward from mirror M_1 journeys of a light ray originating from and returning to mirror M are, respectively, t_1 and t_2 in:

$$ct_1 = L_1 + vt_1 \qquad \text{and} \qquad ct_2 = L_1 - vt_2,$$

the total time required for the complete journey being

$$t = t_1 + t_2 = (2L_1/c)(1 - v^2/c^2)^{-1}.$$

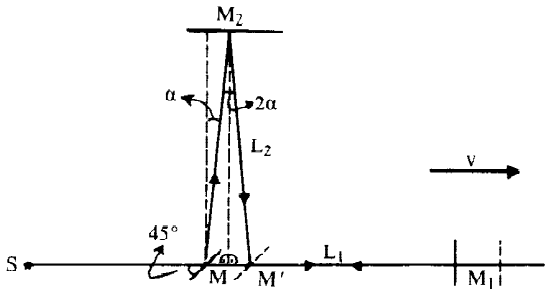

FIG. 1
The Michelson-Morley Experiment.

For the transverse journey, the light ray originating from M and travelling to and from mirror M_2 is regarded to be describing an angle $MM_2M' = 2\alpha$, MM_2 being the outward leg and M_2M' the return leg of the journey. The times required for these two legs are thus taken to be respectively t_1' and t_2 in

$$(ct_1')^2 = L_2^2 + (vt_1')^2 \quad \text{and} \quad (ct_2')^2 = L_2^2 + (vt_2')^2 ,$$

leading to a total time for the complete journey given by

$$t' = [2L_2(1-v^2/c^2)^{-1/2}]/c .$$

The difference in duration between the two trips, for $L_1 = L_2 = L$, is

$$\delta t = Lv^2/c^3$$

In the MM experiment, this should result in a number of fringes

$$n \cong 2L(v^2/c^2)/\lambda$$

being observed in the microscope of the interferometer, λ being the wavelength of light used (= 5.6×10^{-5} cm) and v/c being taken as equal to 10^{-4} (assuming the entire orbital velocity of the Earth around the Sun to be the velocity of the interferometer). Accordingly, $n \cong 0.37$ fringes, yet, no more than 0.01 fringes were observed. This was interpreted to mean the nonexistence of ether, unless the expected fringe difference was somehow made to disappear. Fitzgerald suggested that this in fact would happen if the interferometer length and all lengths parallel to the direction of motion relative to ether were foreshortened by the factor $(1-v^2/c^2)^{1/2}$, a phenomenon caused by the motion itself. The special theory of

relativity, developed on purely theoretical considerations, provided this precise amount of contraction, and thus by replacing "ether" by "spacetime", a supposedly satisfactory explanation of the negative outcome of the MM experiment was provided on a purely theoretical basis and the special relativity theory triumphed.

Two principles only are claimed to be involved in this experiment: that of Huygens on the reflection of light from mirrors and that of the constancy of the speed of light. Yet, *neither principle has been considered well* in the accepted mathematical analysis of the MM experiment, carried out as just reproduced in the previous paragraph: For according to Huygens, light is reflected from mirrors with an angle of reflection equal to the angle of incidence. In the MM experiment, the principal mirror M was fixed at an exact 45° angle relative to the principal axis. The reflected (transverse) light ray should therefore, according to this principle, lie at an exact 90° angle relative to the principal axis. Yet, in the mathematical analysis adopted by Michelson and Morley and accepted ever since, the reflected ray is assumed to lie at a $90° + \alpha$ angle from the incident ray on the principal axis, *in violation* of the Huygens principle. Such a violation has *never* been observed, and on this basis alone, it should not have been allowed in the consideration of the MM experiment: Michelson and Morley obviously were forced into committing this violation in the analysis of their experiment in their effort to apply to that analysis two ideas that are *mutually exclusive,* namely, the idea of light participating *directionally* in the motion of its source and the idea of the velocity of light in the ether remaining, as a scalar, constant. For without these two ideas *co-applied,* it is impossible to see the justification for the reflection to be considered to occur at an angle of $90° + \alpha$ from the incident path, namely, along the hypotenuse of a right-angled triangle, at the same time that light is considered to travel along this hypotenuse with the absolutely constant velocity c! In their effort to co-apply these ideas, they *used* the velocity vector of the source (mirror M) only when they wanted to determine the direction of the reflected ray, but they *ignored* it when they came to determining the value of the velocity of the reflected ray (obviously, on the grounds of light being in essence waves and waves having a scalar velocity independent of the velocity of their source and dependent only upon the properties and conditions of the medium of propagation). Such treatment of velocity vectors is entirely arbitrary and certainly inexcusable when it comes to studying two aspects of the same almost-instantaneous phenomenon, as the reflection of light from the mirror M. A velocity vector either exists (has both a scalar and a direction) or not (when it lacks either scalar or direction or both); it cannot both exist and not exist as treated by Michelson and Morley! Moreover, the accepted analysis lacks self-consistency, because it fails to consider an identical phenomenon occurring at the mirror M_2, which should also have imparted to the there reflected ray an additional directional component. When this is considered, it is found that the transverse legs MM_2 and M_2M' are no longer equal. In light of these objections, it would be most surprising indeed, if the outcome of the MM experiment, which cannot be faulted in itself, were found to corroborate the faulty prediction.

It is very surprising that the illogical and physically faulty foundations of the mathematical analysis of the MM experiment have not yet been exposed and

rejected. It is also very unfortunate, because the null result of that experiment was and has ever since been judged on the basis of the erroneous result of that erroneous analysis. The theory of relativity, when it arrived, utterly failed to draw attention to those grave errors. Rather, it built upon them the physical proof of its own correctness! By providing the way to make the erroneous result of that erroneous analysis come to agreement with the outcome of the experiment, it legitimized the former and purported to explain the latter.

Even without the objections discussed above, the special relativistic interpretation of the null result of the MM experiment can at best be accepted as valid only when the *total* motion of the interferometer is in the direction of its principal axis MM, and the interferometer *is assumed* to suffer no changes in the direction of its transverse axis MM_2. Yet, the experiment gave uniformly null results regardless of its orientation and without *any* special effort being made to ensure that the total velocity vector is *at all in the plane* defined by the two interferometer axes. The interferometer was floated on mercury. The horizontal plane thus established was however not privileged in any way relative to the total motion of the interferometer in space. Therefore, if a fourth mirror M_3 were incorporated in the interferometer, such that the direction MM_3 defined the direction of the perpendicular z axis, there is no doubt that a null result would have been obtained in that direction also. It is therefore necessary to re-analyze the experiment in order to obtain the pertinent relationships for *any* orientation of the *true total* velocity vector.

In this analysis, the principal interferometer axis MM_1 is the x-axis, the transverse axis MM_2 is the y-axis, and the perpendicular axis MM_3 is the z axis. The total velocity vector v is in such a direction that its projection on the x-y plane forms an angle θ with the x-axis, while the angle between v and z is ϕ. Accordingly, the components of motion along the three axes are as follows: $v_x = v\sin\phi\cos\theta$, $v_y = v\sin\phi\sin\theta$, and $v_z = v\cos\phi$. With the zero of the co-ordinate system at M, at time t = 0, the co-ordinates of the four mirrors at times 0 and t are as follows (Fig. 1A):

Coordinates of mirrors	x =	y =	z =	at time t
M	0	0	0	0
M	$vt\sin\phi\cos\theta$	$vt\sin\phi\sin\theta$	$vt\cos\phi$	t
M_1	L_1	0	0	0
M_1	$L_1 + vt\sin\phi\cos\theta$	$vt\sin\phi\sin\theta$	$vt\cos\phi$	t
M_2	0	L_2	0	0
M_2	$vt\sin\phi\cos\theta$	$L_2 + vt\sin\phi\sin\theta$	$vt\cos\phi$	t
M_3	0	0	L_3	0
M_3	$vt\sin\phi\cos\theta$	$vt\sin\phi\sin\theta$	$L_3 + vt\cos\phi$	t

1. Along the x-axis, light leaves the mirror M at t = 0 and arrives at the mirror M_1 at $t = t_1'$: it reflects on M_1 at $t = t_1'$ and returns to M at $t = t_1$. The distances covered by light in the intervals 0 to t_1' and t_1' to t_1 are given respectively by:

$$(L_1 + vt_1'\sin\phi\cos\theta)^2 + (vt_1'\sin\phi\sin\theta)^2 + (vt_1'\cos\phi)^2 = (ct_1')^2$$

and

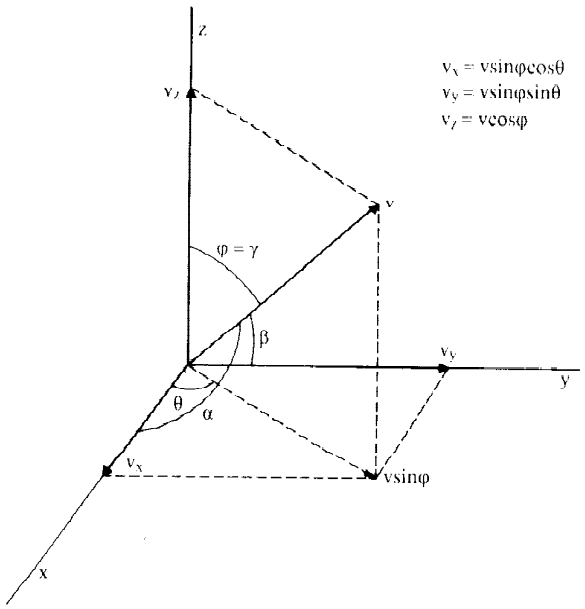

FIG. 1A

The Disposition in Space of the Michelson-Morley Interferometer. The principal axis is parallel to axis x; the transverse axis is parallel to axis y; the overall motion in space is parallel to the velocity vector v. The classical analysis of the experiment ignored vector v.

$$[vt_1\sin\phi\cos\theta - (L_1 + vt_1'\sin\phi\cos\theta)]^2 + (vt_1\sin\phi\sin\theta - vt_1'\sin\phi\sin\theta)^2 + (vt_1\cos\phi - vt_1'\cos\theta)^2 = [c(t_1 - t_1')]^2$$

Upon rearrangement, these equations produce:

$$t_1' = L_1 / c\cdot[(1 - \rho^2\cos^2\phi - \rho^2\sin^2\phi\sin^2\theta)^{1/2} - \rho\sin\phi\cos\theta]$$

$$t_1 = t_1' + L_1 / c\cdot[(1 - \rho^2\cos^2\phi - \rho^2\sin^2\phi\sin^2\theta)^{1/2} + \rho\sin\phi\cos\theta]$$

$$= 2L_1[1 - \rho^2(1 - \sin^2\phi\cos^2\theta]^{1/2} / c\cdot(1 - \rho^2)$$

and in polar co-ordinates:

$$t_1 = 2L_1 (1 - \rho^2\sin^2\alpha)^{1/2} / c\cdot(1 - \rho^2),$$

where $\rho = v/c$ and α the angle between v and the x-axis.

2. Along the y-axis light leaves the mirror M at $t = 0$ and arrives at the mirror M_2 at $t = t_2'$; it reflects on M_2 at $t = t_2'$ and returns to M at $t = t_2$. The distances covered by light in the intervals 0 to t_2' and t_2' to t_2 are given respectively by:

$$(vt_2'\sin\phi\cos\theta)^2 + (L_2 + vt_2'\sin\phi\sin\theta)^2 + (vt_2'\cos\phi)^2 = (ct_2')^2;$$

and

$$(vt_2\sin\phi\cos\theta - vt_2'\sin\phi\cos\theta)^2 + [vt_2\sin\phi\sin\theta - (L_2 + vt_2'\sin\phi\sin\theta)]^2 + (vt_2\cos\phi - vt_2'\cos\phi)^2 = [c(t_2 - t_2')]^2.$$

Upon rearrangement one finds:

$$t_2' = L_2/c\cdot[(1 - \rho^2\cos^2\phi - \rho^2\sin^2\phi\cos^2\theta)^{1/2} - \rho\sin\phi\sin\theta]$$

$$t_2 = t_2' + L_2/c\cdot[(1 - \rho^2\cos^2\phi - \rho^2\sin^2\phi\cos^2\theta)^{1/2} + \rho\sin\phi\sin\theta]$$

$$= 2L_2[1 - \rho^2(1 - \sin^2\phi\sin^2\theta)]^{1/2}/c\cdot(1 - \rho^2),$$

and in polar co-ordinates:

$$t_2 = 2L_2(1 - \rho^2\sin^2\beta)^{1/2}/c\cdot(1 - \rho^2),$$

where $\rho = v/c$ and β is the angle between v and the y-axis.

3. Along the z-axis light leaves the mirror M at $t = 0$ and arrives at the mirror M_3 at $t = t_3'$; it reflects on M_3 at $t = t_3'$ and returns to M at $t = t_3$. The distances covered by light in the intervals 0 to t_3' and t_3' to t_3 are given respectively by:

$$(vt_3'\sin\phi\cos\theta)^2 + (vt_3'\sin\phi\sin\theta)^2 + (L_3 + vt_3'\cos\theta)^2 = (ct_3')^2;$$

and

$$(vt_3\sin\phi\cos\theta - vt_3'\sin\phi\cos\theta)^2 + (vt_3\sin\phi\sin\theta - vt_3'\sin\phi\sin\theta)^2 + [vt_3\cos\phi - (L_3 + vt_3'\cos\phi)]^2 = [c\cdot(t_3 - t_3')]^2.$$

Upon rearrangement, one obtains

$$t_3' = L_3/c\cdot[(1 - \rho^2\sin^2\phi)^{1/2} - \rho\cos\phi]$$

$$t_3 = t_3' + L_3/c\cdot[(1 - \rho^2\sin\phi)^{1/2} + \rho\cos\phi] = 2L_3\cdot(1 - \rho^2\sin^2\phi)^{1/2}/c\cdot(1 - \rho^2)$$

and in polar co-ordinates:

$$t_3 = 2L_3(1 - \rho^2\sin^2\gamma)^{1/2}/c\cdot(1 - \rho^2)$$

where $\rho = v/c$ and γ the angle between v and the z-axis. Because the MM experiment gave uniformly null results, it perforce follows that $t_1 = t_2 = t_3 = t$, so that

$$(1/2)ct = L_1/(1 - \rho^2)(1 - \rho^2\sin^2\alpha)^{-1/2} = L_2/(1 - \rho^2)(1 - \rho^2\sin^2\beta)^{-1/2} = L_3/(1 - \rho^2)(1 - \rho^2\sin^2\gamma)^{-1/2} \quad (23)$$

where the lengths L_1, L_2 and L_3 are the measured lengths of the interferometer parallel respectively to axes x, y and z as it moves through space with velocity v. It is obvious from the multiplicity of measurements performed at all angles and times, that each of the three lengths is related to the fundamental length of the interferometer, defined as $L_0 = L_{01} = L_{02} = L_{03}$ at velocity $v = 0$, in the following manner: $L_1 = L_0 f_1(\rho, \alpha)$; $L_2 = L_0 f_2(\rho, \beta)$; and $L_3 = L_0 f_3(\rho, \gamma)$; for all values of ρ and of α, β, γ, the only constraint being that $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$. For Eq. 23

to hold for all such values, it is necessary that

$$L_1 = kL_0 \cdot (1 - \rho^2)\,(1 - \rho^2 \sin^2\alpha)^{-1/2}, \tag{23a}$$

$$L_2 = kL_0 \cdot (1 - \rho^2)\,(1 - \rho^2 \sin^2\beta)^{-1/2}, \tag{23b}$$

$$L_3 = kL_0 \cdot (1 - \rho^2)(1 - \rho^2 \sin^2\gamma)^{-1/2}, \tag{23c}$$

where k is a dimensionless constant which without any loss in accuracy can be set equal to unity in the simplest case. The MM experiment thus shows that a solid body of length L measured in a particular direction when at *true overall* rest, measures a length $L(1 - \rho^2)\,(1 - \rho^2 \sin^2\delta)^{-1/2}$ in the same direction, when it travels with velocity $v = \rho c$ in a direction forming angle δ with that particular direction. When the angle of the two directions is zero, the body thus measures $L(1 - \rho^2)$ in the direction of travel and $L(1 - \rho^2)^{1/2}$ in a direction perpendicular to the direction of travel.

The above finding is in sharp contrast to the Fitzgerald contraction factor that was postulated simply as $(1 - \rho^2)^{1/2}$ in the direction of travel and unity in the perpendicular direction, which the theory of relativity "established" as compatible with the so-called Lorentz transformations. The MM experiment, when correctly analyzed, is thus seen *not* to support the theory of relativity, though the ratio of the two contractions, parallel and transverse, stands in the same ratio of $(1 - \rho^2)^{1/2}$, in the special case of $\alpha = 0$.

A sphere *measuring perfect when at true overall rest*, when set to motion *is being distorted* according to Eqs. 23, 23a, 23b, 23c along its *arbitrary* three orthogonal axes forming angles α, β, and γ with the direction v of motion. *This must be viewed as a general property of all bodies, the cause of which is very deep indeed,* as we shall see right below. *Because under the corpuscular-interactive view of light there is nothing out there that can possibly affect a moving body*; *distortions in its shape under motion can only be due to causes hidden within the body.*

2.3.2.2.4. The Velocity of the Photon in Free Flight and in Bound States.

The question is now asked: What are the tacit assumptions made in the above re-analysis of the MM experiment, which lie at the foundation of Eq. 23?

If we assume two more mirrors, one at the light source and one at the cross-hairs of the interferometer microscope, each positioned perpendicularly to the direction of light travel at each point, *then, all light from the source will forever be bound within the interferometer, and as such be made a permanent part of it. Yet, there is no question that light is essentially in free flight, except perhaps at the moments of reflection that are theoretically and practically of near zero duration.*

As a result, the first assumption made is that the velocity of light is essen-

tially constant during the brief period of travel from the mirror M to and from the mirrors M_1, M_2, and M_3.

The existence of a unique point such as the center of the universe, imposes the constraint that the velocity of photons, bound within the interferometer be referred both to the center of the universe as well as to the interferometer itself. If the photons in free flight within the interferometer have the entire velocity c relative to the interferometer, while the interferometer as a whole has a velocity v relative to the center of the universe, under the ballistic-interactive principle, under which *all* projectiles obey the same rules, there can be no question that these photons have to have a composite velocity relative to the center of the universe different from c. This is immediately seen from the parallelogram of velocities: $c'^2 = c^2 + v^2 + 2cv\cos\theta$ where θ is the angle between the two vectors c and v. If there is value in having the velocity of light constant, *that velocity must be viewed as necessarily referring to the same universal point of reference, the only such point being the center of the universe, for only then can the term* "*constancy*" *have any meaning*. All such meaning is totally lost in chaos if each photon refers its velocity to its own (latest?) source in space and time.

In order to preserve rationality, therefore, it is necessary that the *total* velocity of the photon, namely, its velocity relative to the center of the universe, have the value c. And thus it is necessary that its velocity relative to the interferometer have a value x such that:

$$c^2 = x^2+v^2+2xv\cos\theta, \quad \text{or} \quad x = c[(1 - \rho^2\sin^2\theta)^{1/2} - \rho\cos\theta], \tag{24}$$

where, $\rho = v/c$. In the simplified case where the velocity v is parallel to a radius of the universe, the velocity of photons relative to the interferometer assumes values dependent upon the angle θ as follows:

Angle θ	Velocity x =
0°	$c(1 - \rho)$
90°	$c(1 - \rho^2)^{1/2}$
180°	$c(1 + \rho)$
270°	$c(1 - \rho^2)^{1/2}$

Under these conditions, the times of flight in a so-positioned MM interferometer become:

$$t = L_1/c\cdot(1-\rho) + L_1/c\cdot(1 + \rho) = 2L_1/c\cdot(1 - \rho^2),$$

$$t' = L_2/c\cdot(1 - \rho^2)^{1/2} + L_2/c\cdot(1 - \rho^2)^{1/2} = 2L_2/c\cdot(1 - \rho^2)^{1/2}.$$

Since the MM experiment yielded $t = t'$, it perforce follows that:

$$L_1 = L_2(1 - \rho^2)^{1/2},$$

identical to the value obtained from Eq. 23 for $\alpha = 0°, \beta = \gamma = 90°$*.

* It follows that the best instrument for the determination of the velocity of light is an interferometer in which the number or fringes observed, n, is reduced to zero. Then, for a two-way trip: [See bottom of next page]

Consider now a body in elliptical orbit, the major and minor axes of which have values 2a and 2b, respectively. Its orbital velocity is given by V in

$$V^2 = 2K/r - K/a,$$

where K = GM, G being the universal gravitational constant, M the attracting mass and r the separation. The latter is given by:

$$r = \alpha\cdot(1 - e\cos E),$$

where e is the eccentricity having value $(1 - b^2/a^2)^{1/2}$, and E the eccentric anomaly. The orbital velocity at periapsis and apoapsis assumes values V_p and V_a given by

$$V_p^2 = K(1 + e)/a(1 - e) \quad \text{and} \quad V_a^2 = K(1 - e)/a(1 + e).$$

Setting these values equal to $V_p = c + v$ and $V_a = c - v$ respectively, and dividing by parts yields:

$$(1 + e)/(1- e) = (1 + v)/(c - v),$$

resulting in $e = v/c = \rho$. Introducing this value for e yields at once:

$$b = a(1 - \rho^2)^{1/2}.$$

From

$$K(1 + e)/a(1 -e) = (c+v)^2,$$

one obtains

$$K/a = c^2\cdot(1 - \rho^2),$$

which is the square of the value of the orbital velocity at $\theta = 90°$ and 270°.

It is thus seen that the velocity of the photon relative to the interferometer, fully satisfies the equation of motion of a photon in an elliptical orbit disposed with the minor axis parallel to the principal interferometer axis. At periapsis, c and v are antiparallel and add up; at apoapsis they are parallel and subtract.

This analysis shows that whereas the photon, relative to the center of the universe is always in free flight and always has velocity c, yet, relative to a body to which it is bound, the same photon has velocity dependent upon the overall velocity v of the body relative to the center of the universe, dependent in such a way that the photon describe an ellipse within the body, an ellipse that is uniquely determined by that velocity v (since $e = \rho = v/c$).

In a universe that fundamentally is composed of photons, it is *not* the orbits of the photons that conform to the shapes of the bodies which the former comprise. Rather it is the *bodies*, which can *only* assume shapes in full conformity to the elliptical orbits of the photons of which they are composed. Those orbits, in turn, are shaped on the requirement that photons retain a velocity the scalar value of which is essentially constant for very short periods of time relative to the center of the universe, regardless of the velocity of the body which they form relative to the same center. In this light, the MM experiment could only produce

$$c = 2L_1/t_1 = 2L_2/t_2.$$

Knowledge of ρ and of the angles α, β, and γ is unnecessary. The interferometer is self-compensating.

a null result. The orthogonality of the disposition of the interferometer demonstrated *as a fact* the participation of the photons in the motion of the interferometer, on the basis of which alone can the angle α be justified that was added to the direction of the outgoing transverse ray in the MM experiment. That angle α is absolutely necessary, if the transverse ray after reflection on M_2 is to return to the crosshairs and not to be left stranded behind as the interferometer moves forward. It is only when regarded relative to the center of the universe that light can be viewed as having constant velocity over short periods of time. Relative to some other body, light behaves just like any other projectile.

Reinforcement or cancellation, as observed in interference phenomena, up on which the notion of light as radiation is based, are only an illusion from the point of view of the photons themselves. Their motions are "affected" through interaction in free space (a more complete interpretation of the wave like nature of light will be given in Addendum V), just as it happens to the motions of molecules of water on the surface of a lake. Those molecules are certainly not aware of their participation in a wave. The wave takes form only when the relative positions of a large number of molecules are examined together. The same should be true of photons. If the so-called dual nature of light is characteristic of the individual fundamental photon, then it must also characterize the photon in a single-photon universe. In such a universe, how is the wave-like nature of the photon to be understood? No interference is physically possible in such a universe!

To return to the original question of this section: No assumption is made other than that stated in the third paragraph. However, full use was made of the concomitant principle that the question of constancy relates logically, necessarily and exclusively only to the center of the universe.

The picture we have presented here seems to be fully capable of explaining another very important phenomenon that has so far eluded satisfactory explanation: In 1956 Lee and Yang were the first to point out, on the basis of careful analysis of the experimental evidence, the absence in Nature of "parity conservation", or in other words, the ability of Nature to distinguish between left- and right-handedness. Although this has been regarded to be confined to weak interactions, especially those associated with β-decay phenomena, it is quite possible that the breakdown of parity conservation is a more general phenomenon but onlyobservable where its effects are strongest.

By its very nature, handedness is understood in terms of rotation around a particular axis. For handedness to exist, both rotation and axis are required. As a result, to be so distinguishing, particles must be capable of recognizing absolutely a particular direction in space, around which they rotate. This is possible either with reference to the outside world, or with reference to themselves. Specifically where neutrinos are involved, which are known for their extremely weak interaction with matter, if handedness is not an intrinsic property of theirs but only created during interaction with matter, it is equally extremely unlikely that their recognition of an absolute direction in space relates to the outside world. To be able to recognize direction with reference to themselves, particles are required to

be cognizant of their own absolute asymmetry. Eqs. 23 and 24 provide an exact basis for recognition of asymmetry with regard to direction for every kind of particle, as long as it moves relative to the center of the universe. When rotation is also present, both ingredients for establishing handedness exist. That photons in neutrinos rotate only lefthandedly while in antineutrinos only righthandedly is not a matter of mere coincidence: Rather, it demonstrates that no detail, however minute, in Nature has been overlooked!!!

2.3.2.2.5. The Expression for the Velocity of Light and Some Relevant Determinations.

The discussion presented so far in the present Section (2.3.2.2), leaves absolutely no doubt that the velocity of universal expansion can be no other than the velocity of light:

$$c = dR/dT = R(3T/2)^{-1}. \qquad (18'')$$

Accordingly,

$$Rc^2 = 2GM. \qquad (25)$$

Eqs. 18´´ and 25 allow the determination of the value of the universal mass, based on the present velocity of light $c_2 = 2.99792458 \times 10^{10}$ cm/sec and the universal age T_2 (estimated to be) = 12 billion years. It is found that

$$M = 1.15 \times 10^{56} \text{ grams}. \qquad (26)$$

Both average universal density and (total) universal mass values obtained here are in excellent agreement with present estimates. Of course, these values will have to be amended *if and when* it is decided that the age of the universe is other than as here assumed. The values may be bettered! The Laws *shall* remain!

On the basis of the above equations, it is also found that the deceleration of the velocity of light is quite simply:

$$dc/dT = \mathcal{G} = -c/3T, \qquad (27)$$

having the present value of

$$\mathcal{G}_2 = -c_2/3T_2 = -2.64 \times 10^{-8} \text{ cm/sec}^2,$$

and the fractional value of

$$dc/c = -dT/3T, \qquad (28)$$

presently being

$$(dc/c)_2 = -8.80 \times 10^{-19}. \qquad (28')$$

At this rate, it takes roughly 12000 years for the velocity of light to change by 0.1 km/sec, which is the present estimate of the uncertainty in its value. Little wonder that the velocity of light has so far been assumed to be constant.

Eq. 17´ now allows the determination of the present radius of the universe:

$$R_2 = 1.70 \times 10^{28} \text{ cm} = 18 \text{ billion present light-years (bply)}, \qquad (17'')$$

also subject to change with improving estimation of the universal age. However,

this radius *cannot presently* be observed by a central observer, because light will take a very long time yet to "return" to the center of the universe from the distance of its present front (see below).

The radius R_1 reached at T_1 that would just be possible to observe from the center at T_2, *if light could* be *sent back from* R_1, *is*

$$R_1 = \int cdT_{(\text{integrated from } T_1 \text{ to } T_2)}, \tag{29}$$

being the distance covered by light in the time interval T_1 to T_2. On substitution of the values for R_1 and c, Eq. 29 leads to

$$T_1 = (1/2)^{3/2}\, T_2 = 0.35355\, T_2 \tag{30}$$

and

$$R_1 = R_2/2 = (1/2)(3/2)(c_2T_2) \tag{31}$$

For T_2= 12 b.y., these quantities become, respectively,

$$T_1 = 4.24 \text{ b.y.} \tag{30´}$$

$$R_1 = 8.50 \times 10^{27} \text{ cm} = 9 \text{ bply.} \tag{31´}$$

where b.y. and bply stand for billion years and billion present light years respectively, given the finding that the velocity of light varies with time. Thus the maximum radius that is theoretically possible to observe is always one half of the radius at the time of observation and 3/4 of the present value of c_2T_2. The earliest age that is possible to observe is always the $(1/2)^{3/2} = 0.35355$ fraction of the age of observation. Thus R_1 was attained $(1 - 0.35355) \times 12 = 7.76$ billion years ago and *not 9* billion years ago, the difference being due to the decreasing velocity of light. The present-billion-light year distance was covered in less than 1 billion years in the past and will be covered in more than 1 billion years in the future.

Eqs. 17´ and 18´´ remove the perceived inconsistency of the observed radius of the universe relative to its age and the present velocity of light. Some present estimates of the radius of the universe require a velocity of expansion, in some past ages, exceeding the present velocity of light. This perceived inconsistency may have influenced the latest greater estimates of the age of the universe. No inconsistency really exists, when the universe is viewed as here described.

Eq. 25 is immediately recognized as the equation giving the Schwarzschild radius (the radius at which light escapes the gravitational pull of a central mass) for a mass equal to the mass of the universe. In other words, the radius of the universe is its Schwarzschild radius and therefore the universe cannot prevent, nor can it ever stop, the light from streaming radially away! Eq. 4a, from which Kepler's third law derives, is equivalent to

$$rv^2 = Gm_o, \tag{32}$$

according to which, an object will revolve around a central mass m_o, very much larger than its own, at a stable radius r with a tangential velocity v. Newton's law of gravitation applies equally well whether the mass m_o is concentrated at the center or extends uniformly (or at least radially uniformly) to any distance up to

the distance between the two bodies. Application of Eq. 32 to a photon revolving around the universe would require the universal mass M to be confined to a sphere of radius R_K given by

$$R_K = GM/c^2 = R/2. \qquad (32')$$

It is thus obvious that no photon can be trapped in an orbit around the universe. In fact, a photon at r = R can have no tangential velocity component. It can only stream radially outward.

Nor is it possible for a photon at r = R to send a message back to the center of the universe by means of a smaller photon. If this were to happen, the radially outward moving photon would have to travel at a superluminal velocity, or the principle of the conservation of momentum would not be upheld. As a result, the theoretically maximum observable radius given above can never really be observed. To conserve momentum, only "ponderable" bodies positioned *inside* (not at) the radius of the universe can send messages. Thus the maximum radius observable from the center can never permit observation of the earliest stages of universal evolution: Since only the radius $r_1 = \rho_1 R_1$ ($\rho_1 < 1$) can be observed (and not R,) such that

$$r_1 = \rho_1 R_1 = \int_{\text{(integrating from } T_1' \text{ to } T_2 \text{ the quantity:)}} c\,dT = R_2 - R_1',$$

which leads to:

$$\rho_1 T_1^{2/3} = T_2^{2/3} - T_1'^{2/3},$$

$$\rho_1 (2^{-3/2} T_2)^{2/3} = T_2^{2/3} - T_1'^{2/3},$$

and finally to

$$T_1' = (1 - \rho_1/2)\, T_2^{3/2}, \qquad (30'')$$

it is obvious that $T_1' > T_1$. The really observed most distant object and most ancient age are thus closer to us, more recent than as calculated earlier (R_1 at T_1).

2.3.2.3. THE HUBBLE LAW.

In 1921, Hubble observed, and it has amply been verified since, that the spectra of distant galaxies are redshifted relative to the spectra obtained here at home and due to the same processes. He interpreted this redshifting as a pure Doppler effect, and on this basis he declared the relative velocity existing between source and observer to be proportional to the distance between them according to what is now known as the Hubble Law:

$$v = H_o d, \qquad (33)$$

where v the relative velocity, d the observer to source distance and H_o the Hubble (proportionality) constant. This interpretation is accepted today as fundamentally correct, notwithstanding some (believed to be minor) objections, and is the basis for the notion that the universe expands. It shall be shown here that the Hubble law obtains directly from Eq. 18´.

In this regard, only expansional motions must be considered. These are the motion of the universal front and the motion of a spherical shell at a distance r = ρR from the center of the universe, where ρ remains independent of the universal age. Observation of these motions is certainly complicated by motions due to other causes, e.g. the motion of distant galaxies relative to the center of the particular group of galaxies to which they all belong. Such motions are not theoretically impossible to screen out.

Imagine an observer located at the center of the universe. His observations of events, in the space around him (and back in time), comply with the Hubble law. These events can be expressed as (ρ_n, T_n), where ρ is the location of the event expressed as a fraction $(0 \leq \rho < 1)$ of the radius R of the universe at the universal age T of the occurrence of the event observed. The velocity $v_{\rho n}$ and the distance r_n of each such event can be expressed as

$$v_{\rho n} = \Lambda_{\rho n} \cdot (dR/dT)_{T = T n} \tag{34}$$

and

$$r_n = \rho_n R_{T = Tn}. \tag{35}$$

The Hubble law then produces

$$(\Lambda_{\rho n}/\rho_n) \cdot (dR/RdT)_{T = Tn} = H_o. \tag{36}$$

Introducing Eqs. 17 and 18 we find

$$\Lambda_{\rho n} = (3/2)\rho_n H_o T_n = (3/2)\rho_n H_o T, \tag{37}$$

so that

$$v_{\rho n} = (3/2)\rho_n H_o T_n \cdot (dR/dT)_{T = T n}. \tag{34´}$$

The events observed also comply with the constraint

$$\int_0 v_{\rho n}\, dT = \int_T c\, dT \tag{38}$$

(integrated to the upper limits of T and T_2, respectively), of which, the left-hand side represents the distance travelled by the expanding fraction ρ in the time interval 0 to T and the right-hand side the distance travelled by light from the event (source) in the time interval T to T_2 (T_2 being the present age of the universe) back to the center of the universe.

The velocity of any point, ρ, at any universal age T can be written as

$$v_\rho = f(\rho,T) \cdot dR/dT \tag{39}$$

where f(ρ,T) must be such that f(ρ = 0, T) = 0 and f(ρ = 1, T) = 1. It is logical to impose the constraint that f(ρ,T) be a simple, monotonic function of both ρ and T. In light of this constraint, the question must now be asked whether, Case I, Eq. 34´ expresses the velocity of *any* point ρ in the interval (0,1) at any time T, in which case

$$f(\rho,T) \equiv (3/2)\rho H_o T, \tag{40}$$

or whether, Case II, it is possible that Eq. 34´ express *only* the velocity of points that are also constrained by Eq. 38. In the latter case, the quantity $(3/2)\rho_n H_o T_n$

in Eq.34´ must represent *only* the specific values of f(ρ,T) in Eq. 39 which also satisfy Eq. 38, the general form of f(ρ,T) being different from Eq. 40. Case II is logically impossible: Given the infinite set of events (ρ,T) and the subset of events (ρ_n,T_n) from the larger set, where $0 \leq \rho, \rho_n \leq 1$ and $0 \leq T, T_n \leq \infty$ it is not possible to have a simple monotonic function f(ρ,T) such that its general form be different for the subset from what it is for the entire set to which the subset belongs. There remains, therefore, as a logical necessity that Eqs. 39 and 40 hold for *all* events (ρ,T) and not only for the events (subset) that are simultaneously observed at T_2. The constraint f(ρ = 1,T) = 1, mentioned above, introduced in Eq. 40 requires that

$$H_\circ = 2/3T. \tag{41}$$

Eq. 36 gives now, in general

$$\Lambda = f(\rho,T) = \rho. \tag{42}$$

In other words, the quantity f(ρ,T) is a function of ρ only; and H_o is a function of the universal age only: The Hubble constant as determined at present is necessarily related to the present age of the universe and *does not* constitute the inverse of a universal time-independent unit of time as would be required by Case II referred to above. Eq. 42 can also be derived in the following way: The simplest form of expansion is that for which the velocity/distance ratios for all points in the universe at constant time are equal: When the velocities and distances are measured from the center, this means that

$$v_1/r_1 = v_2/r_2 = \ldots = dR/dT, \tag{43´}$$

or, in general,

$$v/r = dR/RdT \equiv 2/3T. \tag{43}$$

Expressing v and r in terms of the corresponding frontal quantities,

$$v = \Lambda(dR/dT) \quad \text{and} \quad r = \rho R \tag{44}$$

and introducing into Eq. 43 yields again

$$\Lambda = \rho,$$

as was obtained above, Eq. 42.

This kind of expansion is the only one that allows the geometrical relationships in the universe to remain constant through time as they were at T = 0, in the same sense that an infinite set of similar triangles can be conceived as generated by the endless expansion of an infinitesimally small similar triangle. Under the rules of similar triangles, the ratio v/d of the quantities v and d entering Eq. 33, in a universe expanding according to Eq. 43, is identical to the ratio v/r of the quantities v and r entering Eq. 43. Accordingly,

$$H_o = 2/3T,$$

as was obtained above, Eq. 41.

The current best estimate of the Hubble constant has been obtained by Sandage *(Astrophys. J.*, Vol. 178, 1972, p.12) to be 55 km per second per megaparsec. This is equivalent to $H_o = (17.8 \text{ b.y.})^{-1}$, the value of $T_2 = 11.867$ b.y. thus obtained being in good agreement with the value of 12 b.y., assumed for the pur-

poses of this work. In this connection, the following two things must be said at once: Firstly, the value of 12 b.y. was adopted as a best estimate when this work was initiated in 1974. At that time, Eq. 41 had not been foreseen. Secondly, the possible effects of universal expansion as discussed in this work upon the quantities entered in Sandage's measurements and calculations have not yet been considered. It is, therefore, likely that the present age of the universe may still be different from about 12 b.y. Because of the possibility of introducing systematic errors in the estimation of H_o from the recession of distant galaxies, where the observed distances are obviously not those existing at the present time, the best course for obtaining the exact value of the present universal age is through a determination of H_o from Eq. 33 at the near limit, namely, for $d \cong 0$ and use of the H_o value thus obtained in Eq. 41.

Recent work has indicated that the Earth-Moon distance is increasing by several cm/year. Satellite measurements have shown that the axis of the tidal bulge of the Earth is at a slight angle to the Earth-Moon axis, and this, according to tidal friction theory, causes the angular velocity of the Moon to decelerate and the Earth-Moon distance to increase. The respective values (see F.D. Stacey; *Physics of the Earth;* 2nd Ed., 1977; J. Wiley, p. 98-99) are –27.6 ± 5 arcsec/century^2 and 4.09 cm/year. The effect of the universal expansion on the Earth-Moon system is in addition to the tidal friction effect. Recent astronomical measurements suggest values significantly larger than the above. R.R. Newton *(Science;* vol.166, 1969; p.825) studied a long record of lunar and solar data and found the values of –41.6 ± 4.3 arc sec/century^2 and –42.3 ± 6.1 arcsec/century^2 for the lunar orbital angular velocity deceleration at two different periods of time. These figures correspond respectively to 6.15 cm/year and 6.26 cm/year. The differences from the tidal friction effect thus amount to 2.06 cm/year, and 2.17 cm/year respectively, and they compare very well with the value of 2.135 cm/year being the calculated rate of increase in the Earth-Moon distance based on the equation:

$$dr/r = dR/R = (2/3)\cdot dT/T$$

yielding

$$dr/dT = (2/3)\cdot r/T,$$

where $r = 3.844 \times 10^{10}$ cm and $T = 12 \times 10^9$ years. Other data considered by Oesterwinter and Cohen *(Celestial Mechanics;* vol.5, 1972, p.317) and by Van Flandern *(Mon. Notices Roy. Astr. Soc.*: Vol.170, 1975, p.333) suggest somewhat lower rates of lunar orbital angular momentum deceleration of –38 ± 8 and –38 ± 4 arcsec/century^2 respectively. The value of –38 arcsec/century^2 corresponds to an increase of 5.62 cm/year in the Earth-Moon distance. Subtracting the tidal friction contribution, we obtain 1.53 cm/year for the effect of the universal expansion. This corresponds to a universal age of 16.75 b.y., in disagreement with the value derived above (11.8 b.y.) from the Hubble constant. Van Flandern's deduction of the value of –65 ± 18 arcsec/century^2 from measurements of the lunar orbit using atomic clocks is significantly greater than all other values and leads to a significantly smaller value of 6.95 b.y. for the universal

Picture of the Universe at universal age T_1.

The *physical* picture of the Universe at universal age T_2 .

Law of Expansion:
Proportional, observed strictly by all points in the Universe, whether they be clusters, galaxies, stars, molecules, or subatomic particles.

Geometry:
(Excluding relative motions), prefixed at T = 0, independent of age and applicable to all structures.

A *non-physical picture* of the Universe at the same universal age T_2 .

Law of Expansion:
Non-proportional.

Geometry:
(Excluding relative motions), not independent of the universal age.
Complicated additional laws are needed to regulate the internal geometry of the Universe under these conditions. Each such law must be established separately as regards its validity in space and time and as regards each distinct substructure .

	Distance from Center (or linear dimension)	Velocity of Expansion
Limiting value:	R	c
General value:	$r = \rho R$	$v = (r/R)c = \rho c = 2r/3T$
Hubble law:	$v = 2r/3T = (^{3T}/_{2})^{-1} r = H_o r$	Universally applicable to all structures

Remarks: The velocity of expansion at any point is a function of the dimensionless radial parameter ρ, and of the age of the universe, through the age-dependence of the velocity of light.
It can easily be shown that the ages $T_{1,1}$ and $T_{1,2}$ of two points observed from the center simultaneously at T_2, of which the relative distances from the center are ρ_1 and ρ_2 are related as follows:

$$\rho_1 T_{1,1}^{2/3} / \rho_2 T_{1,2}^{2/3} = \left(T_2^{2/3} - T_{1,1}^{2/3}\right) / \left(T_2^{2/3} - T_{1,2}^{2/3}\right)$$

FIG. 2. The Universal Expansion and the Hubble Law.

age. His suggestion that the difference is due to the time dependence of the universal gravitational constant is not supported by the discussion in Section 2.2 of this work. It is interesting, though perhaps coincidental, that the average of these extreme values is (6.95 + 16.75)/2 = 11.85 b.y., in good agreement with the value obtained from the Hubble constant. It must be mentioned that the effect of the tidal friction due to the Sun upon the lunar orbital angular momentum deceleration has not yet been measured. It appears, therefore, that better measurements are needed before this general issue is fully resolved. At present and based on the foregoing, Hubble's law is satisfactorily explained, at least qualitatively, if not quantitatively also, as a direct manifestation of the Universe expanding under the conditions studied here, namely, constant G and M. A summary of the details of universal expansion and of the dependence of the Hubble law upon it is shown in Fig.2.

2.3.2.4. THE DISTRIBUTION OF MASS.

We now have set the foundations for investigating and determining the distribution of mass in the universe.

Since the universal gravitational field is the only cause of deceleration of the velocity (of expansion) of the universal front, and since that front is composed exclusively of (the first) light (of Creation), we are compelled to conclude that, for light to behave identically everywhere in the universe, that is, for light to have the same velocity everywhere, regardless of direction at the same time, it is necessary that the field of gravity be the same, everywhere. If M_r is the total mass contained spherically symmetrically within a central sphere of radius $r = \rho R$, then the relationship

$$GM_r / r^2 = GM / R^2 \tag{45}$$

must hold identically. It follows that

$$M_r = \rho^2 M \tag{45´}$$

and upon differentiation

$$dM_r = (2\rho d\rho)M. \tag{45´´}$$

Under the same condition of spherical symmetry, a central-spherical shell of radius r and thickness dr contains, at time T, a mass given by

$$dM_r = (4\pi r^2 dr)\cdot(d), \tag{46}$$

where $(d) = \delta \cdot D$ is the local density of matter at radius r, D the average density of matter in the Universe at time T (Eq. 22) and δ a dimensionless proportionality constant. At constant T, $dr = Rd\rho$, so that

$$dM_r = (3\delta\rho^2 d\rho)\cdot(4\pi R^3 D/3) = (3\,\delta\rho^2 d\rho)\,M. \tag{46´}$$

Equating differentials (45´´) and (46´) yields

$$\delta = 2/3\rho. \tag{47}$$

The general expression of the local total-mass density at (ρ,T) thus is

$$(d)_\rho = (2/3\rho)D = (9\rho\pi GT^2)^{-1}, \tag{48}$$

and if the universal mass is distributed smoothly under this law, photons will travel forever along Euclidean straight lines.

The Hubble law, based on the velocity $v = \rho c$ of radius $r = \rho R$ $(0 \leq \rho \leq 1)$, on the other hand, requires that the field of gravity affecting ordinary masses (that is, bodies composed of assembled photons), at r, be given by

$$Gm_r/r^2 = \rho GM/R^2, \tag{49}$$

as only then does their velocity become $v = \rho c$, which requires that

$$m_r = \rho^3 M. \tag{49´}$$

Since $0 \leq \rho \leq 1$, it is also obvious that under the assumptions permitting us to write Eq. 45 and 49, the masses of ordinary bodies entering the law of gravity sum up to *less* than the masses of *all* photons (*bound and free*) in the Universe:

$$m_r \leq M_r^*. \tag{50}$$

Is then the state of affairs denoted by Inequality 50 highly unsatisfactory? Only as far as *the mass of free photons has not so far been considered, adding to the "missing" mass*! But being universal, gravity is due to *all* masses in *any* sphere of radius r, and not just that of ordinary bodies! Does this, then, indicate a basic disagreement between the Law determining the behavior of *all* photons in the Universe (Eq. 45) and the Hubble law (obtained by observing ordinary bodies) leading to Eq. 49? So, *not* entirely! Because implicit in writing down Eqs. 45 and 49 was the *tacit* assumption that test masses entering the law of attraction (Eq. 1) *are of the same nature*. Certainly, that assumption permits resolution of the problems posed by Inequality 50 and allows a general expression to be found for the law of attraction *common to both ordinary bodies and photons*.

The general law of gravity can be written as

$$\text{(force)} = \text{(gravitational field strength)} \times \text{(test mass)}.$$

In the case of photons, this law *has* to be

$$\text{(force)} = GM_r m/r^2 = GMm/R^2, \tag{51}$$

which alone allows identical behavior for all photons everywhere in the Universe, and leads to Eqs. 45 and 45´. In the case of ordinary bodies, the law was

* The equality holds only at $\rho = 0$ and at $\rho = 1$. At these extremes, it is very likely that ordinary particles *and* light are *not* both present: The very center of the Universe must be occupied by a totally motionless particle of zero volume. Perhaps, then, not even an ordinary particle qualifies for such central position. At $r = R$, *only* light can possibly exist, due to the need of photons to have total velocity vectors equal to radial-out velocity vectors, which requires zero velocity components relative to a body (if it existed) for the photons comprising that body. This requirement makes it impossible for an ordinary body to exist at $r = R$. Even if an ordinary body found itself at the universal front, its component photons would be permanently in quasiparallel paths (all meeting back at the center of the Universe). Such a body, therefore, would be totally unlike any other body at a lesser radius $r < R$. The Michelson-Morley experiment makes sense only for bodies (that is, interferometers) at $0 < r < R$.

assumed to be

$$(\text{force}) = Gm_r m/r^2 \tag{52}$$

and the value of m_r was determined by the effect of this force upon masses m at $r = \rho R$ causing them to behave in accordance with the Hubble law.

Eq. 49´ suggests, however, that in the latter case, the law of gravity may also be written, instead, in the following manner:

$$(\text{force}) \equiv Gm_r m/r^2 = G\rho M_r m/r^2 = \left(GM_r/r^2\right)\cdot(\rho m) \equiv \left[GM_r/r^2\right]\cdot m', \tag{53}$$

where $m' = \rho m$, m being the total test mass, by permitting ρ to commute from the field strength factor to the test mass factor (*if* this *not* be a slight of hand!). This commutation allows the field strength due to ordinary masses within sphere r to be the same as regards its effects upon *both photons and ordinary* bodies, and the mass density to be given uniquely by Eq. 48, but *requires* that the gravitationally effective ponderable mass entering the law of gravity be *always equal to the total mass of the all particles and in all cases correctly involved*:

$$(\text{ponderable mass } m') \equiv (\rho) \times (\text{total mass}), \tag{54}$$

where, ρ is a variable, yet, dimensionless constant.

The requirement that photons everywhere behave identically removes their instantaneous location, $\rho = r/R$, as a factor determining the value m´ of their test mass and in a generally applicable law this must be true of all bodies, regardless of whether they be photons or ordinary bodies. *This leaves only the velocity of the test particle as the factor ultimately determining the value of m' (including all photons added)! The correct expression, rather than (54) must thus be*

$$\textit{(ponderable mass, m')} = \textit{(v/c)} \times \textit{(total mass)}, \tag{55}$$

where v is the velocity of the test particle relative to the center of the universe. For photons, v = c, and as a result, their gravitationally effective mass is their total mass. However, for bodies obeying the Hubble law (and only for such bodies), the following equality holds uniquely:

$$v/c \equiv r/R \equiv \rho \tag{56}$$

and Eq. 55 for such bodies reads

$$m' = \rho m.$$

Under this condition, the field of gravity affecting bodies obeying the Hubble law is not Gm_r/r^2 but instead GM_r/r^2 and for such bodies the law of gravity is

$$F = \left(GM_r/r^2\right)\cdot(\rho m) \equiv \left(GM/R^2\right)\cdot(\rho m)\ , \tag{57}$$

that is identical to the law affecting the behavior of photons. Whereas the *total* mass of the particle is 'accelerated' by the field *and not only its seeming* mass, one, eliminating m (from both sides of Eq. 57) and ignoring ρ, *assumes* the field acting upon the particle to be Gm_r/r^2, rather than $(GM_r/r^2)\rho$, thereby writing Eq. 49 and creating the *false* impression of *seeming* disagreement between the law of gravity affecting photons and the law of gravity affecting other bodies, which (impression) is represented by Inequality 50.

In other words, *there is only one law of gravity affecting all bodies, photons and ordinary bodies, alike*. In this law, the field of gravity is determined uniquely by the *total* mass, which is contained within the central sphere $r = \rho R$ i. e. determined by the local *total* mass density given by Eq. 48. The mass of the test particle entering this law is, however, given by the product $(v/c)m$, where m is the *total* mass of the test particle and v/c the dimensionless fraction of its (radial-out expansional) velocity relative to the velocity of light (for all bodies obeying Hubble's Law). The field of gravity *cannot* be affected by the velocity of bodies creating it relative to the center of the universe, because in that case the field *would be* a function of $\rho = r/R$ and *would not* affect light identically everywhere in the Universe.

Although derived from the requirement to have a uniform gravitational field everywhere affecting identically photons as well as ponderable bodies obeying the Hubble Law, the above law relating ponderable and *total* mass is universally applicable to all gravitational phenomena, including local ones such as the fall of Newton's famous apple. This, in turn, is required by the need to have the universal energy *uniquely* defined. This is possible only with reference to the *total* mass, m, of the body, which is the sum of the masses of *all* photons making it up, each of which moves with velocity c relative to the center of the universe regardless of the velocity v relative to the same center of the ponderable body to which they belong, as discussed in Section 2.3.2.2.4. Eq. 55 results in

$$m'v^2 = (v/c)\cdot mv^2.$$

Eq. 24 results in

$$mv^2 = m(c^2 -- x^2 - 2vx\cos\theta).$$

Dividing by parts yields

$$m'/m = (v/c)\cdot[v^2/(c^2 - x^2 - 2vx\cos\theta)] \equiv v/c.$$

2.3.2.5. AN OBSERVER'S POSITION IN THE UNIVERSE.

In a universe such as described here, an observer's position relative to its center is in principle knowable. One needs the direction to the center of the universe and one's distance from it.

The former is relatively easily determined as the direction of maximum perceived mass concentration per unit of solid angle. In the opposite direction, one should find the minimum perceived mass concentration per unit of solid angle. What is required is a sufficiently large telescope to see well beyond the local neighborhood, Fig. 3.

In the absence of observational difficulties, failure to detect differences in mass concentration per unit of solid angle can only be due to the fact either that the observer is so close to the center of the universe that differences become unobservable, or that even the largest telescopes employed cannot see beyond what is essentially a local neighborhood (in which mass density differences are too small to be observable) of a very large universe indeed. In the latter case, a pro-

portionally far greater portion of the universal age was spent for the universal fractional radius ρ to expand to the position of the local neighborhood, than for light to return to the observer (located about centrally in the local neighborhood) from the remotest (yet *observable*) recesses of it.

Unless the center can be identified as such and its distance measured, astronomical measurement alone of (the) distances (to the remotest fringes at the opposite ends of the direction prescribed in the second paragraph above) is insufficient to determine the distance to the center of the universe, Fig. 3.

Consider an observer at O at the present universal age T_2. His distance from the center C, $CO = \rho_2 R_2$, where R_2, being the present radius of the universe, is the quantity required. The most powerful telescope possible cannot see beyond points A and B. The distances OA and OB are assumed to have been measured, as well as the age T_2 of observation (and thereby the value of R_2). These distances are such that

$$r_1 = r_{max} \equiv OA = CA + CO,$$
$$r_2 = r_{min} \equiv OB = CB - CO.$$

The distances of A and B from the center are, respectively,

$$CA = \rho_A R_A,$$
$$CB = \rho_B \cdot R_B.$$

Light just reaching the observer at T_2 left points A and B at ages T_A and T_B, respectively, at which the radius of the universe was, respectively, R_A and R_B. The ages T_A and T_B are subject to the following constraints:

$$\rho_A R_A + \rho_2 \cdot R_2 = \int cdT \text{ (integrated from } T_A \text{ to } T_2) = R_2 - R_A \equiv r_1,$$

$$\rho_B R_B - \rho_2 \cdot R_2 = \int cdT \text{ (integrated from } T_B \text{ to } T_2) = R_2 - R_B \equiv r_2,$$

where, the right-hand sides represent the distances travelled by light returning to the observer from points A and B. It follows that

$$(1 + \rho_A) \cdot R_A = (1 - \rho_2) \cdot R_2 \quad \text{and} \quad R_A = R_2 - r_1,$$
$$(1 + \rho_B) \cdot R_B = (1 + \rho_2) \cdot R_2 \quad \text{and} \quad R_B = R_2 - r_2 .$$

The value of ρ_2, required to fix the distance CO, cannot be extracted because the values of either ρ_A or ρ_B are not known.

The distance from the center of the universe can, however, be calculated indirectly by observation of the local group of galaxies, permitting determination of the local density of matter, and use of Eq. 48. Twenty eight galaxies have been identified as members of the local group having a radius of 500 kpc. The mass of the group is estimated to be about

$$M_{LG} = 28 \times 10^{11} \times 1.989 \times 10^{33} = 5.569 \times 10^{45} \text{ grams},$$

and its volume to be about

$$V_{LG} = (4/3)\pi(5 \times 10^5 \times 3.25943 \times 365.25 \times 24 \times 3600 \times 2.997925 \times 10^{10}$$
$$= 1.5353 \times 10^{73} \text{ cm}^3.$$

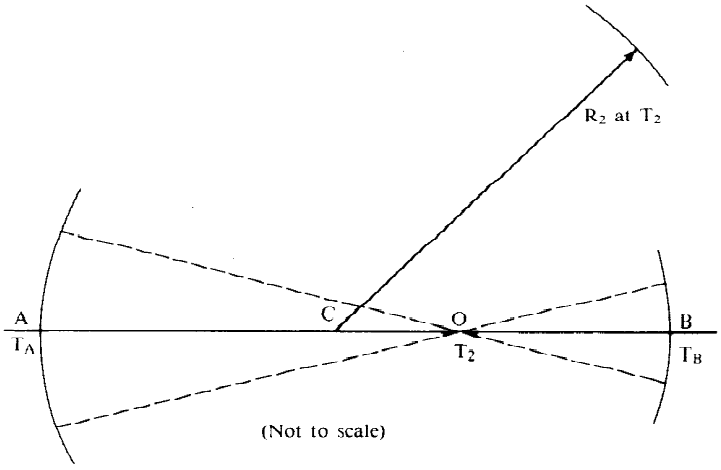

FIG. 3. An Observer's Position in the Universe.

Its average density thus is

$$D_{LG} = 3.6274 \times 10^{-28} \text{ grams/cm}^3.$$

It follows that the position of the local group is at a fractional distance of

$$\rho_{LG} = (2/3)\cdot(D/D_{LG}) = (2/3)\,(5.45 \times 10^{-30}/3.627 \times 10^{-28} \cong 0.01$$

from the center of the universe. The radius of 500 kpc equals 1.542×10^{24} cm or $9.07 \times 10^{-5}\cdot R_2$. In other words, the center of the universe is at a distance of 55 diameters of the local group, or 55 Mpc; and the radius of the local group is only about 0.009 of the distance to the center.

In the above calculation, the space, surrounding the local group, that must be assigned to it, was ignored. As a result, the distance to the center obtained here is a low limit.

It is interesting to note that a central sphere of 500 kpc radius contains mass equal to

$$M_c = (9.07 \times 10^{-5})^2 M = 9.46 \times 10^{47} \text{ grams},$$

or, only about 169 times greater than the mass of the local group. This may suggest a supercluster around the center of the Universe and explain the difficulty of identifying it, due to the fact that the density of matter in the central group is not very much larger than that of our local group, except for the region extremely close to the center, where one may expect a dense spherical galaxy.

The local densities observable at present by a central observer as he looks into the past and the corresponding average densities are shown in Fig. 4. Except for the local densities very close to the center of the universe, all other densities

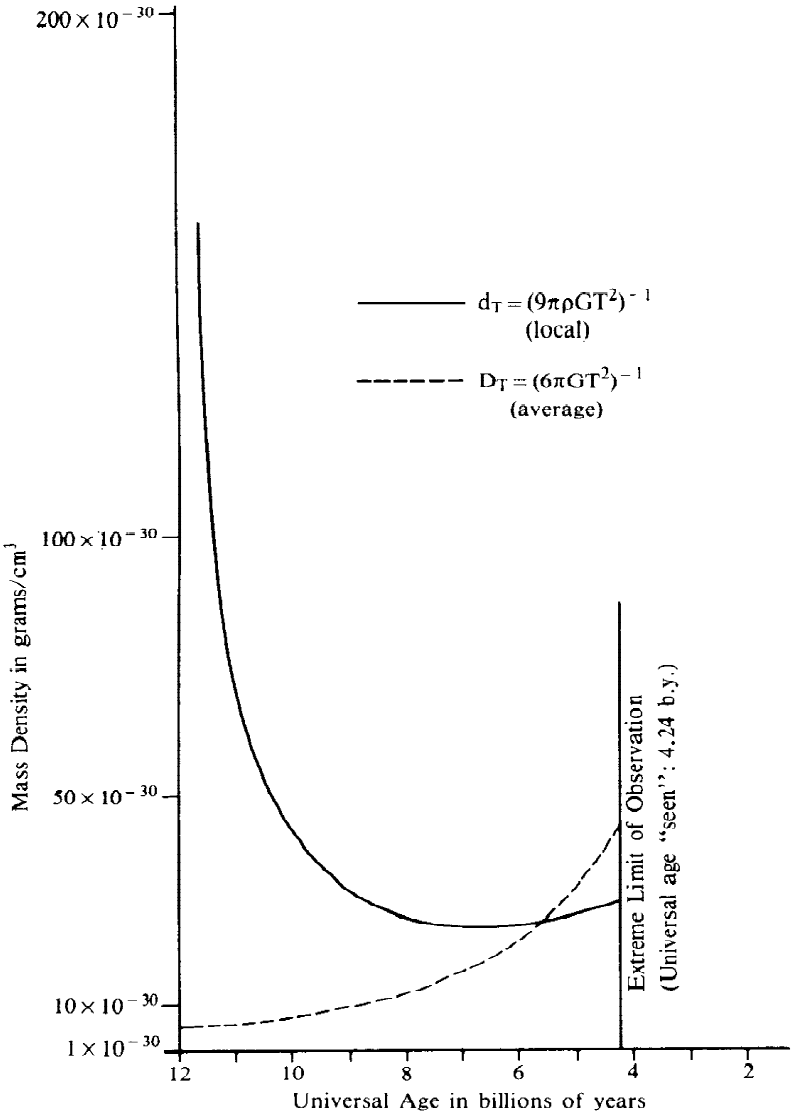

FIG. 4

Mass Density observed by Central Observer at the Universal age of 12 billion years.

are smaller than 5×10^{-29} grams/cm^3 for all observable ages before 1.5 billion years ago, up to the limit of observation of $R_1 = 8.52 \times 10^{27}$ cm reached at the universal age of 4.24 billion years or 7.76 billion years ago as discussed in section 2.3.2.2.5. This explains very satisfactorily why the universe, despite Eq. 48, has the appearance of evenly distributed matter. Given the position of our local

group, it is not surprising why we, too, see the universe basically as would be seen from its center, and why we have drawn some wrong conclusions, so far, about the distribution of matter in it, or, the precise nature of its expansion.

It should be pointed out that the concurrently true average densities of matter are not possible to observe at any age, since our picture of the universe is a mix of present (very closely to us) and past (up to 8.52×10^{27} cm away). Only local densities of a given (T_1', ρ_1) as per Eq. 30'' are truly observable. The composite average of such densities, as astronomically observable, is without value. However, because, as shown in Fig. 4, the observed local densities are all about equal, such composite necessarily has an approximately equal and perceived constant value and has led directly to misunderstanding.

The exception is the central region, the increased density of which, as explained above, is difficult to spot, since it necessarily occupies a very small solid angle of view of about $2\times0.00909\pi$ or 62.5 minutes of angle or less, and is about $r = 0.01R_2 = 1.70\times10^{26}$ cm or more away. This distance was covered by light in the very recent interval of time T_1 to T_2, such that

$$0.01R_2 = (9GM)/2)^{1/3}\cdot(T_2^{2/3} - T_1^{2/3}) = R_2 - R_1,$$

yielding $$R_1 = 0.99R_2 \text{ and } T_1 = (0.99)^{3/2}T_2 = 0.985T_2.$$

In other words, light from the center of the universe was in transit to us for only the last about 180 million years.

It should also be pointed out that the expected to be seen increased density of matter in the remotest observable past is clearly visible in Fig. 4, following a minimum at about 6.5 b.y. of universal age. It is due to the natural limit of observation, that the very high densities of the early universe can never be seen by any observer inside the universe. Such densities are, as a matter of principle, observable only by a *non-physical* observer, who is able to watch from the distance, as the First Light of Creation reaches him, followed by light from the fragments of the Great Fireworks, as it undoubtedly must have been! Once engulfed completely by those advancing fragments, having thus become a *physical* observer, he can never again hope to recapture a glimpse of the past Glory he has already seen!

The existence of the minimum in the plot of local densities observable as per Fig. 4 from the center of the universe was to be expected: As one looks away from the center one also looks at progressively larger radii, ρ, at which the density falls off with ρ^{-1}. It is only when one looks at a sufficiently remote past that one begins to see the effect of T^{-2} upon the observed density of matter.

2.3.2.6. THE REDSHIFT–UNIVERSAL AGE RELATIONSHIP.

Consider a light source S. At the universal age T_1 this source is at the distance of $CS = r_1 = \rho_s R_1$, from C, the center of the universe, and travelling away from it with a total *and* radial velocity $v_1 = \rho_s c_s$. At T_1 this source sends out a photon that reaches an observer at O at the universal age T_2. That observer, at T_2, is at the distance $CO = \rho_O R_2$ from the center of the universe and travelling away

from it with a total *and* radial velocity of $v_2 = \rho_O c_2$. R_1, R_2 and c_1, c_2 are, respectively, the instantaneous radii of the universe and velocity of light at the ages of T_1 and T_2. The value of the angle SCO is thus fixed permanently at a. The distance covered by that (first) photon from S (at ρ_s,T_1) to O (at ρ_O,T_2) is given by both of the following expressions (see Fig. 5):

$$\begin{aligned}(SO) &= [(CS)^2 + (CO)^2 - 2(CS)(CO)\cos a]^{1/2} \\ &= [\rho_s^2 R_1^2 + \rho_O^2 R_2^2 - 2\rho_s \rho_O (\cos a) R_1 R_2]^{1/2} \\ &= \int c\,dt \text{ (integrated from } T_1 \text{ to } T_2) \\ &\cong R_2 - R_1.\end{aligned}$$

It follows that

$$(1 - \rho_S^2)R_1^2 + (1 - \rho_O^2)R_2^2 - 2(1 - \rho_S \rho_O \cos a)R_1 R_2 = 0. \qquad (58)$$

The period of light emission at the source is T, and its wavelength is λ such that $\lambda/T = c_1$. At the universal age $T_1 + \tau$, the universe has a radius of $R_1 + \lambda$. The light source is thus at a distance CS´, such that

$$\begin{aligned}(CS') &= \rho_s(R_1 + \lambda) \\ &\equiv \rho_s \int c\,dT \text{ (integrated from 0 to } T_1 + \tau) \\ &= \rho_s \left[(9/2)GM T_1^2\right]^{1/3} \left[1 + (\tau/T_1)\right]^{2/3} \\ &\cong \rho_s R_1 (1 + 2\tau/3T_1).\end{aligned}$$

It follows that

$$\lambda \cong R_1 (2\tau/3T) = (3/2)\cdot c_1 T_1)\cdot(2\tau/3T_1) = c_1 \tau$$

is the wavelength of the emitted light, but only approximately.

At the universal age of $T_1 + \tau$, the very next (second) photon is emitted. This photon travels on a path S´O´ such that it meets the observer O at his new position O´ at the universal age of $T_2 + \tau'$. Sought is the relationship of τ to τ'. At the moment $T_2 + \tau'$, light has a wavelength λ'* such that $\lambda'/\tau' = c_2$, and the universe has a radius $R_2 + \lambda'$. The distance CO´ is given by:

* For this to be strictly true, the second photon must arrive at O´ at $T_2 + \tau'$ in *phase* with the first photon that arrived at O at T_2. If this does not happen, one is *forced* to count the photons arriving at the observer after the first photon, select the n-th photon that arrives in phase with the first and divide the interval of time passed between these two events by n. One thus assigns the average period τ'_{av} and wavelength λ'_{av} to the second photon arriving at O´ at $T_2 + \tau'$. To be consistent, he also divides by n the time interval passed between the first photon and the n-th photon emitted at the source and assigns the average period τ_{av} thus obtained to the very next photon emitted by the source after the first one. One acknowledges that an error is thus introduced, but one reasons that the error is certainly very small and there *is* nothing one can do to resolve this issue to one's perfect satisfaction. One can ignore all intervening photons and consider only the n-th photon arriving in phase with the first one. If one chooses to do so, no error is introduced, but the wavelength also has to be multiplied by n, since one then has to write $(c_{av})\,(n\tau_{av}) = n\lambda_{av}$, for both source and receiver. In this case, instead of comparing τ to τ' one compares $n\tau_{av}$ to $n\tau'_{av}$. When one considers the ratio of the two periods, it will thus be error-free to understand that the ratio (τ'/τ) truly represents the ratio (τ'_{av}/τ_{av}).

$$(CO') = \rho_O(R_2 + \lambda') = \rho_O \int cdT \text{ (integrated from 0 to } T_2 + \tau')$$
$$\cong \rho_O R_2 (1 + 2\tau'/3T_2)$$

It follows that

$$\lambda' \cong R(2\tau'/3T_2) = (3/2)c_2 T_2 \cdot (2\tau'/3T_2) = c_2\tau'$$

where λ' is the wavelength of the received light. It is obvious that the distance $S'O'$ is given by both of the following:

$$(S'O') = [(CS')^2 + (CO')^2 - 2(CS')(CO')\cos a]^{1/2}$$
$$\cong [\rho_s^2(R_1 + \lambda)^2 + \rho_O^2(R_2 + \lambda')^2 - 2\rho_s\rho_O(R_1 + \lambda)(R_2 + \lambda')\cos a]^{1/2}$$
$$= \int cdT \text{ (integrated from } T_1 + \tau \text{ to } T_2 + \tau')$$
$$\cong (R_2 + \lambda') - (R_1 + \lambda).$$

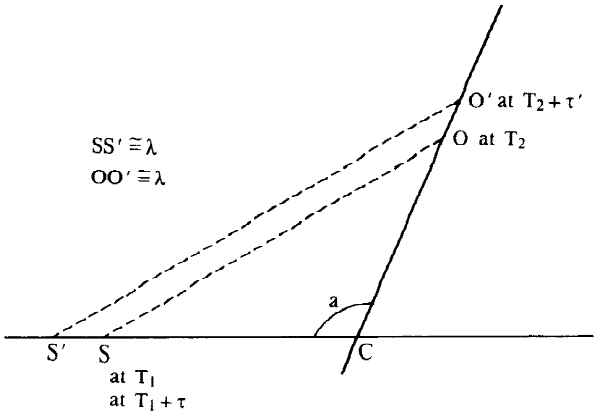

FIG. 5

The Physical Phenomenon linking Universal Expansion to the observed Redshift.

It follows that

$$(1 - \rho_S^2)(R_1 + \lambda)^2 + (1 - \rho_O^2)(R_2 + \lambda')^2 - 2(1 - \rho_S\rho_O\cos a)(R_1 + \lambda)(R_2 + \lambda') = 0 \qquad (59)$$

is the general relationship of emitted and received wavelengths when both source and observer obey Hubble's law in their motions away from the center of the universe. By subtracting Eq. 58 from Eq. 59, one obtains

$$(1 - \rho_S^2)[(R_1 + \lambda)^2 - R_1^2] + (1 - \rho_O^2)[(R_2 + \lambda')^2 - R_2^2]$$
$$- 2(1 - \rho_S\rho_O\cos a)[(R_1 + \lambda)(R_2 + \lambda') - R_1R_2] = 0, \qquad (60)$$

which is an alternative expression to Eq. 59 above. The situation can be studied in detail only in some simple cases:

I. Case of $\rho_o = 0$. The Observer is at the Center. Then:

$$(1 - \rho_S^2)(2R_1 + \lambda)\lambda + (2R_2 + \lambda')\lambda' - 2(\lambda R_2 + \lambda' R_1 + \lambda\lambda') = 0,$$

which simplifies to

$$(\lambda' - \lambda)^2 - 2(\lambda' - \lambda)R_1 + 2(\lambda' - \lambda)R_2 - \rho_S^2\lambda(2R_1 + \lambda) = 0$$

and subsequently to

$$(\lambda' - \lambda)[(2R_2 + \lambda') - (2R_1 + \lambda)] - \rho_S^2\lambda(2R_1 + \lambda) = 0,$$

or

$$(\lambda' - \lambda)(2R_2 + \lambda') - [(\lambda' - \lambda) + \rho_S^2\lambda](2R_1 + \lambda) = 0,$$

so that

$$(\lambda' - \lambda)/[(\lambda' - \lambda) + \rho_S^2\lambda] = (2R_1 + \lambda)/(2R_2 + \lambda') \cong R_1/R_2 = (T_1/T_2)^{2/3} = \xi.$$

It follows that

$$\lambda'/\lambda = 1 + \xi/(1 - \xi)\rho_S^2. \tag{61}$$

Since the right-hand side is always positive, the increase in received wavelength relative to that emitted is obvious.

Eq. 61 can be expressed in terms exclusively of the universal age, or ρ_S, as follows. Eq. 30´´ gave the age of the radial fraction $\rho = \rho_S$ just becoming visible at T_2*. It follows that

$$\xi = 1 - \rho_S/2 \tag{62}$$

and

$$\lambda'/\lambda = 1 + (2 - \rho_S)\rho_S = 1 + 4(T_1/T_2)^{2/3}[1 - (T_1/T_2)^{2/3}]. \tag{61a}$$

Since $\rho_S \leq 1$, it follows that the absolute maximum, but really unobservable (see Section 2.3.2.2.5) value for λ'/λ is 2.

Great care is needed to convert these wavelengths to frequencies because they belong generally to vastly different universal ages: The relationships hold:

$$\lambda' f' \cong c_2, \quad \text{and} \quad \lambda f \cong c_1, \tag{63}$$

so that

$$f'/f \cong (T_1/T_2)^{1/3}\{1 + 4(T_1/T_2)^{2/3}\cdot[1 - (T_1/T_2)^{2/3}]\}^{-1}. \tag{64}$$

Setting now $(T_1 - T_2)/T_2 = \delta T/T$, where $\delta T/T << 1$, in Eq. 64 results in

$$\begin{aligned} f'/f &\cong (1 - \delta T/3T)\{1 + 4(1 - 2\delta T/3T)[1 - (1 - 2\delta T/3T)]\}^{-1} \\ &\cong (1 - \delta T/3T)(1 + 8\delta T/3T) \\ &\cong (1 - 3\delta T/T) \end{aligned} \tag{65}$$

II. Case $\rho_s = 0$: The Observer observes the Center. Then, Eq. 60 simplifies to

$$(2R_1 + \lambda)\lambda + (1 - \rho_O^2)(2R_2 + \lambda')\lambda' - 2(\lambda R_2 + \lambda' R_1 + \lambda\lambda') = 0$$

* The age T_1' in Equation (30´´) is here represented by T_1.

and finally to

$$(\lambda' - \lambda)/[(\lambda' - \lambda) + \rho_S^2\lambda'] = (2R_2 + \lambda')/(2R_1 + \lambda) \cong R_2/R_1\,(T_2/T_1)^{2/3} = \xi^{-1}$$

resulting in

$$\lambda'/\lambda = \left[1 + (1 - \xi)^{-1}\rho_O^2\right]^{-1}. \tag{66}$$

Equation 30′′ still holds, but ξ is now given by

$$\xi = 1 - \rho_O/2. \tag{67}$$

Upon substitution in Eq. 66:

$$\lambda'/\lambda = (1 - \rho_O)^{-1} = \left\{1 - 4[1 - (T_1/T_2)^{2/3}]\right\}^{-1}, \tag{68}$$

and introduction of Eq. 63:

$$f'/f = (T_1/T_2)^{1/3}\left\{1 - 4[1 - (T_1/T_2)^{2/3}]\right\}. \tag{69}$$

Setting again $(T_1 - T_2)/T_2 = \delta T/T$, where $\delta T/T << 1$, results in:

$$\begin{aligned} f'/f &\cong (1 - \delta T/3T)\left\{1 - 4[1 - (1 - 2\delta T/3T)]\right\}^{-1} \\ &\cong (1 - \delta T/3T)(1 - 8\delta T/3T) \\ &\cong (1 - 3\delta T/T) \end{aligned} \tag{70}$$

which is identical to that obtained above (Eq. 65). These results demonstrate that, at least for $\delta T/T << 1$ redshifting is independent of the absolute velocity of source or observer; only their relative velocity is important. In the two cases examined above, the relative source-observer velocity did not change.

Based on our previous finding, the redshifting of the center of the universe is now found to be

$$f'/f = 0.955,$$

which can serve as a calibration for the observed redshifts.

It is very important to remember that the above expressions establish the relationships of the actual wavelength λ and frequency f of the light emitted at T_1 to the corresponding quantities λ' and f′ received at T_2. The quantities λ and f are not possible to know directly by any means and it must be realized that they are not to be identified with the corresponding quantities λ_O' and f_O' measured for the same processes occurring at O at age T_2 ,as is arbitrarily done according to currently accepted practice. *The rates of all processes depend upon the universal age.*

We shall show later (Section 2.5) that the period of *any* clock, in a universe obeying Newton's Law under constant G and M, is proportional to the universal age, as long as the clock participates proportionally in the universal expansion. Unless and until it can be demonstrated that clocks exist that do not so behave and that such clocks are indeed involved in the processes associated with the redshifts measured, *we do not have any grounds* for setting $\lambda = \lambda_O'$ and $f = f_O'$. *Instead, we are compelled* to set

$$\lambda/\lambda_O' = R_1/R_2 \quad \text{and} \quad f/f_O' = T_2/T_1$$

Accordingly,

$$f/f_O' = (1 - \delta T/T_2)^{-1} \cong 1 + \delta T/T \tag{71}$$

for $\delta T/T_2 \cong \delta T/T << 1$.

Consider the following:

$$f/f_O' = (f'/f)\,(f/f_O'). \tag{72}$$

Currently accepted practice considers the left-hand side (namely, the ratio of the received frequency to the frequency of the same process measured here at home at T_2) to be equal to the first ratio on the right-hand side, by arbitrarily setting the second ratio equal to unity. For observations of fairly recent events, the correct relationship must involve the values given by Eqs. 65 or 70 and 71, so that

$$f/f_O' = (1 - 3\delta T/T)\,(1 + \delta T/T) \cong (1 - 2\delta T/T), \tag{72a}$$

which relates directly the age $T - \delta T$ of the event observed to the frequencies f' and f_O' observed here at home at T, given the value of T.

It should be stressed that despite using in the present Section the terms "frequency" and "phase" (in the footnote of p. 90, in an attempt to establish with minimum error the precise moment of reception), no wave-kinematical ideas at all were used in the derivation of the above relationships. In fact, only the velocity of light and the periods of time between two successive events of emission and absorption were involved. As a result, it cannot be said that the present findings are related at all to the Doppler effect, which is characteristic solely of wave-kinematical phenomena. They are the results of the ballistic phenomena of emission and absorption. No Doppler effect is associated with the phenomenon of a "machine-gun" firing "bullets" (photons) at a target (observer): The frequencies of firing and of being shot at are related only through the velocity of the photons and the distances travelled. Since both velocities and distances are functions of the universal age, it is only natural to arrive finally at an ultimate relationship linking those frequencies to the ages of the associated events.

2.3.2.7. MASS AND ENERGY IN AND OF THE UNIVERSE.

We have discussed at considerable length some serious objections relating to mass and energy and their equivalence as introduced by the theory of relativity. Here we shall deal with some additional aspects of this general problem.

The theory of relativity is fundamentally preoccupied with arbitrary frames of reference and how the world looks, or precisely, how the theory wants the world to look, from such frames. "Rest" or "motion" are defined always with reference to such arbitrary frames. The notion of the universe having a (motionless) center was abhorrent to Einstein (see, A. Einstein, "*Relativity*", Crown, Inc., 1961, p. 107). He, therefore, felt free as well as forced to refer all physical quantities to arbitrary frames. He introduced an equivalence of mass and energy and a velocity dependence for them with reference to such frames: If a body is motionless with regard to a particular frame, it has only "rest" mass, m_o, and "rest" energy ϵ_o, such that $\epsilon_o = m_o c^2$. But if it moves with velocity v, it has a total mass

m and energy ϵ such that $\epsilon = mc^2 = m_o c^2(1 - v^2/c^2)^{-1/2}$, relative to, that is, as measured from, the particular arbitrary frame to which the motion is referred.

Now, this picture leaves a very great deal to be desired, because mass, that is, the intrinsic basic quantity that defines and characterizes a body, can arbitrarily, yet, according to the theory of relativity, legitimately, be considered to increase or decrease according to how a body moves relative to a particular frame: Perhaps, this may not appear at first sight to be all that objectionable. But, then, consider that Einstein did not reject the principle of conservation of mass and accepted the universe as finite (loc. cit. p. 108). The universe, even for Einstein has a finite and, therefore, we must presume, objectively defined and fixed total mass. But if the masses of individual bodies measure depending on their velocity relative to an observer, then, the total mass of the universe is similarly dependent also. In the absence of an absolute frame of reference, it is therefore logically impossible to consider the universe as having constant mass. Its total mass *has* to measure differently from each frame and for each velocity. Nowhere does it appear how this obvious, yet, *totally undiscussed* contradiction can be resolved and still leave intact the theory!

Moreover, Einstein made an effort to refer his frames to the fixed stars and this idea continues to be used in the literature. But this is an idea the time of which has passed: In the pre-expansional days it made sense to take refuge in the system of fixed stars. In an expanding universe, *there are no fixed stars:* Unless we want to restrict the theory to the here and now (because only for the *here* and *now* can the distant stars be considered at all fixed), we may *not* take refuge in "fixed stars". For, then, the theory is totally emaciated and utterly useless as a long-term description of the Universe and reduces to dealing with *images and illusion*s, rather than Reality.

Perhaps, then, it is not at all accidental that the theory does not deal in universals but only in particulars. Yet, it is plain as day that a universal theory should deal equally in both and resolve them all perfectly well! It is, therefore, appropriate to ask whether the theory of relativity can still be expected to apply to the Universe expanding as discussed heretofore. It is *not* quite enough to say that a particular solution of the equations of general relativity allows for the Universe to expand. A mathematician might, at first glance, be justified to feel satisfied with the existence, among the infinitude of solutions of the differential equations, of that particular solution that allows for expansion. But a "physicist", meaning an applied natural scientist, finds it logically necessary to ask the reverse question: Given that the universe expands, does the theory of relativity provide an *adequate* description of it? Or put differently, from the knowledge of universal expansion can we be led directly to the equations of relativity (general *and* special), and how do we make those equations provide *only one*, the *correct* answer? If we succeed in such an effort, do we obtain some extra knowledge to justify that effort? If no extra knowledge is obtainable, is the theory worth keeping?

These are all questions for the specialist students of the theory to resolve. In the mind of this author, it is particularly odd that both the average density of matter as well as the total mass of the Universe can be obtained so easily on the basis alone of Newton's law of gravity, while the theory of relativity though pur-

porting to be superior, yet, has *not* yielded *any* values whatever for these quantities, although it was supposedly built in such a way as to include Newton's law as an extreme case!

Moreover, one is justified to expect that the correct theory of the Universe will take full care of its own details and will not have to refer to observation or experiment in order to fix its own exact structure. It is the latter rather than the former that the theory of relativity does: It depends upon "experience", yet, takes pride when it is found to agree with experiment! One would have thought that "experience" may be referred to as the ultimate test of theory, if and only if a theory is built *totally without* reference to *any* "experience". Because, if the world is built throughout according to rational laws (and this world appears so to have been constructed), once a theory is normalized upon even one experiment, then, it rides upon the internal consistency of the Laws of the Universe and will undoubtedly be found to agree with other experiments as well, if it (the theory) is built with sufficient internal consistency. This does not mean that the universe is built upon such a theory. Nor should the latter ever be construed to supplant the laws of the Universe. It is, therefore, fully logical to seek the Laws of the Universe independently of, and uninhibited from, all theories so constructed.

Here, we did indeed obtain a value for the total mass in the Universe. But in order to do so, we had to follow Newton and accept the ponderability of the photon and its absolute indestructibility, on the basis of which alone may the claim be made of constancy for the total mass in the Universe. We also found that Newton's law of gravity under constant G and M calls for rejection of the constancy of the speed of light and along with it of the constancy *over time* of energy. We chose to side with Newton's law and in so doing we also gained an absolute value for the total energy of the Universe as a function of universal quantities: The relationship $E = Mc^2$ among the total quantities M and E and the corresponding relationship among the partial corresponding quantities are no longer arbitrarily introduced. They are seen as a direct consequence of the indestructibility of the photon and the additivity of mass and of energy.

The definition of mass of a particular body and of the entire universe thus becomes independent of the motion of the observer. It is fixed for ever, on the basis of Laws universally applicable and common for all observers.

It was thus inevitable that the large-scale distribution of mass would be found to affect the velocity of light. It was logical to choose that particular distribution which yields a constant gravitational field strength everywhere at constant universal age, which alone guarantees constant velocity for all photons everywhere at constant universal age. Closely related with this, the Hubble law is no longer seen to have been independently-arbitrarily established, but in order to provide the basis for preserving constant over time the ratios of *all* distances and sizes in the Universe, whether they be nucleons, electrons, stars or superclusters, as fractions of the radius of the Universe. In turn, the Hubble law requires a careful distinction to be made between what so far has been called the "ponderable" mass of a body and its total mass. The universal gravitational field is determined by the *total* mass in the universe, that *includes the mass of the photons* that so far have been regarded as massless, yet may be said to act on the ponderable mass of a body in the following manner:

Consider a body of total mass m and 'ponderable' mass m´ = (v/c)m, moving with velocity v, subject to two *equal yet opposite fields* (of forces) each of size $-\rho GM/r^2$. Whether at (in which case alone its 'ponderable' and total mass become equal), or inside, the front of the Universe, it possesses both kinetic and potential energy, whose sum constitutes the total energy of the body. It took the *entire age* of the Universe for the body to reach its present radius r = ρR at T from the original value r = 0 at T = 0. Under these conditions, v/c = ρ,. the force giving to the body its expansional velocity is

$$-\rho GMm/r^2,$$

and the kinetic energy of the body is

$$\begin{aligned} E_{kin,T} &= E_{kin,0} + \int^{\text{(integrating from 0 to T the quantity:)}} (-\rho GMm/r^2)dr \\ &= 0 + -mGM \int^{\text{(integrating from 0 to T the quantity:)}} R^{-2}dR \\ &= mGM/R \\ &= (1/2)mc^2. \end{aligned}$$

But the same body in the same time has also been lifted a distance r = ρR in a gravitational field the strength of which is $-\rho GM/r^2$. Recalling the generally accepted expression for the potential energy of the body, $E_{pot} = -m\gamma h$, where the negative sign is justified on account of the uplift against the gravitational field, we *must* now write the potential energy to read as

$$E_{pot} = -m(-\rho GM/r^2)\cdot r = m(GM/R) = (1/2)mc^2,$$

also! This way, the kinetic and potential energies of the body *are* equal, involve the *entire* mass m of the body as it both moves outward with radial-expansional velocity v at distance r from the center of the Universe, *while it also falls* under the field of gravity, *and* gives the appearance of stately motionlessness! This way, the total energy of the body truly is

$$E_{total} = E_{kinetic} + E_{potential} = mc^2,$$

as it involves *all* the masses present in it! We saw that the Michelson-Morley experiment can be fully explained only if the velocity of the photons relative to the interferometer is also considered. In *strict* fact, the interferometer *is, in no way less, yet another celestial* body!

It is obvious that the above reasoning applies equally well to photons. For those, v/c = 1 and their ponderable mass is equal to their total mass. Since all photons are in incessant motion since Creation, it necessarily follows that the distance travelled by *each* of them, whether in free flight or in a bound state equals R. The kinetic and potential energy of each thus equal $(1/2)m_oc^2$ and their sum is always m_oc^2. It also follows, however, that the photons have no internal energy!

If it is the existence of a positive, non-zero, internal energy that characterizes the common, 'ponderable', bodies, then it also must follow that only those bodies are composite, structured bodies, made up of constituent particles, namely, photons. Bodies without internal energy, i.e. photons, have no parts, are

(in this respect only) "structureless" and belong to a class of their own.

We thus have succeeded in obtaining some very simple general laws equally applicable to all particles in the Universe, without exemptions, or arbitrary a priori assumptions and without any violation of our experimental findings, or of our basic logic and common sense. The dependence of mass upon velocity as predicted by the theory of relativity came as a great shock to all pre-relativists. The understanding we here develop shows, however, that whereas that shock *was certainly unjustified and only due to the notions of massless photons and massless energy*, the theory of relativity *is also not needed* to explain the increase of ponderable mass with velocity, once it is understood that it is the photons themselves that constitute the seat of all mass:

Let us consider a body of total mass m_o moving with velocity $v_{c,o}$ relative to the center of the Universe, but at rest relative to a frame F, until time t, when energy is supplied to the body in the amount of $(\delta m)c^2$ by photons absorbed by the body, the total momentum of which is $(\delta m)c$ in the particular direction ϕ relative to the velocity $v_{c,o}$. Since the photons are massive particles, their mass is added to the mass of the body. The thus resulting body moves with velocity v_c relative to the center of the Universe such that

$$(m_o\, v_{c,o})^2 + ((\delta m)c)^2 + 2(\delta m)m_o \cdot v_{c,o} \cdot c \cdot \cos\phi \equiv [(m_o + \delta m)\cdot v_c]^2 \qquad (73)$$

yielding

$$\delta m = m_o[(\gamma^2 - \beta\cos\phi)/(1 - \gamma^2)]\left[1 + \left(1+(1-\gamma^2)(\gamma^2 - \beta^2)(\gamma^2 - \beta\cos\phi)^{-2}\right)^{1/2}\right] \qquad (74)$$

where, $\beta = v_{c,o}/c$ and $\gamma = v_c/c$. It is obvious that the relative increase in mass of the body is dependent on both its previous velocity $v_{c,o}$ and its new velocity v_c, as well as on the angle ϕ. For $\beta = 0$,

$$m = m_o\gamma/(1 - \gamma) \qquad (75)$$

In the special case of $\phi = 0°$, one finds

$$\delta m = m_o(\gamma - \beta)(1 - \gamma)^{-1}$$

and in the case of $\phi = 180°$, one finds

$$\delta m = m_o(\gamma + \beta)(1 - \gamma)^{-1}$$

The direction (see Fig. 6) of v_c forms an angle ω with $v_{c,o}$ such that

$$(\delta m)c/\sin\omega = m_o v_o/\sin(\phi - \omega)$$

resulting in

$$\tan\omega = (\delta m/m)\sin\phi\left[\beta + (\delta m/m)\cos\phi\right]^{-1}.$$

But this line of reasoning places the cart before the horse. In reality, given m_o, δm, and β, Eq. 74 determines the magnitude γ of the new velocity.

Before photons of total mass (δm) were added to the body, the velocity of each photon comprising the body, relative to the body as a whole, was x_o such that

$$v_{c,o}^2 + x_o^2 + 2v_{c,o}\, x_o \cos\theta_o \equiv c^2. \qquad (76)$$

Therefore, the energy of the body associated with motion in the direction $v_{c,o}$ was

$$m_o v_{c,o}^2 = m_o\left[c^2 - \sum(x_o^2 + 2v_{c,o}x_o.\cos\theta)\right],$$

(where the summation is for photons already present in the body). After the photons of total mass δm are added, the velocity of each (old *and* new) photon com-

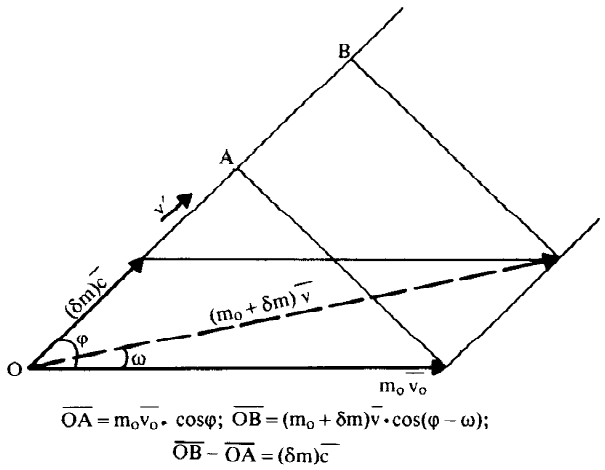

FIG. 6. The Parallelogram of Momenta.
(Simplified notation)

prising the resulting body, relative to the body as a whole is x, such that

$$v_c^2 + x^2 + 2v_c x\cos\theta \equiv c^2. \qquad (76')$$

The energy of the thus resulting body of mass $m = m_o + \delta m$ associated with motion in the direction v_c is

$$mv^2 = m\left[c^2 - \sum(x^2 + 2v_c x\cos\theta)\right],$$

It follows that

$$mv^2 - m_o v_{c,o}^2 = (\delta m)c^2 - \left[m\sum(x^2 + 2vx_o\cos\theta_o) - m_o\sum(x_o^2 + 2v_{c,o}x_o.\cos\theta)\right], \quad (77)$$

where the difference of the two summations *may not* a priori be assumed to be equal to zero. A special-relativistic observer, stationary in frame F and ignorant of the need to refer all motions to the center of the Universe, measures the "rest mass" of the body as m_o and sees it to move in a direction x with velocity v_x, when the *true* momentum $(\delta m)c$ associated with the energy $(\delta m)c^2$ is supplied to it; which, however, he ignores under the belief that the photons are massless! If such an observer tried to reconcile in his own frame the principles of conservation of mass, energy and momentum, he *would still have to write*, respectively:

$$m_o + (\delta m)_{ph} \equiv m_o, \qquad (78)$$

$$m_o 0^2 + (\delta m)_{ph}\, c^2 = (1/2)[m_o + (\delta m)_{ph}]v^2, \tag{79}$$

$$m_o 0 + (\delta m)_{ph}\, c = [m_o + (\delta m)_{ph}]v. \tag{80}$$

Under orders of special relativity theory, he would also have to write:

$$\delta m = m_o \cdot \left[(1 - \gamma^2)^{-1/2} - 1\right], \tag{81}$$

where $\gamma = v/c$. He would then be amazed to find that, by stating the masslessness of the photons by Eq. 78, he mutely also denies their energy defined as the product of their (mass) × (velocity)^2, while by Eqs. 79 and 80 yielding respectively:

$$\delta m = (^1/2)m_o\gamma^2(1 - \gamma^2/2)^{-1}, \tag{82}$$

$$\delta m = m_o\gamma(1 - \gamma)^{-1} * \tag{83}$$

he mutely also agrees that there is no single acceptable value of γ that can simultaneously satisfy Eqs. 81, 82 and 83! The last two equations yield $\gamma = 2$! If this value is used in Eq. 81, it makes for a complex value of δm! Even if we ignore the specific demand of special relativity as regards the value of δm given by Eq. 81, the value $\gamma = 2$, obtained solely from Eqs. 79 and 80 (that is, independently of special relativity), is unacceptable in a Universe where c is still the maximum velocity possible. That these inevitable conclusions have been missed so far is only due to two facts: (a) The principle of conservation of momentum has so far been applied only to bodies already in motion and the fact has been ignored that *for the principle to be correct universally it is also necessary that it be applied to bodies at rest as they are put to motion*. Nihil ex nililo: Nothing at rest can be put to motion without something pushing it!** (b) In relativity theory, we introduce Eq. 81 in Eq. 79, whereupon we write:

$$m_o c^2 \left[(1 - \gamma^2)^{-1/2} - 1\right] = (1/2)\, m_o v^2 \left(1 - \gamma^2\right)^{-1/2} \tag{84}$$

and conclude that this is a true equality because after we write the approximation for the left-hand side as

$$m_o c^2 \left[(1 - \gamma^2)^{-1/2} - 1\right] \cong m_o c^2(\gamma^2/2) = (1/2)m_o v^2 \tag{84a}$$

and the approximation for the right-hand side as

$$(1/2)m_o v^2 \left(1 - \gamma^2\right)^{-1/2} \cong (1/2)m_o v^2 \tag{84b}$$

we find that the two results, separately arrived at, are identical. We ignore the fact that in so doing we *do not* apply the approximation uniformly: Because, in the approximation of (84a) we *do not outright* ignore γ^2 as too small, and we proceed to use it as there indicated, whereas we *do outright* ignore it in writing the approximation (84b); If we do the same thing in (84a) we can only get zero

* Note that this is similar to Eq. 75.

** It is only an extremely small part of the energy and momentum of the incessantly, since Creation, moving photons that we unknowingly use in all our present engines. Certainly, more of their immense energy will become available to us once we find the way, if we do, to channel more of their momentum in a particular direction.

rather than $(^1/2)m_o v'^2$. The theory of relativity thus depends on dubious and unacceptable treatment of approximations for its validation. Moreover, we ignore the fact that even if this were ignored, logically the theory can be taken to apply *only* to the regime where the approximations hold. Instead, we seek to apply it universally! As for the momentum, we use the special-relativistic expression:

$$p = m_o v(1-\gamma^2)^{-1/2} = (m_o + \delta m)v \tag{85}$$

for the body *after* it has been put to motion and we ignore to equate it to the momentum of the photons, which according to the theory should be written as:

$$(\delta m)c = m_o c\,[(1-\gamma^2)^{-1/2} - 1], \tag{86}$$

which photons, alone, may put a body at "rest" to motion. If we did not ignore this requirement, we would have to write:

$$m_o c\,[(1-\gamma^2)^{-1/2} - 1] = m_o v(1-\gamma^2)^{-1/2} \tag{87}$$

and by resorting to similar dubious approximations as before, namely,

$$m_o c\,[(1-\gamma^2)^{-1/2} - 1] \cong (^1/2)m_o c\gamma^2 = (^1/2)\, m_o v^2/c \tag{87a}$$

and

$$m_o v(1-\gamma^2)^{-1/2} \cong m_o v, \tag{87b}$$

for the left- and right-hand sides of (87), respectively, we would have to conclude that

$$(^1/2)m_o v^2/c = m_o v \tag{87c}$$

or that $v = 2c$, which outright vitiates the theory!

Thus, whether one accepts the theory of relativity or rejects it, one still *cannot* resolve the outcome of $v = 2c$, as long as one insists on doing physics from arbitrary frames that one erroneously feels free to use at will as supposedly at rest.

This situation does *not* arise when one considers the photons making up the body before and after it is put to motion. Their energies and momenta sum up entirely satisfactorily by the following equations:

$$\sum m_{ph}c^2 + (\delta m)c^2 = \left(\sum m_{ph} + \delta m\right)c^2 \equiv (m_o + \delta m)c^2, \tag{88}$$

$$\sum m_{ph}\mathbf{c} + \sum(\delta m)\mathbf{c} = \left(\sum m_{ph} + \delta m\right)\sum \mathbf{c} \equiv (m_o + \delta m)\sum \mathbf{c}, \tag{89}$$

the first of which refers to energies and the second to the momenta; and the summations in Eq. 88 to the masses of the photons making up the body before and after it is set to motion, while in Eq. 89 the masses comprising the moving body can be separated out and multiplied by the resultant vector of the individual velocity vectors of all the photons comprising the resultant moving body. The summations, respectively of energies and momenta, $\sum m_{ph}c^2$ and $\sum m_{ph}\mathbf{c}$ are never zero, even when the body is at rest relative to the arbitrary frame F. *It is, therefore, wrong to write Eqs. 79 and 80, in other words, to believe that we can obtain a complete and correct picture of the world from arbitrary frames that*

we arbitrarily assume to be at rest. In this specific instance, reference to such frames led to conflict between the principles of conservation of energy and momentum. We are compelled to conclude that not all physics made in, or from, such frames is necessarily correct.

In an expanding Universe, *only* its center is at true rest, and *only* with reference to that center is it correct to write

$$^{M}\sum m_{ph}\mathbf{c} = 0 \tag{90}$$

where M signifies that the summation is carried out over the *entire* mass, namely, *all* the photons in the Universe. When one selects photons of total mass (δm) of parallel momenta (δm)c, then necessarily these are

$$(\delta m)\mathbf{c} = {}^{M}\sum m_{ph}\mathbf{c} - {}^{(M-\delta m)}\sum m_{ph}\mathbf{c} = -{}^{(M-\delta m)}\sum m_{ph}\mathbf{c}. \tag{91}$$

All other physical points in the Universe, namely, particles, and all frames centered on them are in motion relative to its center, and this fact must be taken into account in a complete analysis.

With the above discussion in mind, it is obviously very important to know how the quantities m_o', $\delta m'$, and v', considered by the special-relativistic observer in some arbitrary frame F′, relate to the *correct, error-free* quantities m_o, δm, and v that enter Eq. (73). Referring to Fig. 6, we observe that the momentum (δm)**c** of free photons is fixed both in size and direction, whether reference is made to the center of the Universe (namely, a frame the origin of which is at the center of the Universe), or to some frame F so oriented as to be parallel to the one centered at the center of the Universe. On this point there can be no confusion. Regardless of how the free photons come into the state of free flight, they cannot be considered to be affected, while in that state, by any body or frame. For if they were, their momentum would be different from (δm)**c** and thus either their mass or velocity, or both, would be different, which is absurd in a Universe in which photons come with eternally fixed masses and temporally yet universally fixed velocities. As a result,

$$\delta m' = \delta m. \tag{92}$$

We also observe that

$$(\delta m)\mathbf{c} = (m_o + \delta m)\mathbf{v}\cos(\phi - \omega) - m_o\mathbf{v}_o\cos\phi. \tag{93}$$

holds for the momenta. Thus upon equating the momenta of Eqs. 80 and 93:

$$m_o\mathbf{v}' = m_o\left[\mathbf{v}\cos(\phi - \omega) - \mathbf{v}_o\cos\phi\right] + \delta m\left[\mathbf{v}\cos(\phi - \omega) - \mathbf{v}'\right]. \tag{94}$$

That a relationship analogous to Eq. 93 also exists for velocities, namely,

$$\mathbf{v}' = \mathbf{v}\cos(\phi - \omega) - \mathbf{v}_o\cos\phi \tag{95}$$

is not intuitively obvious, nor is it easily proven. Assuming that it holds, and entering it in Eq. (94), we find:

$$m_o' = m + (\delta m)\mathbf{v}_o\cos\phi\left[\mathbf{v}\cos(\phi - \omega) - \mathbf{v}_o\cos\phi\right]^{-1}. \tag{96}$$

Consider the obvious

$$m_o v_o^2 + (\delta m)c^2 = (m_o + \delta m)c^2 - m_o(c^2 - v_o^2). \tag{97}$$

The momentum of the resultant body is such that

$$(m_o + \delta m)^2 v^2 = m_o^2 v_o^2 + (\delta m)^2 c^2 + 2m_o(\delta m) c v_o \cos\phi. \quad (98)$$

Dividing through by $(m_o + \delta m)$ and subtracting from Eq. 97 gives

$$m_o v_o^2 + (\delta m)c^2 - (m_o + \delta m)v^2 = (m_o + \delta m)c^2 - m_o(c^2 - v_o^2) - (m_o + \delta m)^{-1} \times \left[m_o^2 v_o^2 + (\delta m)^2 c^2 + 2m_o(\delta m) c v_o \cos\phi\right]$$
$$= m_o(\delta m)(m_o + \delta m)^{-1} (c^2 + v_o^2 - 2cv_o \cos\phi). \quad (99)$$

For all composite-ponderable bodies, the quantity in parentheses is positive, since $v_o < c$. As a result, it is always true that

$$m_o v_o^2 + (\delta m)c^2 = (m_o + \delta m)v^2 + m_o(\delta m)(m_o + \delta m)^{-1}(c^2 + v_o^2 - 2cv_o\cos\phi), \quad (100)$$

which is identical to Eq. (77) and demonstrates that the fact that the principle of conservation of momentum applies to motions relative to the center of the Universe implies that not all absorbed energy shows up as energy associated with the new velocity v. This is more easily seen by adding $(\delta m)c^2$ to each side of Eq. 100 and dividing through by 2. If all absorbed energy did so show up, the quantity in the square brackets in

$$(1/2)m_o v_o^2 + (\delta m)c^2 = (1/2)(m_o + \delta m)v^2 + (1/2)m_o(\delta m)(m_o + \delta m)^{-1} \times \left[c^2 + v^2 - 2cv_o\cos\phi + [(m_o + \delta m)/m_o]c^2\right] \quad (100')$$

should be zero, implying that

$$\left(2 + (\delta m)m_o^{-1}\right)c^2 + v_o^2 - 2cv_o\cos\phi = 0,$$

which is impossible for $v_o < c$. For $v_o = 0, \phi = 0°$ and Eq. (100) reduces to

$$(\delta m)c^2 = (m_o + \delta m)v^2 + m_o(\delta m)(m_o + \delta m)^{-1} c^2$$

which simplifies to

$$(\delta m)^2 c^2 = (m_o + \delta m)^2 v^2$$

namely, the principle of conservation of momentum. Under these conditions, $\omega = 0°$ also and in light of Eq. 95, $v' = v$. This is the situation of a body *truly stationary (*relative to the center of the Universe, *if* such a body exists other than the center) being set to motion; and does not necessarily prove that the principle of conservation of momentum truly holds as seen from the arbitrary frame F, in which the body m_o was arbitrarily assumed to be stationary and to have mass equal to m_o'.

We conclude that addition or subtraction of photons to or from ponderable bodies in no way affects the photons themselves, but the velocities of such bodies (whether referred to the center of the Universe or to any arbitrary frame) cannot comply with both principles of conservation of energy and momentum. When translational motions are involved, it is more consistent to invoke the second principle in order to determine the size of the velocity v, since obviously, its direction is automatically determined by the size and direction of the velocities v_o and c before such addition. When no translational motion is involved, as, for

example, when energy is added to or removed from electrons in bound states that do not affect the motion of the atom but only result in quantum (discontinuous) changes in the "orbital" radius and velocity of the electron around the atomic nucleus, it is not at all clear that the principle of conservation of momentum does apply. In such cases, it may indeed be wiser to assume that

$$m_o v_o^2 + (\delta m)c^2 = (m_o + \delta m)v^2, \tag{101}$$

which even eliminates the distinction between kinetic and potential energies, the significance of which is not at all clear is such cases. It is this expression that we shall use later on in this work.

The reader has by now recognized that the mathematical analysis of the last few pages attempts to connect the mechanical notion of the velocity "v" of a ponderable body as a whole and the associated ideas of conservation of mechanical energy mv^2 and momentum mv to the corresponding quantities of the photon, that alone can produce the externally observable properties of ponderable bodies. This is a connection that has not yet been recognized as fundamentally required, even under the less pressing light of current quantum theory: The latter abolishes the notion of continuity: all processes in Nature that depend upon the exchange of energy are quantal, namely, discontinuous. All mechanical notions, paramount amongst them the notion of "force" (except gravitation), must be reconciled to the fundamental quantum notions. In this work, we have gone to the ultimate extreme and recognized the *fundamental and discrete* photon as the sole building block of matter. Consistency compels us to relate all quantum notions and all exchange processes in Nature to the photon. Bulk mechanical properties and the notions associated with them must ultimately be referred to the photonic processes that cause them if they are to be understood at all.

The abolition of continuity perforce results in the abolition of the mechanical idea of "continuous" "force" (except gravitation). Only impulses exist in Nature, each of which relates to a particular photonic event exchange and necessarily lasts for a period of time required for the exchange to be completed. (We shall have more to say on this in Part Three of this work). The notion of a continuous force resulting in the acquisition of velocity v comes about essentially as the sum of the effect of all impulses experienced by a body per unit of time. Consideration of the notion of continuous force, as in ordinary mechanics, leads to yet another mass-velocity relationship different from those already considered. The existence of multiple mass-velocity relationships relating the mechanical behavior of ponderable bodies to the mass, energy and momentum of the photons exchanged only demonstrates how inexact are our current notions about ponderable bodies.

Consider the case of a body of mass m_o, at true rest relative to the center of the Universe, to which a "force" is applied for a period of time $\delta T = T - T_o$, during which it travels a distance x and at the end of which it acquires a velocity v, momentum p and energy E. The following relationships hold:

$$f = dp/dT = d(mv)/dT,$$

$$d\epsilon = fdx = (dx/dT)d(mv) = vd(mv) = v^2dm + mvdv.$$

Since according to arguments developed earlier in this work the particle has total energy $\epsilon = mc^2$, the above change in energy is also equal to

$$d\epsilon = d(mc^2) = c^2dm + 2mcdc,$$

so that

$$dm/m = (vdv - 2cdc)/(c^2 - v^2)$$

Setting $v = \gamma c$ and $dv = cd\gamma + \gamma dc$ gives:

$$dm/m = \gamma(1 - \gamma^2)^{-1}d\gamma - (2 - \gamma^2)(1 - \gamma^2)^{-1}(dc/c)$$

and upon integration between the limits m_o and $m_o + \delta m$:

$$(m_o + \delta m)/m_o = (1 - \gamma^2)^{-1/2} - \int(2 - \gamma^2)(1 - \gamma^2)^{-1}(dc/c).$$

The first term on the right is immediately recognized as the special-relativistic expression for the dependence of mass upon velocity. The second term on the right is the effect of the variability of the velocity of light. Even if γ is variable, as long as $\gamma^2 << 1$, no appreciable error is introduced by setting $(2 - \gamma^2) \times (1 - \gamma^2)^{-1} = 2$. Now, since $dc/c = -dT/3T$, it follows that the second term is essentially equal to $-(2/3)\ln(1 - \delta T/T_o)$, which is very nearly zero for for all processes completed in time δT very short relative to the universal age. As a result only for negligible change in γ_o and $\delta T/T_o$ is it very nearly correct to write

$$(1 + \delta m/m_o) \cong (1 - \gamma^2)^{-1/2}, \tag{102}$$

which is thus shown to derive *directly* from the properties of the Newtonian Universe (under *strictly constant G and M, and massive photons* composing the so-called ponderable bodies, and changes in energy associated *solely* with the exchange of photons) when the kinetic energy of the ponderable body as a whole is seen from the "force"-mechanical viewpoint. As a result, Eq. 102 implies no mass transmuting to or from energy and no additional theory such as that of relativity is needed for the phenomena to be understood. It also implies that $\delta m/m_o \cong \gamma^2/2$ or $(\delta m)c^2 \cong (1/2)m_o v^2$, which demonstrates *directly* that a body at rest, of mass m_o, can acquire velocity v only by absorbing photons of total mass δm. This absorption is thus shown to be a physically real phenomenon, as real as mass and force, and not only an apparent one based on the notion of reference frames. When Eq. 102 is very nearly correct, the expression for force reduces to:

$$f \cong [1 - (m_o/m)^2]^{1/2} \cdot c \cdot (\delta m/dT) \cong m(dv/dT)[1 - \gamma^3(dc/dv)](1 - \gamma^2)^{-1}.$$

Only when $v = \rho c$ and ρ is constant, as in the case of the Hubble motion, is it true that the third term in the last expression equals unity. In all other cases, including planetary motion, in addition to all other corrections, the third term in the last expression must also be considered.

The inexactitude of the mechanical notions about ponderable bodies can now be gauged by direct comparison of the values of γ obtained after absorption of a particular fractional amount of mass $\delta m/m_o$, as derived from the principles

of conservation of momentum (Eq. 80), conservation of energy (Eq. 101), the mechanical notion of "force" by energy transfer (Eq. 102) and the conservation of kinetic energy (Eq. 79), which are given respectively by:

	Value of γ for $\delta m/m_o = 0.01$	γ_n/γ_1
$\gamma_1 = (\delta m/m_o)(1 + \delta m/m_o)^{-1}$	0.009901	1.00
$\gamma_2 = (\delta m/m_o)^{1/2}(1 + \delta m/m_o)^{-1/2}$	0 099504	10.05
$\gamma_3 = 2^{1/2}(\delta m/m_o)^{1/2}(1 + \delta m/2m_o)^{1/2}(1 + \delta m/m_o)^{-1}$	0.140371	14.18
$\gamma_4 = 2^{1/2}(\delta m/m_o)^{1/2}(1 + \delta m/m_o)^{-1/2}$	0.140720	14.21.

The numbers suggest that closer examination is needed as regards the capability of a body to absorb photonic energy in order to effect a particular result. The application of "mechanical" force in order to increase the velocity of a body and thus its kinetic energy may not be limitless, as rearrangement of masses and or dissolution of the body may result. This is an area where closer examination is needed of the relationships existing between the photonic mass absorbed (fraction $\delta m/m_o$) and the velocity obtained (expressed in terms of γ_n), and one may not have to depend solely on experimental results that always involve heavy theorizing for their "interpretation".

The above relationships show that if the principle of conservation of momentum is the one regulating the process, a much smaller velocity v would result for the resulting body, for the same mass absorbed, than would be possible if one of the other three principles applied. If so then, the extra energy absorbed that is not exhibited as kinetic energy of the resulting body as a whole must be added to the internal energy of the body, as the photons absorbed along with those already there adjust their motions to the internal dynamics of the resulting body. (This, obviously, is an idea reminiscent of entropy: not all energy absorbed can result in useful work). If, on the other hand, the entire kinetic energy of the absorbed photon shows up as kinetic energy of the resulting ponderable body as a whole, the latter might acquire a momentum far in excess of the momentum supplied. The extra momentum, then, could only come from the photons already *in* the body. Because of the directionality of momentum, the "internal momentum" of the photons in the direction of motion of the body, as well as the velocity components of the photons relative to the body as a whole in the direction of its motion would inevitably be reduced and this would result in flattening of the body in the plane perpendicular to the direction of motion. Whether this is the flattening already discussed in Sections 2.3.2.2.3 and 2.3.2.2.4, or whether it is in addition to that cannot at the moment be decided. For the present, these are just mere thoughts. It is also possible that an intermediate situation applies. Whatever the case, there can be no doubt that the energy and momentum absorbed or surrendered by a ponderable body affect *both* its external dynamics as well as its internal constitution: As the body as a whole acquires higher and higher velocity in a particular direction, *it must also suffer corresponding changes in composition*: In the utmost extreme, when the ponderable body essentially reaches the velocity of

light, it itself *must* become light-like, that is, essentially decompose to its constituent photons that *must* then travel in quasi-parallel directions as a front, retaining however their reference to the center of the Universe. For the present, no more can be said on this *obviously unified* and thus most serious matter.

2.3.2.8. TEMPERATURE AND THERMODYNAMICS OF THE EXPANDING UNIVERSE.

We now must turn to a more formal discussion of the applicability of thermodynamics to the Universe as a whole, to see whether or not the discussion of the introductory Section 1.1 was justified in light of the findings of this work. Thermodynamics is built upon a few concepts and principles none of which has so far been used in the development of the ideas of this work. The possibility must thus be faced that the Universe may ultimately be understood without first recourse to thermodynamics. If so, the laws of thermodynamics are not fundamental to the Universe, despite their preeminence in human science, but rather and at best derivative laws that must be explained in terms of the fundamental laws of the Universe; and at worst only approximations bestowed with undeserved significance due to our hereto peculiar conception of the world. Seen in this light, the question of the applicability of thermodynamics to the Universe as a whole is obviously of very great significance.

In order to understand the possible role of thermodynamics in the Universe, we must first understand the basic concepts and ideas upon which thermodynamics is built.

2.3.2.8.1. The Zeroth Law

The first basic concept of thermodynamics is that of temperature. The concept had its origins in the human sensation of hot and cold, and little scientific use of it would have been made had it not been for the discovery that materials generally suffer changes in their properties as a result of their hotness-coldness. Closely associated with temperature and impossible to measure directly and independently is the second basic concept of thermodynamics, namely, heat-energy. It was discovered that other forms of energy are easily converted to heat and that there is a definite relationship between the temperature of a body and the amount of heat it absorbs or delivers, of which temperature is a first, if somewhat inexact, measure.

It has been agreed that (a) a body be assigned a higher temperature and a greater heat content when hot than when cold; (b) heat flows spontaneously only from a body at a higher temperature to a body at a lower temperature and never in the reverse direction; (c) no net heat transfer takes place between bodies at the same temperature; (d) two bodies are at the same temperature after being allowed to remain in contact for a period of time long enough as to establish between them “thermal equilibrium”, i.e. no further net heat flow from one body to the other. All this underlies the Zeroth Law of thermodynamics, yet it is obvious from

the above that the definition of, and reasoning behind, thermal equilibrium, heat flow and temperature is entirely circular: According to (c) above, the absence of heat transfer is understood in terms of the identity of temperature; yet, according to (d), identity of temperature is understood exclusively in terms of thermal equilibrium, i.e. no net heat flow! Such is the nature of, and the connection between, temperature and heat, that there is no way in which the circularity involved in their definition can be removed. We should therefore consider ourselves very lucky indeed for the fact that thermodynamics works as well as it does based on the Zeroth Law, for it is obvious that the law leaves much to be desired as a principle upon which a Universe may be built: It is of utter uselessness to the builder to state that a house has two vertical extremes A and B (one being possibly the basement, the other possibly the attic, yet, which is which being deliberately left unclear) which mutually define each other (circularity of definition). On this information alone, the builder cannot decide wherefrom to start building. He needs an unambiguous statement as to which end of the house is its foundation. We may feel fully justified to expect that, though and because the Universe is as "complex" as it is, a perfectly unambiguous definition of order, priorities, sequential structuring and construction was indeed needed to bring it about.

The very fact that there is natural Law (the possible existence of which, assumed initially as a mere working hypothesis, science in its beginning set out to investigate, and the continuous *success* of the latter in *uncovering* rather than *discovering* consecutive layers of physical structure, together with the corresponding elaboration of the natural Law, which in itself constitutes the maturation of science, *which in turn proves the validity of the initial assumption that there is indeed an operative natural Law) and no lawlessness (the possible existence of which is disproven beyond doubt by the very success of science), testifies to the existence of the basic unambiguity of Order. Because a law is quite simply a poor if at all "law" indeed if it does not expel forever any such unambiguity. We* must not think of *the natural Law in* terms of the *human laws. Human* societies apparently have decided that they can afford the waste involved in waiting for higher courts of appeal to settle precisely the priorities which their parliaments and congresses either because of unwisdom or because of *deliberate* action, as more often is the case, have failed to spell out in the promulgation of their laws. On the contrary, in Nature there are no higher courts of appeal, nor can there be any such courts, for the Universe would collapse into unimaginable chaos if that were the case. The existence of natural Law, therefore, carries with it the full weight of the unambiguity of Order to which any circularity of argument or definition is absolutely alien. It is in this fundamental sense that science had initially conceived of the unidirectional, *causal,* relationship existing between cause and effect. That in recent years that relationship appears to have been confused is only to be taken as proof of our puzzlement due to the co-application of theories among which the basic conflicts of order have yet to be resolved. No failure has yet been proven of the causal relationship of cause and effect in the objective natural Reality that alone is the field of application of the natural law.

It becomes obvious now, in light of the above, that the Zeroth Law by its

very nature cannot be fundamental to the construction and operation of the Universe.

An additional difficulty enters the discussion of the thermodynamics of the Universe: We need the additional concept of "universal temperature". This is not to say that we need only the value of the average temperature of the Universe. We also need a broadening of the very concept of temperature such as to encompass all states of matter in the entire Universe and not just the "solid", "liquid" and "gaseous" states with which our thermodynamics is concerned. The concept of temperature as currently used in thermometry and thermodynamics is fundamentally molecular, or at the very best atomic, which is exemplified by the way temperature enters the ideal gas law. It is obvious that an expanding Universe *did not always consist, nor will it always* continue to *consist, of atoms and molecules as presently understood*. It is, therefore, obvious that for an exact or, at least, satisfactory thermodynamic treatment of the Universe as a whole, the concept of temperature must be broadened to incorporate correctly all states of aggregation of matter from the infinitely condensed ideally most solid initial state to the infinitely dilute ideally "gaseous" final state, the two extremes of aggregation between which the atomic-molecular state of matter is but a way station. Ideally, such broadening is equivalent to devising a single thermodynamic equation of state that will hold for the entire universal mass, and for any part thereof, regardless of the state of aggregation between the two extremes just mentioned. Any other way of treatment will of necessity yield incomplete and basically inaccurate results. Thermodynamics is still very far away from such development, and on this basis alone, it is safe to say that there is no way that the present thermodynamic theory can be applied to the Universe as a whole.

The development of thermodynamics suggested the existence of an absolute lowest limit of temperature, which has been called the "absolute zero of temperature". The existence of this limit has been verified experimentally and in principle widely agreed upon as indefinitely approachable, though in practice unattainable on account of the infinite work of refrigeration required. This alone suggests that the true nature of the absolute zero of temperature is not well understood; for according to the above, it is only our lack of infinite energy that makes it practically impossible for us to attain 0°K. Yet, consider the case of such energy being placed at our disposal. Obviously, according to current thermodynamic theory, this energy being used (plus the energy removed from the system being refrigerated) would have to be discharged into the environment of the system refrigerated, as heat. Such discharge would raise the temperature of the environment beyond any limit however large that environment might be, provided that it remained finite. In such an environment, to isolate a system and to cool it to 0°K is not just a problem of great practical difficulty, it is also entirely inappropriate even to consider it theoretically, given the limitations set by our finite Universe. Because, between an environment of infinitely great temperature and a system cooled to 0°K, a perfectly insulating interface is required. In current thermodynamic treatment, the interface between system and environment is considered infinitely thin and is ignored. In the present case, the interface cannot be ignored, for we know of no material that can do the job, unless it were of infinite thickness

and as such uncontainable in a finite Universe! The absolute zero of temperature thus remains theoretically unattainable in a finite Universe, and our Universe by all current accounts, as well as by the findings of this Section (2.3.2) is indeed finite. Even if the Universe were infinite, the theoretical attainability of 0°K would still remain questionable, for then we would have the problem of one infinity (insulation) being well contained in another infinity (environment) where an infinite amount of heat should still be possible to discharge. Surely, such infinities strain the limits of any theory.

The concept of 0°K is ill-understood also from the aspect of the residual energy content of a body cooled to 0°K. Despite the fact that the heat capacity of materials is a function of temperature and approaches zero at 0°K, to date, there is no agreement on the residual amount of energy remaining in a body at 0°K, yet, it is believed that the residual exists (namely, that it is positive). It is true that the residual energy at 0°K cancels out when we are interested in temperature differences and the energy differences corresponding to them; yet, it is equally true that the knowledge of the Universe will remain necessarily incomplete, if there can be no objective way of knowing the energy content of a body at 0°K; for then, there can be no way for the total energy content of the Universe to be made known. It is obvious, therefore, that in order to retain the hope of ultimate understanding, the question of energy content at 0°K must be resolved.

Currently, we confuse further the concept of 0°K by regarding it somewhat like the zero of the ordinary mathematical scale, which is definitely and precise ly attainable by a suitable subtraction. In reality, 0°K is a *physical* quantity (or rather, as we shall see later, the ultimate physical non-quantity, or in other words, the *perfect absence of all physical quantities*), and as such it is equivalent to $10^{-\infty}$ °K! Seen in this light, the absolute zero of temperature is no more attainable than any other infinity in any finite period of time.

2.3.2.8.2. The First Law

Undoubtedly, the most fundamental aspect of energy currently adhered to is its constancy, namely, that it can neither be created from nothing, nor be destroyed, converted somehow into absolutely nothing. This notion of constancy constitutes the essence of the First Law. The law was based on an experimental basis in about the middle nineteenth century, and its validity has never since been doubted, especially in view of our inability to construct a perpetuum mobile of the "first kind", a work-producing machine fed with absolutely nothing. The constancy aspect of energy was intensified through its union with the constancy aspect of mass, a union brought about by the development of the theory of relativity: This union is predicated exclusively and solely upon the constancy of the velocity of light, energy being the product of mass and the square of the velocity of light. Take the constancy of the velocity of light away and the union of mass and energy as incorporated in the theory of relativity completely vanishes! Retain the formal relationship of mass and energy as held by the theory but under the constraint of a variable velocity of light (which obviously is contrary to the theory of relativity) and the First Law of thermodynamics collapses! This is precisely

the situation we are faced with in an expanding universe obeying Eqs. 1 and 10 as we have already seen earlier in this Section (2.3.2).

As the universe ages, the velocity of light gets reduced and so indeed does the entire energy of the universe. The inexorable expansion weakens the gravitational field, in other words, the gravitational potential energy. The kinetic energy of the universe, therefore, is not converted to potential energy and the gradual disappearance of the *total* energy is assured on both counts.

There was up until now no need to doubt the experimental basis of the First Law. Now, however, in view of the findings of this work, that basis *must* be re-examined. Whether or not measurements can be carried out with sufficient accuracy (at least equal to $dE/E = -2dT/3T$, or in other words better than 1.5×10^{-13} parts/part on a daily basis, taking the age of the universe as 12 b.y.) as to check the findings of this work, must await the judgment of the specialists and very likely the development of new experimental techniques. The enormous output of quasars, which has so far been impossible to explain on the basis of the known laws of physics, may just be the observational evidence needed of the huge energy present in the universe in the remote past.

2.3.2.8.3. The Second Law

Experience shows that whereas all other forms of energy can be converted totally to heat, heat of a certain grade cannot be converted totally to some other form of energy and to that form alone. Our inability to construct a perpetuum mobile of the "second kind" namely, a work-only producing machine, a machine fed exclusively with heat of a certain grade and producing work exactly equal to the heat fed to it, is the negative experimental verification of the Second Law. For we always find that besides work, heat engines fed with heat of a certain grade also produce heat of a "lower" grade. Thus heat is the most degraded form of energy and is itself subject to further degradation, as we shall see shortly.

The classical development of the Second Law was based upon the validity of the First Law, but also upon the possibility of devising cyclic processes with precisely reversible steps. It is obvious from the preceding development that in a universe expanding as discussed in the present Section, all processes and (most) properties are universal-age-dependent. Therefore, neither is the energy of a (*any*) system conserved, *nor can an apparently cyclic process reproduce exactly the past state of a system, for we can never return to a past age of the Universe*! In light of the universal expansion, therefore, a re-examination of the foundations of the Second Law is certainly required. In such re-examination cognizance must be given to the fact that not one natural reversible process has been discovered and for this reason alone, the employment of reversible processes, even in a thought experiment, is certainly contrived and unnatural, especially if conclusions of cosmic significance are to be based on the findings of such an experiment. So far, the absence of natural reversible processes has not been linked to the universal expansion, nor has such a link even been hinted at. It is certainly possible that even an inhomogeneous universe driving towards homogeneity, though basically non-expanding, may well allow no reversibility, at least until

homogeneity has been reached. The irreversibility is however certainly reinforced in a universe which expands in an age-dependent manner and which can never attain equilibrium except at infinite age when its total energy has vanished to zero. It appears, therefore, quite natural to surmise right from the outset that the applicability of the Second Law in the real expanding Universe must somehow be due to its non-equilibrium. (Obviously, the rate itself of approach to equilibrium must be related to the "distance" between the present state and the final state, a "distance" that is dependent upon the present age of the Universe).

In light of the above discussion, it becomes clear that the classical derivation of the Second Law in an expanding universe is certainly false. Yet, it must be admitted that the notion of entropy, used in connection with the Second Law, appears quite straightforward and natural as introduced in the classical discussion of heat engines, whereas it is too abstract and unnatural when introduced a priori in the manner, say, of E.A. Guggenheim.

In view of these difficulties and for a non-mathematical and qualitative only discussion of the subject to which we shall at present restrict ourselves, we may introduce the entropy as the "temperaturization factor" of that energy portion involved in a given process that cannot be converted to work. This definition is in full accord with experience and in itself quite accurate, for strictly speaking, it is only to the energy that is impossible to convert to work that the entropy refers; not every energy/temperature quotient has real physical significance. On the other hand, it is probably only because of the existence of entropy (so defined, and its relationship to heat capacity) *as a property of Nature* that there exists a relationship between energy and temperature.

From this definition, it follows directly that the entropy of a going process is always positive, for it is for going processes that there is a positive difference between the total heat input and net work produced. Processes at equilibrium produce no net work and therefore have zero entropy. It also follows from the above definition that the entropy of the universe always increases: For the expansion of the universe is a continuously going (though continuously slowing down) process which can be considered as a set of an infinite number of consecutive processes extending to infinite universal age. Upon using the work produced in the first such process, an amount of heat equivalent to that work is obtained. Upon using this heat to drive a second process, a still smaller amount of net work is produced and so on. The continuous increase of entropy is therefore intimately related to the inexorable degradation of heat, that is, the rejection of heat at a lower and lower temperature in an infinite series of heat engines*, the first of which may be regarded as absorbing all the heat present in the original high-temperature reservoir.

The above discussion thus leads to the following conclusions: (a) Grading of heat is accomplished in terms of the temperature at which it becomes available. (b) Heat degrades, meaning that it becomes available at lower and lower temperatures, until the absolute zero is reached, even if at infinite universal age. (c) The decrements of temperature at which heat becomes available in a series of conse-

* It must be stressed that what is important here is not the infinitude of physically distinct heat engines, but rather the infinitude of repetition of the process of a heat engine.

cutive heat engines become smaller and smaller. (If this were not true, the temperature would reach absolute zero in a finite number of steps, namely, at a finite universal age, after which it would remain constant at absolute zero. This value would apply *identically everywhere,* because of the physical impossibility of negative temperatures, precluding the zero value from being a statistical average, which would still remain in full force). (d) There is a corresponding change in entropy: In a series of consecutive heat engines, each engine contributes a positive, yet, smaller and smaller increment of entropy, until finally, when the zero temperature is reached, the entropy "produced" is also zero. (If the zero temperature state were to be reached at a finite age, the entropy would henceforth cease to increase and the proposition that the entropy of the universe always increases would obviously be false for it admits of no time limit). (e) The reason why the state of zero temperature and zero entropy "production" cannot be reached at a finite universal age cannot be found without due consideration of the universal energy, which is not due to become zero before infinite universal age. Thus, if the universal temperature reached absolute zero and the universal energy did not also become zero, a peculiar and indeed absurd situation would arise: identical masses would not be impossible to exist at the same time which would have different energy contents but the uniformly identical temperature of absolute zero. Would these masses be at equilibrium or not? It would be impossible to decide. Indeed, generally, it is the existence of differences in energy content that gives rise to differences in temperature and forces the flow of energy. Yet, identity of temperature would forbid such flow! Moreover, if that situation were to develop, conversion of energy to heat would be impossible. This would be necessitated by the fact that if heat were to develop as a result of such conversion, it would be possible to store it in a heat reservoir, the temperature of which would necessarily rise above zero, in violation of the universal temperature having already attained, and been stabilized, at absolute zero. Nor can we avoid these predicaments by supposing that only heat would be banished from the universe then but not other forms of energy. For example, what would become of chemical energy? The situation here does not necessarily preclude the existence of all chemical elements but one and, therefore, the reaction of, say, hydrogen and oxygen would still be possible. Then, what form would the energy released upon reaction take? Or, what form would the energy released upon equalization of gravitational or electrical potential take? The impossibility of answering these questions in a physically meaningful manner, namely, in a manner fully consistent with the basic and tandem laws of universal gravitation and expansion, for it is to heat that all other forms of energy convert and it is heat that is dissipated in the expansion of gases and, by extension, in the expansion of the Universe, suggests not ignorance on our part but rather the logical and physical impossibility of attaining a universal temperature of value zero any time sooner than at infinite universal age. Rejection of the peculiar situation of zero-universal-temperature/ non-zero-energy leads directly not only to continuously diminishing decrements of temperature and increments of entropy involved in an infinite series of consecutive heat engines, but also to similar changes in the Universe as a whole: The universal

temperature decreases unendingly towards absolute zero; the universal entropy increases unendingly; yet, the rates of both these changes decrease unendingly.

On closer examination, it is recognized that the above non-mathematical definition of entropy does not refer explicitly, nor indeed can it easily be shown to apply exclusively, to a universe expanding as discussed in this Section. We, therefore, need to redefine the entropy of the thus expanding universe in a manner that makes it both mathematically exact as well as compatible with the universal expansion. In classical thermodynamics, the entropy change of a system absorbing heat Q_1 from an external reservoir held at a temperature Θ_1, and rejecting heat Q_2 into an external reservoir held at a temperature Θ_2 ($< \Theta_1$) is introduced as the difference $\delta S = Q_1/\Theta_1 - Q_2/\Theta_2$. Neither of the two quotients comprising this difference has real significance for the system in question; only the difference as a whole has real significance and is an exact property of the system. And herein originate all conceptual difficulties associated with the classical definition of entropy. One moment's reflection shows that such a definition of entropy for the entire universe will not do. Firstly, no high- or low-temperature reservoirs external to the universe exist. And secondly, only one (the average) temperature can possibly be used: that at which the isothermal equivalent substitute universe can exist and still have all its integral properties equal to the corresponding integral properties of the real universe and related to the universal age in precisely the same manner in which the corresponding properties of the present universe are related. This means that for the Universe as a whole, the only possible and only permissible definition of entropy is:

$$dS = (+ \text{ or } -)dE/\Theta, \tag{103}$$

where dS represents the instantaneous integral entropy change, while dE and Θ represent, respectively, the instantaneous integral energy change and instantaneous absolute temperature of the Universe. Which of the two signs is to be retained will be decided shortly.

It is immediately obvious that this definition removes automatically all imprecision and all conceptual difficulties associated with the classical definition of entropy based on the Carnot cycle. The universal entropy now relates in a mathematically exact form to the energy of the Universe and its average temperature and is thus compatible with the notion of the entropy as the "temperaturization factor" of the energy introduced earlier in the nonmathematical definition of entropy. However, now, the entropy is shown to be related not just to the portion of the energy that is not available for the production of useful work, a portion that may, or may not, be retained in the Universe, a subject on which the non-mathematical definition of entropy used above is entirely non-committal, but rather to the amount of universal energy that vanishes at any instant and only thus becomes unavailable for the production of useful work.

At this point we must advance the principle that *what is objectively real must by definition be written as a positive quantity*. In the present case, since both universal energy and average universal temperature are real they both are to be written as positive quantities. Since energy is proportional to the $-2/3$ power of the universal age, it follows that dE/dT is negative (and proportional to the

$-5/3$ power of the universal age). The quotient $dE/\Theta dT$ thus is also negative. As a result, for dS to be a real property of the universe, and not just a mathematical one, and in order to preserve complete agreement between the non-mathematical and mathematical definitions of entropy given above, it is necessary that the negative sign be employed in Equation (103). It follows that

$$dS/dT = -dE/\Theta dT, \quad (104)$$

and therefore that the entropy increases with the universal age.

(In this sense, both the energy and the temperature of the expanding universe are seen to be "broadly similar" functions of the universal age: they both are positive at any age and they both decrease with age. It is illogical to claim that the universal temperature increases, or perhaps, stays constant, while the universal energy decreases unendingly).

In light of all previous discussion in the present Section (2.3.2.8), we are justified in seeking to determine the exact dependence of the universal entropy and temperature upon the universal age and, to the extent possible, upon the other two universal quantities G and M. We shall not make it one of the objectives of this work to recast classical thermodynamics in a form compatible with the universal expansion.

For simplicity, and in view of the very low density of matter in the Universe and the very high temperature required of the equivalent isothermal universe, as we shall see shortly, we shall assume that the latter is composed of elemental hydrogen (mass of the $^1H_1$ atom: 1.6735719×10^{-24} grams) obeying closely the ideal gas law, but otherwise retaining the mass distribution we have already determined.

A shell of gas between ρ and $\rho + d\rho$ at age T has volume $dV = 4\pi r^2 dr = 4\pi R^3\rho^2 d\rho$, and considering Eq. 48, it contains mass $2M\rho d\rho$. The weight of this gas, according to what was developed in Section 2.3.2.7, is

$$dW = 2GM^2R^{-2}\rho^2 d\rho.$$

The weight of the universe between $\rho = 0$ and $\rho = \rho$ is thus given by:

$$(2/3)\rho^3(GM^2R^{-2}),$$

and the weight of the universe between $\rho = \rho$ and $\rho = 1$ is

$$(2/3)(1 - \rho^3)(GM^2R^{-2}).$$

The pressure at $r = \rho R$ thus is

$$P = (2/3)(GM^2R^{-2})(4\pi r^2)^{-1}(1 - \rho^3) = (1/6\pi)(GM^2R^{-4})(1 - \rho^3)\rho^{-2} \quad (105)$$

The local PdV product is

$$(1/6\pi)(GM^2R^{-4})(1 - \rho^3)\rho^{-2} \times 4\pi R^3\rho^2 dr = (2/3)GM^2R^{-1}(1 - \rho^3)d\rho \quad (106)$$

This product, according to the ideal gas law, equals $R_g\Theta_{loc}\, dn$, where dn is the number of gram-atoms contained in the shell, R_g is the gas constant and Θ_{loc} is the local temperature. Since $R_g = N_A k$, where N_A is the Avogadro number (6.022×10^{23} atoms/gram-atom) and k is the Boltzmann constant (1.3807×10^{-16} erg/

atom, °K), it follows that,

$$PdV = (2/3)GM^2R^{-1}(1-\rho^3)d\rho = (2\rho d\rho)M(N_A k\Theta_{loc})(N_A m_H)^{-1}$$
$$= (2\rho d\rho)N_H k\Theta_{loc}\,, \tag{107}$$

leading to

$$(1/6)m_H c^2(1-\rho^3)\rho^{-1} = k\Theta_{loc}\,, \tag{108}$$

and the global product (integrated from $\rho = 0$ to $\rho = 1$)

$$PV = (2/3)GM^2R^{-1}\int(1-\rho^3)d\rho = GM^2/2R = Mc^2/4, \tag{109}$$

which, by the ideal gas law, equals $nR_g\Theta_{av} = (M/N_A m_H)(N_A k\Theta_{av})$, so that

$$PV = Mc^2/4 = (M/m_H)\,k\Theta_{av}\,, \tag{110}$$

and

$$m_H c^2/4 = k\Theta_{av} \tag{111}$$

thereby resulting in

$$\Theta_{loc} = (2/3)(1-\rho^3)\rho^{-1}\Theta_{av}\,. \tag{112}$$

The local and average temperatures are equal at $\rho = 0.5536$. Eq. 111 is in effect the global equation of state, yielding the average temperature for the isothermal equivalent universe of

$$\Theta_{av} = 2.72349 \times 10^{12}\,°K.$$

The significance of this high temperature will be discussed later in this work.

Adiabatic expansion of an ideal gas is carried out under PV^γ = constant, where $\gamma = R_g/c_v$, c_v being the heat capacity under constant volume. (For a monatomic gas, $\gamma = 2/3$). The question is raised: What is the corresponding expression for the equivalent universe under the real non-energy-conservation conditions? To find the answer we consider the local pressure $P + dP$ at ρ at the later universal age $T + dT$. From Eq. 105:

$$dP/dT = (1/6\pi)(1-\rho^3)\rho^{-2}\cdot(GM^2)d(R^{-4})/dT$$
$$= (1/6\pi)(1-\rho^3)\rho^{-2}\cdot(GM^2R^{-4})(-4R^{-1})(2R/3T)$$
$$= (-8/3)PT^{-1} \tag{113}$$

and

$$P + dP = P(1 - 8dT/3T) \tag{114}$$

The local element of volume $V + dV$ at $T + dT$ is found as follows:

$$dV/dT = (4\pi\rho^2 d\rho)(R^3/dT) = (4\pi\rho^2 d\rho)(3R^3)\,(R^{-1})(2R/3T)$$
$$= 2VT^{-1} \tag{115}$$

and

$$V + dV = V(1 + 2dT/T) \tag{116}$$

Thus, in order that PV^x = constant, namely, in order that

$$PV^x(1 + dP/P)(1 + dV/V)^x = PV^x(1 - 8dT/3T)(1 + 2dT/T)^x = PV^x, \tag{117}$$

it is necessary that

$$(1 - 8dT/3T)(1 + 2dT/T)^x = 1, \tag{118}$$

yielding

$$x = 4/3, \tag{119}$$

which is twice the value of γ for energy-conservation conditions.
The local temperature at T + dT will be Θ+ dΘ such that

$$\begin{aligned} PV(1 + dP/P)(1 + dV/V) &= (2\rho d\rho)M(N_A m_H)^{-1}(N_A k\Theta)(1 + d\Theta/\Theta) \\ &= (2\rho d\rho N_H k\Theta(1 + d\Theta/\Theta) \end{aligned}$$

and upon introducing Eq. 107:

$$(1 + dP/P)(1 + dV/V) = (1 + d\Theta/\Theta). \tag{120}$$

Use of Eqs. 114 and 116 results in

$$d\Theta/\Theta = -(2/3)(dT/T). \tag{121a}$$

Use of Eq. 115 results in

$$d\Theta/\Theta = -(1/3)(dV/V). \tag{121b}$$

Thus the temperature decreases with the –2/3 power of the universal age and the –1/3 power of the universal volume.

The Boltzmann constant is a conjugate quantity of Θ in that their product has the dimensions of energy. Since energy is proportional to the –2/3 power of the universal age, it necessarily follows that k is independent of the universal age. We may thus write the following:

$$\Theta_{ave} = w_1 G^x M^z (3T/2)^{-2/3}, \tag{122}$$

$$k = w_2 G^u M^v. \tag{123}$$

It is now obvious that as regards time alone, Θ is proportional to the velocity squared, so that, very likely, k is proportional to mass. On the basis of this hypothesis, a search was conducted to find the values of x, u, z, v, w_1 and w_2 that provide the exact arithmetical retrieval of Θ and k on the basis of Eqs. 122 and 123 alone. The following constraints apply:

$$x + u = 2/3,$$

$$z + v = 5/3,$$

$$w_1 + w_2 = (1/4)2^{2/3} = 2^{-4/3}$$

The search led to

$$\Theta_{av} = (6^{1/3}/40)\, Gc^2 *, \tag{124}$$

$$k = (10/6^{1/3})m_H/G. \tag{125}$$

They respectively give the numerical values of 2.7240885×10^{12} and $1.3803988 \times 10^{-16}$ in essentially perfect agreement with the numerical values of Θ_{av} obtain-

* This makes the average temperature inversely proportional to the universal radius:

$$\Theta_{ave} R = 6^{1/3} \cdot 20^{-1} \cdot G^2 M = (3/32)^{1/3} \cdot 5^{-1} \cdot G^2 M,$$

in agreement with the already known fact that black-body radiation changes in such a way that each spectral wavelength remains proportional to $1/\Theta$ (see: Richtmyer, Kennard, Lauritsen: "*Introduction to Modern Physics*" McGraw-Hill, 1955, p. 117).

ed above (and based on the currently accepted value of $k = 1.3807 \times 10^{-16}$ erg/atom, °K) and of k. Especially in view of the proof presented above that k is a true constant, the numerical success of Eqs. 124 and 125 lends compelling weight to the proposition that these equations truly represent also the dimensional definitions of temperature and k; as it also shows that the $k\Theta_{av}$ product represents the quarter of the energy of the hydrogen atom speeding with the velocity of light! In ordinary dimensions, then,

$$|\Theta| = |M^{-1}L^{5}T^{-4}| \quad \text{and} \quad |k| = |M^{2}L^{-3}T^{2}|,$$

and in universal dimensions

$$|\Theta| = |G^{5/3}M^{2/3}T^{-2/3}| \quad \text{and} \quad |k| = |G^{-1}M|.$$

Θ_{av} as given by Eq. 124 may be thought of as the natural unit θ of temperature.

Eqs. 110 and 111 can of course be written in terms of other "molecules" of weight m:

$$PV = (1/4)Mc^2 = (M/m)k\Theta_{av,m}, \tag{110´}$$

resulting in

$$(1/4)mc^2 = k\Theta_{av,m}, \tag{111´}$$

and upon introduction of Eq. 125, in:

$$\Theta_{av,m} = (6^{1/3}/40)(m/m_H)Gc^2. \tag{126}$$

For velocities other than c it is obvious that the temperature must be written in the general form

$$\Theta = (1/4k)(mv^2). \tag{127}$$

The velocity used in this equation thus is $(\pi/2)^{1/2} = 1.2533$ times greater than the arithmetic mean velocity and $(4/3)^{1/2} = 1.1547$ times greater than the root-mean-square velocity obtained from the kinetic theory of gases; and is the average velocity of molecule m in the equivalent universe, if the latter were filled only with molecules of this particular kind m and had cooled down to the average temperature Θ, under the non-energy-conservation conditions imposed by Eq. (10) and the constancy of G and M, as already studied in Section 2.3.2.

On the basis of the general Eq. 127, the temperature of a "molecule" m is seen to be proportional to its "molecular" weight relative to the $^1H_1$ atom, and thus to be the "thermodynamic equivalent of its kinetic energy", increasing not with the mass of the "molecule" as in mechanics, but with its "molecular" weight. At the same time, the temperature remains strictly proportional to the square of the velocity $v = \gamma c$ (where γ is a dimensionless proportionality constant) and through it, proportional to the 2/3 power of the universal mass as already given above in universal dimensions.

If the "heat capacity" of the hydrogen atom is defined as

$$c_H = (1/4)d(m_Hc^2)/d\Theta$$

it is found that

$$c_H = kd\Theta/d\Theta \equiv k.$$

In other words, the Boltzmann constant represents the average heat capacity of the $^1H_1$ atom in the equivalent universe, under the non-energy conservation condition applying to the real expanding universe.

As regards the entropy, Eq. 104 leads to

$$ds \equiv -d\epsilon/\Theta = -(1/4)d(m_Hc^2)/\Theta = -d(k\Theta)/\Theta = -k d\ln\Theta, \quad (128)$$

and upon integration, to

$$s = k\ln(\Theta_o/\Theta) = k[(\ln\Theta_o - \ln\Theta)] \quad (129)$$

where Θ_o is a constant. This directly explains the increase in entropy, since Θ decreases with the universal age. Dividing Eq. 128 through by dT gives

$$ds/dT = -2k\Theta^{-1}d\Theta/dT = -kc^{-2}d(c^2)/dT = -2kc^{-1}dc/dT = 2k/3T, \quad (130)$$

which represents the rate of increase with the universal age of the entropy of the $^1H_1$ atom, in full accord with the previous discussion. It must be emphasized that the $^1H_1$ atom for the purposes of the present discussion is to be regarded as totally "structureless"; only its mass matters. For heavier but similarly "structureless" molecules it follows that

$$\begin{aligned} -dE = \quad & \Theta_H\, dS_H \quad = \Theta_m\, dS_m \\ = \quad & \Theta_H\, N_H\, ds_H \quad = \Theta_m\, N_m\, ds_m \\ = \quad & \Theta_H\, (M/m_H) ds_H = \Theta_m\, (M/m_m) ds_m\,, \end{aligned}$$

simplifying to

$$ds_m = [(\Theta_H\, N_H)/(\Theta_m\, N_m)]ds_H \quad \text{and} \quad s_m = s_H + \text{constant}.$$

That the increase in entropy slows down with age is immediately seen from

$$d^2s/dT^2 = -(2k)(3T^2)^{-1}\,. \quad (131)$$

Integration of Eq. 130 leads to

$$s = (2k/3)\ln(T/T_o)\,. \quad (132)$$

In the beginning, when $T = T_o$, the quotient T/T_o was unity, although T_o was zero, and the entropy was indeed zero. The entropy increase since $T_o = 0$ is indeed infinite, as is the energy already lost:

$$\delta\epsilon = m[(4/3)GM\,0^{-1}]^{2/3} = -m[(4/3)GMT^{-1}]^{2/3}.$$

Eqs. 129 and 132 show the logarithmic dependence of entropy upon both temperature and universal age and explain the dimensional relationship of entropy, the Boltzmann constant and heat capacity.

2.3.2.8.4. The Third Law

To summarize briefly the previous discussion, the universe expands and in so doing loses its energy and cools down. The points of zero total energy and zero temperature will not, however, be reached before $T = \infty$. The sole *physi-*

cally discernible objective of the universal expansion is the attainment of the final and only true state of total equilibrium, equivalent to perfect immobility of everything. Since expansion means decreasing pressure, the final state is also the state of perfect vacuum, namely, of infinite separation among the fundamental particles themselves (assumed as concentrated each at a point). Under these conditions, the significance of the solid, liquid and gaseous states of aggregation completely vanishes. The Third Law of thermodynamics and its applicability to the universe as a whole must be seen in this light.

In its original form (the heat theorem of Nernst), the Third Law only stated that at 0°K the entropy of reaction is zero. This is certainly in complete agreement with the demands of the expanding universe, since under perfect immobility, any reaction will be impossible. The later reformulation of the Third Law, to the effect that the entropy of a (solid) body at 0°K is zero is not in agreement with the demands of the expanding universe: The universal entropy at infinite universal age and zero temperature will itself be infinite, *if we accept as basic the proposition that the entropy of the expanding universe is positive and keeps on increasing*. Since the universe is of fixed mass, as a matter of necessity, it contains a fixed number of fundamental particles, each of fixed non-zero mass; it follows that the entropy of each fundamental particle will be infinite at $T = \infty$.

As a result, the unending increase in universal entropy does not come about through the "production" of previously non-existent "pieces" of entropy and their addition to a common pool, as it were. Nor does it come about through the faster and faster splitting of the existing "pieces" of matter to smaller and smaller such pieces, in such a way that the number of "contributors" increases faster than the size of each contribution diminishes,* in order to justify both the continual increase in total entropy and the continual decrease towards zero of each contribution as the current reasoning appears to be demanding. For otherwise, it is impossible to reconcile the presently accepted notions. Take, for example, the entropy of atomic hydrogen: It increases with temperature: Under the constraint of continual entropy increase, one should expect, therefore, the universe to end up being unlimitedly hot, rather than limitedly cold, as the universal expansion demands.

In his elaboration in the Third Law, M. Planck ("*Treatise on Thermodynamics*", Dover Publications, p. 273, 276) stated that the currently accepted formulation of the Third Law strictly speaking admits of the possibility of the entropy of a body being $-\infty$ at 0°K.

These conflicts are more apparent than real and due to our confused convention. They all dissolve perfectly when one considers the definition of entropy as given by Eq. 103, where either sign may certainly be used. We may choose to define entropy according to only one out of the six options shown in Table 4. There is no option as regards the change of temperature with age. Our earlier choice was to define entropy according to option A, thereby ensuring that the entropy is positive and increasing while the temperature decreases. This is contrary to current convention: Current tabulations comply with Option C, but the current notion that the universal entropy increases does not.

Actually, a better choice may be made between Options E and F. Then, the

* Because, finally, infinite times zero is still zero, not infinity.

TABLE 4

THE DEFINITION OF ENTROPY

Option:	T	Θ	S	The Entropy is understood to be
I: initial; F: final				
A	I	0	∞	0	positive and increasing with decreasing Temperature. $ds = -k d\ln\Theta$; $s = \int ds\,(\text{from } 0 \text{ to } S) = -k\int d\ln\Theta\,(\text{from } \Theta_o \text{ to } \Theta) = -k\ln(\Theta/\Theta_o)$ Integration is forward in time. Θ_o is very high.
	F	∞	0	-∞	
B	I	0	∞	-∞	negative and increasing with decreasing Temperature. $ds = -k d\ln\Theta$, $s = \int ds\,(\text{from } 0 \text{ to } S) = -k\int d\ln\Theta\,(\text{from } \Theta_o \text{ to } \Theta) = -k\ln(\Theta/\Theta_o)$. Integration is forward in time. Θ_o is very high.
	F	∞	0	0	
C	I	0	∞	∞	positive and decreasing with decreasing Temperature. $ds = k d\ln\Theta$, $s = \int ds\,(\text{from } 0 \text{ to } S) = k\int d\ln\Theta\,(\text{from } \Theta_o = \infty \text{ to } \Theta) = k\ln(\Theta/\Theta_o)$. Integration is forward in time. Θ_o is very high.
	F	∞	0	0	
D	I	0	∞	0	negative and decreasing with decreasing Temperature. $ds = k d\ln\Theta$, $s = \int ds\,(\text{from } 0 \text{ to } S) = k\int d\Theta\,(\text{from } \Theta_o = \infty \text{ to } \Theta) = k\ln(\Theta/\Theta_o)$. Integration is forward in time. Θ_o is very high.
	F	∞	0	-∞	
E	I	0	∞	-∞	negative; then, positive and increasing with decreasing Temperature. $ds = -k d\ln\Theta$, $s = \int ds\,(\text{from } -\infty \text{ to } S) = -k\int d\Theta\,(\text{from } \Theta_o = \infty \text{ to } \Theta) = k\ln(\Theta/\Theta_o) \equiv k\ln\Theta$. Integration is forward in time. Entropy is defined as zero at 1°K.
	F	∞	0	∞	
F	I	0	∞	∞	positive; then, negative and decreasing with decreasing Temperature. $ds = k d\ln\Theta$, $s = \int ds\,(\text{from } \infty \text{ to } S) = k\int d\Theta\,(\text{from } \Theta_o = \infty \text{ to } \Theta) = k\ln(\Theta/\Theta_o) \equiv k\ln\Theta$. Integration is forward in time. Entropy is defined as zero at 1°K.
	F	∞	0	-∞	

initial infinite temperature Θ_o or the final zero temperature Θ_∞ may be *defined out* of the logarithmic expression by assigning the zero entropy value to the unit of temperature, e.g. to 1°K. Under Option F, entropies at < 1°K race towards – ∞ as Planck indicated as possible, but the statement that the universal entropy increases must be reversed. This option leaves the signs of entropy in the existing tabulations intact, but requires adjustment of the entropy values assigned to various temperatures to comply with $s = k\ln\Theta$. It also removes the floating value of Θ_o which appears to have crept into current tabulations. This is analogous to our earlier assigning of a definite value to the current energy content of the universe, despite the fact that the original energy value at $T_o = 0$ was infinite.

Whether under these conditions, one chooses to consider entropy as a physical or only as a mathematical property of matter becomes inconsequential.

Obviously, the effects of internal structure upon the atomic (molecular) entropy will be in addition to the values assigned as above. For we should not forget that according to currently accepted notions, at 0° K, only the vibrations, i.e. only the oscillatory motion of the atom (molecule) as a whole relative to some middle point, cease, while the inner constituents of atoms (molecules) continue moving about relative to the center of the atom (molecule). The kinetic theory of gases and the theoretical thermodynamic temperature scale work so well only because they ignore the inner structure by considering the "atoms" as perfectly hard solid spheres. Practical difficulties arise only in so far as this picture is less than a satisfactory approximation to reality.

Nor should we ignore the fact that the kinetic theory continues to apply to a perfect gas moving as a whole, by dealing only with the motion of the gas molecules relative to the center of mass of the gas. It is for this reason that both the theory and the thermodynamic temperature scale based on it are insensitive to the motion of the gas as a whole relative to the center of the universe. The "thermodynamic thermometer" only records temperature differences relative to its own temperature, while its own temperature (i.e. its kinetic energy) relative to the center of the universe may, or may not be zero. It is only thus that the absolute zero of the thermodynamic scale can accurately be defined as the state of *perfect motionlessness,* regardless of whether such motionlessness is relative or absolute. And it is thus that the thermodynamic scale as ordinarily understood is equally applicable to the entire universe.

2.3.2.8.5. Summary and Final Comments.

The thermodynamics of the expanding universe can be summarized in the following three sentences:

(a) The universal energy is not conserved but decreases monotonically towards zero.

(b) The universal entropy, namely, the thermodynamic measure of the energy lost, increases or decreases monotonically, according to the convention used in its definition.

(c) The only state of true equilibrium for the entire universe is its final state

of zero energy, zero temperature, absolute vacuum, infinite separation and absolute immobility of all fundamental particles.

We have succeeded in expressing the temperature, Boltzmann constant, heat capacity and entropy in terms of the universal dimensions G, M and T. The indisputable dependence of universal temperature upon the –2/3 power of the universal age, identical to the dependence of the universal energy, suggests that the conjugate quantity k is indisputably a true constant fixed for all time. We succeeded in finding an expression for k that closely reproduces the measured value arithmetically. We then were able to obtain an expression for temperature based solely on the velocity and molecular weight of the moving particle and independent of heat capacity. Temperature thus ceases to be an additional physical dimension. The simplicity of the expressions obtained and the fact that they meet all requirements made of them are their strongest recommendation. These expressions now permit thermodynamics to be understood in universal terms, without final reference to temperature. So far, temperature was meaningful only to those with tactile sensory equipment; with these expressions in hand, temperature now becomes meaningful universally. The objective world out there thus becomes comprehensible in its own mechanical and, as a consequence, objective terms without reference to human psychosomatic functions. Thermodynamics is now seen as a branch of mechanics and dynamics not only in the very small scale, but also in the very large. The usefulness of thermodynamic theory as the best tool we possess for understanding in aggregate, i.e. statistical, terms systems of (almost similar) particles, too many to measure individually, is now further increased by making it possible to understand in more ordinary terms the unified and congruent workings of the universe from the smallest to the largest scale. The thermodynamics of the expanding universe is quite simply another way of expressing the effects of universal gravitation and expansion, amounting in effect to a mere tautology under constant G and M.

2.3.2.9. ON THE FORMATION OF CHEMICAL ELEMENTS AND STELLAR EVOLUTION.

The Laplacian notion of an original tenuous "gas" has been incorporated into the current notions of evolution of the Universe. The very early stages of this evolution are very uncertain. Yet, and very briefly, it is believed that the temperature of the "fireball" of the "big bang" was too high to permit the existence of anything other than what we today call the elementary particles. "Compound" forms of matter resulted only later, when the Universe became cooler. Then, at a temperature of about 10^9 °K, it is allowed, some thermonuclear fusion took place, resulting in the formation of helium (27% of the total mass) and traces of a few heavier elements. Accordingly, hydrogen is claimed to have been the original chemical form of matter out of which all other chemical elements resulted. At a later stage, at only about 3000°K, matter and radiation "decoupled" and the Universe became "matter dominated" and transparent to radiation. "Somehow" instabilities ensued that caused the gas to condense and form galaxies and stars,

which to this day remain mostly gaseous, at the center of which, by nucleosynthesis, the heavy elements form.

The evolution just sketched is ruled out by the conditions studied here. At zero age, the volume of the Universe also was zero. The Universe was then the ultimate condensed body and all matter in it was in the densest possible state of aggregation. Today, we speculate of "black holes", namely, of a "final" state of aggregation into which matter collapses when it can offer no resistance to gravitational contraction. The composition of such "holes" remains axiomatically beyond investigation and even reasonable speculation. The state of the Universe at T = 0 was precisely the state of the ultimate "black hole", which at that moment exploded and became the ultimate "white hole". This condition does *not* allow us to talk of the earliest stages of the Universe in terms of what we call the elementary particles. Also, it is unquestionably inelegant, and therefore unreasonable to believe that, the Universe passed directly from the densest state possible to the dilutest chemical element, hydrogen, thereby bypassing all intermediate states of aggregation, which states it formed later at 10^{9}°K, or much later when matter "reheated" at the centers of the stars. We have absolutely no grounds to accuse, as it were, the Universe of such gross inelegance and inefficiency! The exact opposite process of gradual decomposition from the densest to less dense forms is more elegant, more reasonable and in keeping with the uniformly monotonic expansion discussed here. Thus, hydrogen *cannot* have been the first chemical element in the Universe. Rather, it must be the last, since it is the lightest, chemical element into which the universal mass decomposes.

We must remember that when the Universe was very young, it also was extremely dense and energetic. Energy was not removed by subtraction, as it were. The Universe, composed of a fixed number of fundamental particles, photons, gradually lost energy as those photons became slower through ageing. Yet, when the photons were so very much faster, they also held so very much closer together, forming "bodies" that were so very much denser. This notion is in full accord with the ideas presented in Part Three, based on a new and objection-free model of the electron.

We should not look at the Universe as if it were a gas expanding in proportion to the heat supplied to it under constant pressure. Rather, we should look at it as a gas expanding solely against its own self-gravitation with no outside pressure containing it, and having more energy at any previous moment, when it was *at* (rather than, *under)* a higher average self-created pressure and occupied a smaller volume. We should look at the Universe as a piece of high explosives packing both more energy and a higher energy density before explosion than *immediately* afterwards. We should *not* be misled by the "low" sensible temperature of the explosives before explosion: *The photons never rest! Yet, in this expanding Universe, they gradually slow down*!

Nor should we object that when the photons were so very much faster, the Universe was also expanding at an equal rate, so that it is not true that it "held" more closely together: There is nothing unique about the unit of time we have adopted. One can always select a time unit, say, 10^{-100} sec., within which the Universe appears for all intents and purposes to be at a standstill. In such a time-

scale, then, the Universe does indeed "hold" closer together while it contains more energy. The term "hold" must be seen in this light. *In an expanding Universe nothing holds together absolutely*!

The universal lesson, then, is that (a) bodies are able to hold closer together as they are more energetic, however precarious that situation always is in view of the continual expansion, and (b) they loosen up as they lose energy through ageing.

The Universe thus allows a uniform and most natural explanation for the process of ageing itself, which in nothing other than the gradual loss of energy and of the ability to hold more, *or even a constant,* amount of energy. This natural process must only slightly be more complicated in living organisms, which are characterized also by a period of growth: children are indeed packing more energy than adults, not perhaps as individuals compared to adult individuals, but certainly on a gram-to-gram basis! The common saying is not without physical significance!

In this light, it is entirely proper to suggest, then, that the nuclei of the chemical elements are micropictures of the entire Universe: The heavier they are, the more energetic they are and the more energy they lose in absolute terms with every passing moment. Under this continual depletion, their stability will depend entirely upon their ability to hold together with less and less energy content albeit a "constant" mass content. Ultimately, the moment will come when its decreased energy will be insufficient to hold together the expanding nucleus. When that moment arrives, the nucleus will spontaneously break up. The nuclear contents thereby being released can be expected to rearrange themselves into what appears at the moment of disintegration, from the standpoint of the decomposing nucleus, as the most stable configuration that will take some extra, short or long, time before it itself becomes unable to resist its own expansion. The determining factors in this process must be the universal age, the local (nuclear) mass and energy content and the environment that determines the flow of mass and energy into and out of the nucleus. The evidence seems to suggest that when the nucleus is close to its limit of stability, it may need some nudging to form, say, a thermal neutron. At other times, it may break up entirely spontaneously, thus emitting the earliest neutrons, which then become available to activate additional nuclear disintegrations. The present universal age, the conditions within the uranium nucleus and the environmental conditions on Earth, must be just about those needed to bring that element to the brink of its stability. All heavier elements have already decomposed, at least here on Earth.

That with an extreme expenditure of energy we can, if only fleetingly, reconstitute transuranic elements, demonstrates that packing more energy and mass within the nucleus is not altogether impossible in principle at the present universal age. Yet, the stability of such elements under the here and now conditions becomes all the more problematical as the atomic number increases, in keeping with the general tenor of the present arguments. No transuranic element has been found to be stable, and conjectures of "islands of stability" may not prove to be of any significance on the cosmic time scale. This, certainly, must be

the case if the present Universe is indeed an expanding one, as here discussed, as all indications suggest. From another perspective, it appears that efforts to construct (*re-construct*) transuranic elements are nothing other than efforts to turn back, as it were, the cosmic clock. In an expanding Universe they cannot but be doomed.

The transuranic elements seem to resemble, yet here on Earth to have exhausted their resemblance to, the neutron. The latter is stable only within the nucleus, namely, in an environment of high mass and energy; outside such an environment, it disintegrates. The former are undoubtedly stable in an environment of much higher mass and energy, conditions that held generally in the remote past and (may) still do at the center of stars and galaxies. It is, therefore, reasonable to conclude that all chemical elements, the heavier ones first, will in time become naturally unstable and disintegrate.

We should not confuse longevity with "stability". Extending our reasoning from ordinary chemical reactions, where a substance is regarded as more stable relative to its constituents if formed from them under release of energy, we believe that this applies to nuclei also: An alpha particle is more "stable" than its constituent parts. Will it however outlive them? This is not possible yet to answer. The situation is similar to that of transuranic elements: Their nuclei also are by the ordinary criterion more "stable" than their constituent protons and neutrons, and yet they break up. When the alpha particle becomes naturally radioactive and begins to disintegrate we do not know how much mass it will then be packing in what arrangement of particles. We do not know whether mass is lost only upon decay such as observed at the other end of the periodic table, or whether it is possible, or will become possible in the future, on a more gradual scale. Will the alpha particle, neutron and proton be able to hold on to the mass they now possess, despite their gradual loss of energy through decrease in the velocity of light, until a final explosive moment, or do they continually and imperceptibly lose mass, and at what rate, as the Universe ages?

The complexity of the naturally occurring elements suggests that the nuclear decay does not necessarily proceed in strict order from one nuclear state to the very next less dense (smaller total mass per nucleus) nuclear state, but rather to an aggregation of less dense nuclear states that can most stably contain all or most of the masses being released upon decay. Excess mass, i.e. mass that cannot be contained in large distinct easily identifiable fragments, is being released in very small fragments that together constitute the so-called mass deficit. More elements can thus be produced in parallel processes, than one at a time, as would be required by the former course.

Atomic decay need not end at hydrogen. As discussed later in this work, the spectroscopic data are compatible with a spherical finite-wall-thickness model of the electron. The electronic mass composed ultimately of fundamental particles (photons), is held within the two wall surfaces, either by some as yet unknown force, or quite simply and in the most exuberant extreme of elegance and simplicity of design, by gravity. There is little question that their velocity plays a crucial role in their dynamical arrangement within that confined space. When at $T = \infty$, $c = 0$, how is the electronic mass going to hold together so closely? Now, the

presence of charge of opposite sign suggests that the proton too as well as the neutron, (that can be synthesized from a proton an electron and sufficient additional "energy" to bring those two together, which process however is never observed to be spontaneous in Nature), have their own internal structures, in which the velocity of light plays an equally crucial role. When the latter gets to be zero, what will those structures be? It is for this reason that decomposition down to the ultimate fundamental photons seems to be the ultimate fate of the Universe in the most extremely remote future.

In the previous discussion and in an effort for complete consistency throughout, we went against current opinion and suggested that the universal mode of element formation is fission rather than fusion. This is not (or, in the very least, not yet), a statement running against the facts. Because, our labeling as fusion reactions those reactions that currently go by that name is quite simply an abuse of language. Neither the reactions in the hydrogen bomb, nor any other man-induced reactions are purely fusion reactions. Rather, they are fusion-fission reactions, in which not only heavier but also lighter products result. For example, the easiest of all fusion reactions, namely,

$$D + T \rightarrow \alpha(3.5\ \text{Mev}) + n\ (14.1\ \text{Mev}), \tag{133}$$

produces not only an alpha particle (fusion) but also a neutron (fission) out of a deuteron and a triton. Similarly, the reaction that is currently believed to be occurring in the Sun, namely,

$$4p \rightarrow a + 2\beta^+ + 2\nu + 25\text{Mev}, \tag{134}$$

producing an alpha particle out of four protons, also produces two positrons and two neutrinos. Are these reactions fusion *or* fission reactions? To be fully consistent, any reaction *at all that produces energy, even if no other discernible products lighter than the original reactants, must be regarded as a fission reaction:* the energy produced is nothing other than photons, i.e. massive particles, according to the arguments already presented in Section 2.3.2.2.2. No reaction has ever been proposed that is spontaneous in Nature and truly fusing, that is, only absorbing both masses *and* energy, to produce exclusively only products that are heavier than the original reactants. [Surely, would such a reaction be of limited academic interest and no practical use?] It logically follows, that the energy released in fusion-fission reactions is more due to its fissioning characteristics and less due to its fusing ones, although the two aspects in such reactions are inseparable. The very fact that the lighter fragments carry off most of the energy (inversely to the ratio of their masses, as a result of momentum conservation), is an additional proof of the basic validity of the view adopted here.

If it be true that nucleosynthesis proceeds spontaneously (under certain conditions) in Nature from lighter to heavier nuclei, it is very hard to see why it stops at uranium. As we have already remarked, the uranium atom is lighter than the sum of the separate protons, neutrons and electrons composing it, and so is plutonium. So, on the face of it, there is no reason why the process of neucleosynthesis cannot proceed naturally further. Why then is uranium radioactive and all heavier elements, transiently produced by Man, even more so? And why

have we never observed a spontaneous synthesis of lighter nuclei? Why must those "certain" conditions be so special? If observation is to continue to be interpreted as only demonstrating at least the outward appearance of the nature of things as they are, then, surely, Nature fissions and does not fuse, in full agreement the general theme of universal expansion.

In view of these conclusions, forced upon us by *both* universal expansion *and* logic, and in order that we remain consistent, it appears that we have to revise drastically our view of the Sun and the stars as well. Our failure to observe the solar neutrino flux predicted by current theory is very serious indeed. This is a true, and possibly the *only* test we have of our present theory of the Sun. It *must* be considered presumptuous of us to insist that our theory still holds good but for the effect of additional ad hoc theories, the sole purpose of which is to save the first one from abandonment, which is what we are doing at the moment!

Moreover, the solar wind, the existence of which was unknown when the solar model was first proposed, adopted and elaborated, militates against our current views of the Sun. By current theory, the solar wind originates in a region of the Sun having a temperature of about 4×10^6 °K, namely, quite deep within the Sun, the center of which, again by current theory, is believed to be at about 15 to 20 million °K. In other words, the solar wind proceeds from an area in the Sun of very high, though perhaps not the highest, gravitational field possible in that celestial body. Hence the question: If the Sun in its present state of condensation and high gravitational pull cannot fully restrain its own solar wind and thus continually loses huge amounts of mass, how was it possible for it to have reached its present state by, as believed, condensing out of the primordial gas, namely, by starting from diffuse particles that should have had no difficulty at all escaping from the original virtually non-existent solar gravitational field, in full agreement with the known laws of gases? Current theory takes its start from an *unknown, totally speculative and ad hoc* "turbulence" of the primordial "gas" that alone set off the process of star and galaxy formation. In so doing, current theory, after having rejected the Creator, still finds itself obliged to take refuge under the aegis of Aeolos, a *lesser* god of the Greek pantheon, who alone is left to stir up the Winds! How ironic! A "deus ex machina" may indeed save the Greek theater from irresolution in its efforts to expose the ways of Men and gods. But can he be called upon to carry, as Atlas upon his shoulders, the full weight of a consistent, scientific view of the Universe? The weight is doubtless much too heavy! (Before my reader rushes to condemn me of the same sin of substituting one deus ex machina for another, whom I call the Creator in the place of the mythical Aeolos, may I respectfully request that he withhold his judgment, at least until I complete the deposition of my "defense"?)

An additional and serious difficulty exists relating to the temperature of the equivalent isothermal universe, which may well be taken to be the universe of the primordial gas. At the present age, that universe should have had the temperature of about 2.72×10^{12} °K (see Section 2.3.2.8), which is no less than 1.36×10^5 times the temperature theorized for the center of the Sun. If the Universe, therefore, were to condense into stellar bodies today, their temperature should rise adiabatically many orders of magnitude higher still. Current theories cannot

cope with this situation, certainly not for stars in the main sequence.

These and possibly other difficulties are removed if the Sun, instead of fusing to, fissions from a superheavy central core. The current model demands a central density of about 180 g/cm^3, an overall composition of about 70% hydrogen and about 30% helium and an internal structure that in essence is totally speculative. A fissioning Sun must have a totally different structure and composition, possess a very much denser core and possibly emit fewer neutrinos. It must, in effect, be nothing other than a white hole slowly expanding beyond its Schwarzschild radius and shedding in the process all excess mass and energy.

2.3.2.10. EVIDENCE OF THE UNIVERSAL EXPANSION ON EARTH.

The strong astronomical evidence that the Universe expands was first discovered in the 1920s. Yet, the inevitably significant effects of the universal expansion upon the history of the development of the Earth have almost totally been ignored, except for the possibly unique work of P. Jordan ("*The Physicist's Conception of* Nature", J. Mehta, Ed., D. Reidel Publ. Co., 1973, p 60). There can be no question that the parallel and theoretically all-important question of the effects of the universal expansion upon the development of physical theory has indeed been totally ignored! It is the effects of universal expansion as they pertain specifically to the general (planet-wide) and particular (standard rigid-rod) problem of length, that we shall discuss in this Section. It appears that having placed so much emphasis on and trust in, and having made such absolute philosophical commitment to, the infallibility of "experiment" and "experience", we have found it totally beyond our capacity even to imagine, let alone concede, that the apparent "permanence" of our environment may indeed be totally illusory, namely, that the "experiment" can possibly deceive us. Eq. 10 requires that the Earth and every body, however large or small, expand along with the Universe. To re-phrase it then, the real problem is to assess the *exact* significance and meaning of this "along with".

If today, a scientist were to be asked which one is his most valuable tool, he would most unhesitatingly answer: "why, my rigid rod!" Horrors of Hell, ever to doubt the existence of such an instrument! And yet, this is exactly what the expanding Universe demands: the non-existence of a fixed measure of length!: Consider the initial state of the expanding Universe: The Earth, then as now, undoubtedly occupied a very small part of the total volume of the Universe, which was zero! Consider the final state of the expanding Universe: The Earth as part of the Universe will be stripped of *all* its energy, and without it, it *cannot* hold together. Thus, our so-called "rigid rod" (if it is to have universal physical significance through time and be not merely a purely non-physical theoretical construct, or only a transient instrument of very limited temporal value) must have had a zero initial length and must have an infinite final length. So, in order to assess the true significance of physical measurement in an expanding universe, it is all-impor-

tant that we determine, if at all possible, how the "rigid rod" behaves between the two extremes of the universal age.

The simplest rule to be applied to a "rigid rod" is that it constitute a fixed fractional value of the universal radius, so that the two expand with time in exact and forever fixed proportion to each other. Does such a rigid rod exist? If it does, is it a body or a process?

It is obvious that such a rigid rod as just now suggested is not at all similar to that envisioned by Einstein. His rigid rod is *absolutely* invariable. For him, the velocity of light is *absolutely* constant. His clocks behave in such a way that the rigid rod and the distance covered by light in the unit of time measured in *any* of his clocks are *absolutely* synonymous. It follows that in order to retain a process-type rigid rod as understood by Einstein in a Newtonian expanding universe, we have to allow for extremely accurately regulated infinitesimally successively increasing units of time. Such units are required in order to compensate exactly for the velocity of light decreasing with $T^{-1/3}$. The problem is how to design such a clock, in face of the fact that *all* our clocks in reality *are* mechanical devices, from the ancient sundial to the Big Ben to the atomic clocks of today (see Section 2.5), and as such dependent upon length which varies with the universal age. The *length* of the year has value as a unit of length only in so far as the Earth's orbit is a closed one. But in an expanding universe, that orbit is an elliptical outward spiral. The length of the Earth's orbit can, therefore, only be understood in terms of 360°-complete revolutions and a time-dependent polar distance from the center of the spiral. As regards revolutions, their precise angular determination depends upon distant stars and galaxies which in a Newtonian universe recede from us and from each other with velocities increasing with their distance. Therefore, even the angular determination of exact revolutions requires consideration of distances fixed as fractions of the universal radius, to which superadded must be the distances due to the relative-to-each-other motions of distant galaxies. As regards the polar distance from the center of the spiralling ellipse, we need another "rigid rod" to measure it upon completion of an exact 360° revolution! How, therefore, the problem of a process-type "rigid rod" as envisioned by Einstein is to be resolved, if ever, is not at all clear in view of the fact that determination of such a rod seems to be going around in circles as the example just cited clearly shows. Unless this problem is resolved, even the question of applicability to the Universe of any theory (including relativity) that assumes the physical existence of "rigid rods" must be held in suspension.

To return to the question posed two paragraphs above, and in light of the far greater difficulties posed by a "constant through time rigid rod" as discussed in the last paragraph, the search for a rigid rod proportional to the universal radius must proceed *independently of any established theory*. In the remainder of this Section (2.3.2.10), we shall examine the claims of the Earth as a whole as a potential candidate for the role of such a rod, within the entire context of the effects upon the planet of universal expansion.

In discussing briefly the work of Jordan, we must first note that he started out from Dirac's hypothesis of 1937, according to which $G \approx T^{-1}$. In the context of the present work, this is seen as a special case of a variable G. The whole ques-

tion of variability of G in agreement with Eqs. 1 and 2 was examined in Section 2.2 for constant universal density and will be completed in Section 2.4. The analysis presented in both Sections shows that the evidence does not support the possibility of a variable G. To the extent, therefore, that Jordan's discussion is dependent upon Dirac's hypothesis, we are obliged to conclude that it does not reflect the type of expansion permitted under Eqs. 1 and 2. This dependence is, however, not very obvious, because Jordan's discussion of the expansion of the planet employed a general and unfocused language and did not relate to a precise universal formalism, as has been developed in this work. In fairness, Jordan's dependence upon Dirac's hypothesis of $G \approx T^{-1}$ (which itself was *not* backed by an exhaustive examination of its consequences upon the Universe, as attempted in this work), could not possibly allow Jordan to be any more specific. It is rather surprising that no more has been made of Dirac's hypothesis. Perhaps, this is due to failure to appreciate the universal consequences of Eq. 22 as already discussed in the Footnote on p.59, Section 2.3.2.1.

Despite it all, Jordan concluded that volcanism, namely, the periodic release of pressure is a prima facie evidence of the expansion of the globe. Yet, on how exactly universal expansion affects the Earth's crust and interior, Jordan did not elaborate. There is no question that volcanism, as periodic release of pressure, suggests long interim periods of pressure buildup. For this to happen, it is necessary to conclude that, the crust does not allow the gradual non-explosive release of pressure. If such a process were in operation, volcanism would be absent. Besides regular volcanism, we also observe the growth of oceanic ridges and subduction of oceanic floors under the continents. Together, these phenomena suggest that the crust, after a time (volcanism) or continually (oceanic ridge formation) grows too small for the material it encrusts. The same conclusion is reached from the observed 10 to 20 cm rise of the ground over a wide area of NE Italy after the earthquakes of the mid 1970s. We are thus forced to conclude that the expansion of the Earth's interior proceeds faster than that of the crust. Further, no voids seem to exist in the interior of the Earth, as is clearly the case of the Moon. The gases released during volcanic activity, therefore, do not get compressed in the gaseous state within such voids, but remain dissolved in the solid or liquid phases constituting the Earth's interior until released. The absence of voids, then, must be seen as the result on the one hand of material expanding from within at a rate greater than the crust can accommodate and on the other hand of the great weight of the *essentially* plastic crust compressing the interior. The voidity observed in the Moon, suggests that the kind of activity present in the Earth is there absent. The Moon is, as a result, totally solid and expands in much the same rate throughout. It is probably safer to view the voidity of the Moon in terms of porosity of its material rather than as presence of large cavities in its interior. If so, given the absence of an atmosphere ($\sim 10^{-15}$ atm. of pressure), the Moon is a quiescent and well degassed body. This is significant in juxtaposition to the Earth as we shall see below.

Two diametrically opposite theories have been advanced as regards formation of the Earth. Both have very serious weaknesses. The theory of the hot beginning proposes that the Earth was once at least as hot as to have been liquid

and to have cooled slowly, forming first a solid crust around a still liquid interior. Mountains formed as a result of further cooling and wrinkling of the solid envelope. The still continuing geologic activity has, however, resulted in recycling, or in the very least transforming so drastically, the early material of the crust as to make further discussion of the subject mostly conjectural. The following observations are, however, safe to make:

The crust is subject to heating from within and from the Sun and to cooling by radiation to space. Overall, the crust cools. After it built to a significant thickness, heat flow from within ceased to make an important contribution to the maintenance of the surface temperature and the latter changes principally as a result of the negative difference between radiation received from the Sun and re-emitted into space.

As regards its geometrical size, the crust on the one hand expands as a result of the universal expansion, and on the other it contracts as a result of gradual cooling. [Atmospheric heating due to human activities is totally superficial in this scale of phenomena.] The size of the crust must be seen as the net result of these opposing tendencies. It is certainly important that the continents out to their slopes fit together essentially like a jigsaw puzzle. This has been interpreted as due to the formation of a single giant plate upon the surface of the still liquid planet. However, the surface of the plate comprises only 41 -44% of the present surface of the planet. One is left to wonder as to what happened to the rest of the early crust and as to how its remnant can still fit so well together despite the very serious erosion to which it must inevitably have been subjected since its formation and the breakup of the continents. On the other hand, if the giant plate was smaller than the crust covering the entire planet, one is left to wonder why solids should form iceberg-like and then float about on the surface of the planet, why the solids gathered together in a giant mass and did not spread thinly to cover the entire planet (after all, icebergs break away from the huge ice-cover at the poles, ice does not initially form as icebergs), and what happened subsequently in a second separate stage when the rest of the crust finally formed.

These questions can be resolved if it is assumed that the single giant plate that today comprises the continents was at *some past time the entire crust of the Earth and has since not changed in size, at least by much relatively to the rest of the globe*. The age of that happening can be calculated from

$$A_1/A_2 = [T_1/T_2]^{4/3}, \tag{135}$$

if it is further assumed that the rest of the planet continued to grow in size in proportion to the universal age. For $A_1/A_2 = 0.41$-0.44 and $T_2 = 12$ billion years, one finds $T_1 = 6.15$-6.48 b.y.; the crust, if so, practically ceased to grow some 5.85-5.52 b.y. ago. This is entirely different from the age of the continental plate drift, set by current geological theory to have begun recently, a mere 200 million years ago. It also is more ancient than the age of the planet, assumed to be about 4.5 to 5 billion years old. It is hard to see why the continents could not have begun their drifting any sooner than as set by current drift theory, when the underlying material was certainly more plastic and therefore more conducive to drifting. As regards the age of the planet just quoted, it should be noted that it is not firm and

perhaps deliberately chosen to be in rough agreement with the age of the Sun, believed on the basis of current solar theory to be 5-6 billion years old. If in light of the discussion of the previous Section (2.3.2.9), we decide to revise the age of the Sun, in all likelihood, the Sun will prove to be older, and so will the Earth. According to the above assumption, the periphery of the Earth increases with $A^{1/2} \approx T^{2/3}$, so that over the past 5.85-5.52 billion years, the periphery has increased by 0.246-0.244 cm/year. The Atlantic Ridge is estimated to have grown about 1.25 cm/year and the Pacific Rise by about four times this figure, during the last 6 million years to which present measurements can be extended. If these values are correct, oceanic ridge growth is too great to be due solely to the universal expansion. The true effect of the latter must be hidden in the net result of peripheral growth and oceanic floor subduction.

The age T_1 calculated above is the greatest possible: If the crust continued to grow after T_1 but at a pace slower than the rest of the planet by a factor x, then the present size of the continents is

$$A_1 = AT_o + x(A_2 - A_o), \tag{136}$$

where A_o was the size of the giant plate when it last (age T_o) covered the entire planet. Then,

$$[A_o + x(A_2 - A_o)]/A_2 = (1 - x)(A_o/A_2) + x = 0.41\text{-}0.44$$

and

$$T_o = T_2[A_o/A_2]^{3/4} = T_2\left[(0.41\text{-}0.44 - x)/(1 - x)\right]^{3/4}.$$

It is thus seen that x can assume values only between 0 and 0.41-0.44, resulting in $T_o < T_1$. In such a case, therefore, the Earth is even more ancient than as calculated above.

If indeed this is the explanation of the giant plate, the formation of the continents would follow quite naturally, as the plate broke up into pieces in order to accommodate itself to the decreasing curvature of the expanding planet. Subsequent orogenesis is then simply due to wrinkling of the continents as they collapse under their own weight in order to fit the ever decreasing curvature. This orogenetic mechanism is more ancient in origin and in addition to the later mechanism of continental collision.

Much more serious than the above, is the problem of the chemical composition of the Earth, especially as it pertains to the two lightest elements. Current theory takes the view that hydrogen is by far the most abundant element in the Universe, and helium the next most abundant, together comprising about 0.999 of the universal mass. It is obvious, then, that the Earth has lost most of these two elements, that would otherwise bring the planet in even gross compliance with the estimated average composition of the Universe. The theory of the hot beginning fits this gross picture. High temperatures and the low gravitational field of the planet are certainly conducive to loss of the lighter volatiles. However, the theory does not explain how any hydrogen and helium at all were left on the planet! Even today, the cold planet cannot retain hydrogen and helium.

A hot planet would have a far greater difficulty: Above about 3850°K water decomposes completely into hydrogen and oxygen. The period of time the Earth found itself at temperatures in excess of this value was certainly *very* long, and the vacuum surrounding the planet was certainly sufficiently *very* high. Even today, with the Earth at a low temperature, the lower atmosphere contains on average 0.5 ppm hydrogen, which is about 35 orders of magnitude higher than the equilibrium value for 0.21 atm. oxygen and 50% relative humidity. Given the highly dynamic conditions of the lower atmosphere, there is no question that so much elemental hydrogen is still present in it because the Earth's interior is still degassing hydrogen in amounts sufficient to maintain its fraction in the lower atmosphere at 0.5 ppm, despite the high activity in the latter that continually consumes hydrogen towards the equilibrium value. Few other hydrides are more stable than water (HF, HCl), but the respective elements are nowhere abundant enough to help retain so much hydrogen as is still found in the planet (including its hydrosphere), and given sufficient temperature, such hydrides would also decompose.

The significant amounts of helium still escaping from the interior is even more perplexing. Since helium does not form compounds, there is absolutely no way for it chemically to have been retained in the planet. The *only* explanation for the existence of helium is nuclear disintegration and alpha particle formation. But then, how is the fact to be explained that the most prolific source of helium is natural gas, which supposedly is of organic origin, namely, organic matter from the surface recycled into the interior of the planet? Uranium and other radioactive elements are found in igneous rocks, not in sedimentary deposits that are the natural geological environment of recycled organic matter. The atmosphere contains about 5 ppm helium on average while the gravitational field is manifestly too weak to hold it. There can be no doubt that the planet still produces helium and degasses it at a fair pace, far in excess of what can possibly be justified by the visible abundance of igneous rocks on the surface of the planet. The horizontal migration of helium towards the pockets of natural gas, when igneous rocks are so far away from sedimentary strata is altogether beyond easy explanation on the basis of current theory.

The theory of the cold beginning was devised specifically in order to answer part of the criticism relating to the retention of volatiles. But even that theory cannot explain the facts: According to it, the Earth was formed by coagulation and compaction of small fragments (planetesimals) orbiting at this distance the Sun. The temperature of those planetesimals was low enough for the volatiles to be frozen. This does not explain the presence of helium: For that to be retained, the temperature would have to be close to 0°K. This is very unlikely if not altogether impossible, given the supply of energy from the Sun, that is still high enough to keep the water mostly liquid at this distance.

Besides, formation of the planet was certainly gradual, and on impact, the planetesimals would without doubt heat up enough to give up their volatiles, *well before* the gravitational field could build up sufficiently to retain them. According to the theory, the heat released on impact was enough to melt the entire planet. Without such melting, the high radial uniformity of the distribution of

masses in the Earth, which has produced the oblate sphericity of the planet, and the highly uniform and essentially wobble-free rotation of the globe, would be altogether impossible to achieve. The way, therefore, to global melting was through the intermediate temperatures at which the planetesimals *had to* degas. The theory of the planetesimals was devised before Man set foot on the Moon. The highly sparse atmosphere of the Moon and its highly degassed present state, as already discussed, suggest that planetesimals *could not possibly* have fared any better with regard to volatiles.

Moreover, the theory of planetesimals leaves *unanswered* all questions relating to their own formation: Did they form during an explosion of a hot star? It could then be expected that they would have thoroughly degassed not too long after the explosion, even if the parent star did not deprive them of their volatiles in some manner. Or did they form in another "cold" body that somehow exploded? In that case, the formation of this Earth is referred to the formation of an earlier, yet basically similar, Earth and the theory is thus useless. Or did the planetesimals form directly by condensation from the primordial gas? This is contrary to the theory stating that the primordial gas was made up of hydrogen and all other elements formed by nucleosynthesis in the interior of stars; as far as is known the theory of planetesimals has not gone as far as to challenge that entire concept. It also is contrary to the laws of gases as we know them and contrary to universal expansion that is in broad agreement with those laws and not with their opposite. This possibility is therefore even weaker than the other two.

Thus, when examined in detail, both current theories meet crucial challenges which they cannot overcome. The problems of chemical composition of the Earth and of its degassing *can,* however, be explained on the basis of universal expansion. Yes, universal expansion implies a hot beginning, the hottest possibly imaginable, for everything and not only for the Earth. But it also implies a much smaller size in the past that enabled the Earth more effectively to resist degassing.

But even more importantly, because it refers to a process that still goes on in the interior of the planet (or at least to a process the effects of which are still being demonstrated), universal expansion results in the decomposition of the heavy elements to the very lightest ones, thus replenishing the lightest elements, *helium as well as hydrogen,* that otherwise would long ago have been absent from the planet, regardless of their present chemical binding to heavier elements, as that of hydrogen to oxygen. The co-existence of helium and hydrogen (as hydrocarbons) in natural gas, in the face of the highly improbable horizontal transportation over long distances and admixing of these gases should they be of basically *different* origin, must be taken as proof of their *co-generation* in the interior of the planet, and therefore as the strongest evidence on the planet to date of universal expansion.

Finally, it should be noted that in a way similar to that employed in Section 2.2, the conditions studied here permit a rough calculation of the temperature on the surface of the Earth 3.5 b.y. ago, when life is estimated first to have appeared: The energy emitted by the Sun is proportional to c^2, i.e. to $T^{-2/3}$. The energy received on Earth is proportional to the energy emitted and inversely proportional

to the square of the distance, i.e. to T^{-2}. The energy of the black body is proportional to Θ^4. So, on the assumption that the Earth operates like a black body, one finds that

$$\Theta_1/\Theta_2 = (T_2/T_1)^{1/2}.$$

Setting $\Theta_2 = 285°K$ (the average day-night temperature) and $T_2/T_1 = 12/8.5$ results in $\Theta_1 = 338.6°K = 65.5°C$. There is no question that the earliest forms of life would have found a more uniform and a higher than today's temperature more conducive to their continued existence. Whether an average temperature of 65.5°C was right or perhaps too high by perhaps 10° to 15° cannot be said. We do not know what the earliest forms of life were. The appearance of cold-blooded animals is indicative of a higher average temperature in the past, as is the lush vegetation upon which they fed. The latter also indicates a more humid climate in the past, as inevitably would have resulted from a higher temperature. The disappearance of both as the Earth grew colder certainly fits the general trend. The subsequent appearance of warm-blooded animals, as the conditions on the planet became more tolerable, also fits the picture.

2.3.3

THE SUBCASE OF VARIABLE MASS AND VOLUME

As we stated in Section 2.1, a universe of variable mass and volume requires two equations for its complete definition. The variability of volume can still be expressed by Eq. (10):

$$V = \alpha^{-1}GMT^2, \tag{10}$$

but the value of the dimensionless constant must be re-determined, because it can no longer be assumed to have any of values determined under different title conditions. The simplest expression for the variability of the universal mass is

$$M = \mu T^{\nu} \tag{137}$$

where the proportionality constant μ *must* have the dimensions of (mass) × (time)$^{-\nu}$ and *cannot* thus be an arithmetic time-invariable constant as in fact are the dimensionless constants α and ν. Like α and ν, so also μ *must* be a true universal quasi-constant (see below) and the values of both μ and ν *must* be completely determined for the universe to be completely defined. Strictly, in a Universe where time is not or cannot objectively be defined except in terms of its age, a time-invariable universal proportionality constant μ is a logical and physical impossibility, *if* in its definition, besides mass other universal quantities (such as G, dependent, as that is at present defined, on time as per Eq. 10) are

also involved. *If* the universe is ageless, time is *not* physically introduced *nor* defined, but remains a *psychological parameter improperly introduced* by Man in his considerations of the physical World. (Something analogous and possibly even worse in terms of its consequences is true of the constant η in Eq. 149, Section 2.4). The analysis carried out both here and there is only intended to show that, even if this be overlooked under the notion that such constants may still "somehow" be possible, one still *cannot* conclude that a universe obeying such constraints exists. An expression for the variability of mass more complicated than the *seeming* simplicity of Eq. 137, while not forbidden, introduces *additional* complexity by allowing additional universal constants for no obvious good reason. [Dimensional complexity is ameliorated if the total universal mass be expressed as $M = nm_o$ where, m_o states the *equal* mass of n massive time-invariable fundamental particles, thus permitting the unambiguous presence of mass in the Universe, *while transferring the dependence on time to the number* of particles in the Universe, in which case, instead of Eq. 137, we may write

$$M = (nT^{\nu})m_o, \tag{137a}$$

understanding it to denote the dependence on time *only* of the dimensionless n, while T *is, in this case, to be understood strictly as the age of the Universe*!] The subsequent analysis is, therefore, carried out not on the belief that Eq. 137 is the only simple expression that can possibly apply, but only to show what additional complexities are introduced even under the simplest expression for the vari ability of mass.

Eq. (10) and (137) yield

$$V = (\mu/\alpha)GT^{\nu+2}, \tag{138}$$

in view of which we may use the same arguments for a spherical finite universe that we used in Section 2.3.2.1. The radius of the universe is now given by

$$R = [(3\mu/4\pi\alpha)(GT^{\nu+2})]^{1/3}. \tag{139}$$

As a result, the velocity of the universal front is given by:

$$dR/dT = [(\nu+2)/3][(3\mu/4\pi\alpha)GT^{\nu-1}]^{1/3}, \tag{140}$$

and the rate of change of this velocity by:

$$d^2R/dT^2 = [(\nu-1)/3][(\nu+2)/3][(3\mu/4\pi\alpha)GT^{\nu-4}]^{1/3}. \tag{141}$$

Consistent with the convention already adopted (Sections 2.3.1 and 2.3.2), we shall continue to regard the radial outward-centrifugal direction as positive and the radial inward-centripetal direction as negative. The sole cause of change of the velocity of the universal front is the gravitational field at the front:

$$d^2R/dT^2 = \mathcal{G}. \tag{142}$$

The gravitational field is always centripetal and therefore always negative. At the front, it has the value

$$\mathcal{G} = -GMR^{-2} = -(4\pi\alpha/3)^{2/3}(\mu GT^{\nu-4})^{1/3}. \tag{143}$$

Contractional velocities being parallel to the field are accelerated; their accelerations are negative. Expansional velocities being antiparallel to the field are decelerated; their decelerations are negative.

The title conditions place severe constraints on the value of ν. Mass variability requires that $\nu \neq 0$. Volume variability requires that $\nu \neq -2$. Under these initial constraints, it must be investigated further whether it is possible for the universe to contract or to expand.

(a) Contracting Universe

The velocity of contraction and the field are parallel. By the convention above, they both must be negative. This requires that the conditions

$$(\nu + 2) < 0,$$
$$(\nu - 1)(\nu + 2) < 0.$$

be *both* satisfied. It is impossible to meet both of these conditions at once: If $(\nu + 2)$ is negative, $(\nu - 1)$ is even more negative and their product is positive. It follows that the universe cannot contract.

(b) Expanding Universe

The velocity of expansion and the field are antiparallel: The first positive, the second negative. This requires that the conditions

$$(\nu + 2) > 0, \quad (\text{but } \nu \neq 0)$$
$$(\nu - 1)(\nu + 2) < 0.$$

be *both* satisfied, or that

$$(\nu - 1)(\nu + 2) < 0 < (\nu + 2) \quad (\text{but } \nu \neq 0)$$

meaning that

$$-2 < \nu \neq 0 < 1. \tag{144}$$

From Eqs. 141, 142 and 143, it follows that:

$$(\nu - 1)(\nu + 2) = -12\pi\alpha. \tag{145}$$

The velocity of the front must satisfy another condition also: It can be no other than the velocity of light:

$$dR/dT \equiv c \tag{146}$$

If this were not so, photons would find themselves outside the universe which is absurd, or they would lag behind the expanding front, meaning that the velocity of light is not the highest in the universe. This option must also be rejected: We know of nothing faster than light, so that Eqs. 140 and 146 are equivalent. Now, the total energy of the photon mc^2 at the front must be the sum of its kinetic energy $mc^2/2$ and its potential energy $m(GM/R^2)R = GMm/R$. It follows that kinetic and potential energies are equal, so that

$$Rc^2 = 2GM, \tag{147}$$

to which, introducing Eqs. 137, 139, 140, and 146 produces

$$(\nu + 2)^2 = 24\pi\alpha. \tag{148}$$

Now, Eqs. 145 and 148 require that

$$-2(\nu - 1)(\nu + 2) = (\nu + 2)^2$$

meaning that

$$n = -2 \quad \text{or} \quad n = 0,$$

which however are both unacceptable under the constraint (144). It follows that the universe cannot expand.

We conclude that no universe can exist, contracting or expanding, that satisfies both Eqs. 10 and 137.

2.4

THE CASE OF A UNIVERSE OF VARIABLE G AND D

The examination of this case will follow the procedure of Section 2.3.3. As was stated in Section 2.1, three distinct subcases fall under the present title conditions. Of these, two require two defining equations, and the third three. The variability of the universal volume, universal mass and G can most simply be expressed by:

$$V = \alpha^{-1}GMT^2, \tag{10}$$
$$M = \mu T^{\nu}, \tag{137}$$
$$G = \eta T^{\sigma}. \tag{149}$$

Here, as in Section 2.3.3, the last two expressions do not imply exclusivity in the dependence of M and G on the universal age; they are used simply in order to establish the simplest possible basis for analysis. All five parameters, namely α, μ, ν, η, and σ are universal constants. Of these, μ and η are also dimensional *. The values of all five are required for complete definition of the universe they regulate. The values of α, μ and η will in general be different from those already discussed. Where applicable, it follows that $\nu \neq 0$, $\sigma \neq 0$. Also, $\sigma \neq -2$. The last constraint is required in order to ensure that the product GT^2 and therefore D remain variables of the universal age. As a result, constraint $\sigma \neq -2$ applies to all three cases here to be examined.

2.4.1

THE SUBCASE OF CONSTANT VOLUME AND VARIABLE G AND M

Eqs. 10, 137 and 149 yield

$$V = (\mu\eta/\alpha)T^{\nu+\sigma+2} \tag{10a}$$

The title conditions impose the constraints

* See Discussion on p. 136-7 following Eq. 137, where reference is made to Eq.149.

$$\nu + \sigma + 2 = 0,$$
$$\nu \neq 0, \text{ equivalent to } \sigma \neq -2,$$
$$\nu \neq -2, \text{ equivalent to } \sigma \neq 0.$$

The radius of the universe is thus fixed at

$$R = (3\mu\eta/4\pi\alpha)^{1/3} = \text{constant}. \tag{150}$$

From such a universe light cannot escape. Outward moving photons must eventually get trapped in a pseudo-Keplerian orbit at the very edge of the universe. In this case, then, the product Rc^2 must fall just short of the value 2GM, here expressed as

$$Rc^2 \approx\leq 2GM. \tag{151}$$

Without this constraint, the kinetic and potential energies of a particle at R would be equal and the universe would grow larger as already discussed in Section 2.3.2. As a result, the velocity of light must be *just short* of the value of the right-hand side of

$$c \approx\leq (32\pi\alpha\mu^2\eta^2/3)^{1/6} T^{-1}. \tag{152}$$

The gravitational field is given by

$$\mathcal{G} = -GMR^{-2} = -(4\pi\alpha/3)^{2/3}(\mu\eta)^{1/3}T^{-2}. \tag{153}$$

Both c and $\mathcal{G}$ decrease numerically with the universal age, having been infinite at T = 0. At T = ∞ they will approach zero from opposite directions.

If $v > 0$, namely, if the universal mass increases with age, $\sigma = -(\nu + 2)$ and G decreases with age. At T = 0, the universe was perfectly devoid of any mass, yet, $\mathcal{G}$ had an infinite negative value. The conditions at T = 0 are paradoxical, because the product GM was then infinite. But the product (G) × (M), where G = ∞ and M = 0, must have a zero value. The product of zero and *any* number is uniformly zero. This paradox arises purely from the order of mathematical operations. The picture of a universe obeying these conditions, that we acquire by studying the universal quantities must, therefore, depend on the order of the mathematical operations to which those quantities are subjected. It is thus impossible to obtain a single picture of such a universe. It does not appear that our Universe is of this kind.

If $\nu < 0$, namely, if the universal mass decreases with age, the quantity $\sigma = -(\nu + 2)$ will fall in the range $-2 < \sigma < 0$ (for $-2 < \nu < 0$) and in the range $0 < \sigma$ (for $\nu < -2$).

For $-2 < \nu < 0$, G was infinite at T = 0, as was M. In such a universe, the Sun-Earth distance is independent of the universal age, as are all distances, but the radiation of the Sun is proportional to Mc^2, namely, proportional to $T^{\nu-2}$. As a result, the temperature on the surface of the Earth relates to the universal age according to

$$(\Theta_1)(\Theta_2)^{-1} = (T_2/T_1)^{(2-\nu)/4},$$

where

$$2 < 2 - \nu < 4.$$

For $\Theta_2 = 285°K$, $T_2/T_1 = 12/8.5$ and $\nu = 0$, the average day-night temperature 3.5 billion years ago was:

$$\Theta_1 > 338.6\ °K = 65.5\ °C.$$

For $\nu = -1$, it is found that $\Theta_1 \cong 96\ °C$. For this case, therefore, to be at all the case of our universe, ν cannot be much smaller than zero; otherwise, the earliest forms of life must have had to be capable of sustaining temperatures well in excess of 65.5 °C. This is very unlikely.

For $\nu < -2$, the universal mass at $T = 0$ was infinite and G was zero. Objections similar to those discussed above regarding the product GM are thus permitted to be raised in this case also. Besides, in this case, Θ_1 is found to have, at a minimum, the value of

$$\Theta_1 = \Theta_2\,(T_1/T_2) = 402.3\ °K = 129.2\ °C,$$

which is much too hot for any water-dependent form of life*.

2.4.2

THE SUBCASE OF CONSTANT MASS AND VARIABLE G AND V

The constant ν in Eq.137 is zero and $\mu \equiv M$. The universal radius is, therefore, given by

$$R = [(3\eta/4\pi\alpha)MT^{\sigma+2}]^{1/3}. \tag{154}$$

As a result, the velocity of the universal front is given by:

$$dR/dT = [(\sigma + 2)/3]\cdot[(3/4\pi\alpha)\eta MT^{\sigma-1}]^{1/3} \tag{155}$$

and the rate of change of this velocity by

$$d^2R/dT^2 = [(\sigma - 1)(\sigma + 2)/9]\cdot[(3/4\pi\alpha)\eta MT^{\sigma-4}]^{1/3}. \tag{156}$$

The gravitational field at the front is now given by:

$$\mathcal{G} = -\ GMR^{-2} = -(4\pi\alpha/3)^{2/3}(\eta MT^{\sigma-4})^{1/3}. \tag{157}$$

This case, then, is completely analogous to that of Section 2.3.3, and shall be examined under the same convention used there. Under the initial constraints of $\sigma \neq -2$, $\sigma \neq 0$, it must be investigated further whether it is possible for the universe to contract or to expand.

* Dirac's hypothesis of $\sigma = -1$ implies $\nu = -1$ and $\Theta_1 = 96\ °C$, certainly not life-conducive.

(a) Contracting Universe

The velocity of contraction and the field are parallel. According to the convention, it is necessary that:

$$(\sigma + 2) > 0,$$
$$(\sigma - 1)(\sigma + 2) < 0.$$

It is impossible to meet both of these conditions at once: If $(\sigma + 2)$ is negative, $(\sigma - 1)$ is even more negative and the product $(\sigma - 1)(\sigma + 2)$ is positive. It follows that the universe cannot contract.

(b) Expanding Universe

The velocity of expansion and the field are antiparallel. According to the convention, it is necessary that:

$$(\sigma + 2) > 0 \text{ (but } \sigma \neq 0),$$
$$(\sigma - 1)(\sigma + 2) < 0,$$

or that

$$-2 < \sigma \neq 0 < 1. \tag{158}$$

From Eqs. 156 and 157, it follows that:

$$(\sigma - 1)(\sigma + 2) = -12\pi\alpha. \tag{159}$$

By the same arguments presented in Section 2.3.3, the velocity of the front is identical to the velocity of light. As a result, the latter is now given by:

$$c = (2GM/R)^{1/2} = (32\pi\alpha/3)^{1/6} (\eta M T^{\sigma-1})^{1/3}, \tag{160}$$

From Eqs. 155 and 160 it follows that:

$$(\sigma + 2)^2 = 24\pi\alpha. \tag{161}$$

Eqs. 159 and 161 thus result in:

$$-2(\sigma - 1)(\sigma + 2) = (\sigma + 2)^2,*$$

meaning that

$$\sigma = -2 \quad \text{or} \quad \sigma = 0,$$

which are unacceptable under the constraints (158) applying to this case. It follows that the universe cannot expand.

We conclude that no universe can exist, contracting or expanding, that satisfies Eqs. 10 and 149 under constant M.

* Dirac's hypothesis of $\sigma = 1$ results here in an impossibility.

2.4.3

THE SUBCASE OF VARIABLE G, M AND V

Equations 10, 137 and 149 are simultaneously applicable under the title conditions. The universal volume is given by Eq. 10a where, necessarily:

$$(\nu + \sigma + 2) \neq 0, \tag{162}$$

so that the radius of the universe is

$$R = [(3\mu\eta/4\pi\alpha)MT^{\nu+\sigma+2}]^{1/3}, \tag{163}$$

the velocity of the universal front is

$$dR/dT = [(\nu + \sigma + 2)/3]\cdot[(3\mu\eta/4\pi\alpha)MT^{\nu+\sigma-1}]^{1/3}, \tag{164}$$

the rate of change of this velocity is

$$d^2R/dT^2 = [(\nu + \sigma - 1)(\nu + \sigma + 2)/9]\cdot[(3\mu\eta/4\pi\alpha)MT^{\nu+\sigma-4}]^{1/3}, \tag{165}$$

and the gravitational field at the universal front is

$$\mathcal{G} = -GMR^{-2} = -(4\pi\alpha/3)^{2/3}(\mu\eta MT^{\nu+\sigma-4})^{1/3}. \tag{166}$$

This case, then, is again completely analogous to that examined in Sections 2.3.3 and 2.4.2. Whether it is possible for the universe to contract or to expand must be investigated under the constraints $\nu \neq 0$; $\sigma \neq 0, -2$; $\nu + \sigma \neq -2$, applying under the present title conditions.

Arguing as before (Section 2.3.3), we conclude that for the universe to contract it is necessary that both conditions

$$(\nu + \sigma + 2) < 0,$$
$$(\nu + \sigma - 1)(\nu + \sigma + 2) < 0,$$

be satisfied at once, which is impossible. The universe cannot contract. For the universe to expand it is necessary that

$$-2(\nu + \sigma - 1)(\nu + \sigma + 2) = (\nu + \sigma + 2)^2,$$

requiring that

$$\nu + \sigma = -2 \quad \text{and / or} \quad \nu + \sigma = 0.$$

Of these, the first contravenes the variability of universal volume. The second suggests that G and M vary in opposite directions: at T = 0, either M was zero and G was infinite, or the reverse. Arguments similar to those presented in Section 2.4.1 about the value of the product GM are applicable here also: If the values of M and G from Eqs. 137 and 149 be introduced to the product GM and only then the value of GM be calculated, it is found that $GM = \mu\eta T^0 = \mu\eta$, at any T. But if the values of M and G be calculated first for T = 0 and only then be in-

troduced to the product GM, it is found that GM assumes the value $(\infty)(0) = 0$. This is paradoxical and arises simply from the order in which mathematical operations involving the universal quantities are carried out; it also confuses the picture of the universe that we obtain, at least for $T = 0$. Without fear of error, one can reject the possibility that our Universe can be so confusing. Included here is Dirac's hypothesis of $\sigma = -1$, implying $\nu = 1$.

We thus arrive at the final conclusion for this Section (2.4), which is that the present Newtonian Universe does not satisfy the requirements of variable G and variable D.

This completes the examination of all eight combinations of variability identified in Section 2.1. All but one were found to contain internal contradictions, or not to be supported by the physical evidence. Only the Case of G and M being *both* constant, examined in Section 2.3.2, was found to be in agreement with the known facts about the Universe. The detailed examination of this case *showed an extreme simplicity of basic principles and a simultaneous wealth of consistent and important, yet, totally unforeseen and unexpected implications stemming directly out of Newton' s Law of Gravitation*. In face of the fact that as far as is known at all Newton's Law applies very closely indeed to all scales and at least to a high order of approximation, *it is safe to conclude that Newton's Law of Gravitation is truly universal and perhaps few other natural laws are as universal as that Law. Thus, to be fully consistent, our view of the Universe and of everything in it must be brought into consistent agreement with Newton's Law, in all its implications, to at least an equally high order of approximation, for the simplest of all reasons possible: that the findings exposed here simply cannot be the products of naked chance; as certainly as the Science of Mathematics is not!* This requires that we amend some of the current theories and principles of Physics and abandon others*, as already indicated in Section 2.3.2. How our view of the notion of time must also be changed, in order to conform to the universal picture arrived at under Newton's Law of Gravitation, will be shown in the next Section.

* Casinos are *not* built on chance, but on the Sciences of Mathematics and Mechanics; they only use the notion of chance as a *lure* for a much too well known objective the mention of which by its exact name would certainly insult the reader of this book! Let us at last not insult our intelligence regarding the Universe, that for a *purpose* some attempt to present as the product of naked chance! Such people most certainly do *not* deserve their Nobel prizes!

2.5

THE ESSENCE AND MEASUREMENT OF TIME

No physical concept pervades science and everyday life more fundamental ly than time. And no other physical concept is more elusive and fugitive. Whereas a piece of matter can be grasped and a length spanned, that is, whereas they both can be re-examined closely and minutely at leisure, a "piece of time" can only fleetingly be experienced as it goes by one moment after another. We live and conduct experiments in time, but can never re-live and repeat an experiment in the *same* time. This at least is the common experience, the so-called "arrow of time". Thus, it is not surprising that both lay as well as professional philosophy has hardly penetrated the concept of time. As for science, before Einstein, it used time and the concept of the clock routinely but did not bother with their study, nor did it advance a satisfying definition of either concept. Einstein and the Relativists, have tried to unite the concept of time with the somewhat-easier-to-understand concept of space, and thus created the entirely new concept of "spacetime". Yet, the concept is nothing other than an elaborate mathematical formalism involving (a) the measurement of lengths by means of "rigid rods", (b) the measurement of two *different kinds of time* (cosmic and proper) by means of "suitable" (yet, otherwise unspecified) "clocks" and (c) statements about the velocity of light and about inertial and other frames of reference and motions relative to such frames. It is a fair question to ask whether this new formalism has helped our comprehension of time, space, or spacetime itself. And it is fair to answer that other than now having more "accurate" (in this case a deliberate misnomer for "precise") clocks, a development that would have come about at any rate with the general development of technology even in the total absence of relativity, we today continue to conduct our lives and science very much as before. Relativity has failed to advise practical technology as to how to construct a new single instrument, call it "meterclock" by analogy, that should be the *proper* instrument to use to measure the new "reality" of spacetime. Absent such advice and such device, it is hard to see how real, if at all, the new "reality" is. In light of which, it is fair to say that our previous lack of understanding of a single concept, namely, time, has now spread over a wider range, for although the theory of relativity uses the concepts of "rigid rods" and "clocks" etc., yet, it has failed to provide the necessary adequate definitions of these ancillary concepts.

Ordinary mechanics is formulated in a way that permits statements about the moments in time at which simple mechanical events happen, will happen or happened to be essentially neutral as regards the flow of time. In reality, the extra-

polation into the past thus carried out essentially is *only a* reversal (involving the simple substitution of – t for t), of the logical steps by means of which we are able to predict the future happenings in a mechanical system from events we observe occurring in the system in the here and now. Whether such "postdictions", as opposed to "predictions", could actually have occurred can never be verified. Thus, our faith in the accuracy of postdictions *is only a* re-statement of our faith in the existence of physical laws (nay, Laws *in* Nature) that are strictly causally (that is, *unidirectionally in time)* related to events: A certain event happens now and will continue to happen in the future only because a cause (has) existed in the past that alone brought about this whole array of events. When the search for "a cause in the past" seems to come to more or less a definite beginning at some given moment in the past we *immediately* think of preexisting causes that caused the first cause that we set out to investigate. By this means, an infinite regression into the past is being built, which has found during the twentieth century a very considerable encouragement under the auspices of relativity.

Because, the latter has much more than ordinary mechanics emphasized the interconvertibility of t and –t. The presuppositions and formalism of the theory make it mathematically immaterial whether events happen in the future or in the past. The possibility of recapturing the past thus seems to have been given scientific sanction by the preeminent scientist of the century and has considerably abetted an otherwise forgivable psychological weakness, given our propensity to be nostalgic of youth lost (that is, of days of "innocence" when lack of even the most rudimentary wisdom shielded us from the obligation to come face to face with the awesome responsibility of opening or keeping shut our mouths) and fearful of wrinkles and of the future, that together define in terms of time the limitations of the human condition and predicament as seen by pedestrian so-called "thinkers" always ready to use words the deep meaning of which most of them do not even know! Relativistic-velocity travel, images of seeing your own twin brother age before your own eyes as you bid him farewell and climb upon the photon, as it were, while you retain, or almost, your eternal youth, talk of tachyons that will allow you to see things yet to come, or overtake images of the remote past, but just barely forbid you from interfering with the lineal array of the very causes that caused you, lest you be lost in the netherwhen, have all given flights to the fancy of scientists and "philosophers", and only thus to novelists seeking to "familiarize" the "ignorant" populace with the "advances" of science. In this light, scientists should not be surprised if they find themselves accused of having, yet once more, utterly confused our common understanding of yet another concept, this time of time, that was perhaps less sophisticatedly yet perhaps *better* understood by the pre-Einsteinians, that they (scientists) set out to elucidate on behalf of us all. If, *arguably, one* of *the two most sophisticated "scientific" in appearance theories ever devised by man can produce seemingly "logical" time paradoxes, how are we ever to be saved* from *eternal confusion?* [Or just that was the *hidden* purpose of the "exercise"?]

Before proceeding to show the answer to the question of time provided by the Universe, it is well to stop and examine some of the fundamental concepts of

relativity. For unless we do so, we leave ourselves open to the charge of having accepted a theory containing contradictions that we dare not discuss in public, lest we lose the aura of the awe to which the populace holds the new priesthood that, in that case, only replaced the old one without bringing any additional benefits in understanding, since it (the theory), like the old religion it replaced, demands an *equally blind and unquestioning* "faith".

Firstly, the theory of relativity places a very great burden of significance upon the quantity

$$ds^2 = dx^2 + dy^2 + dz^2 - c^2dt^2, \tag{167}$$

a pseudo-Pythagorean construct, which upon Lorentz transformation remains invariable, thereby permitting events to be "mapped" identically regardless of the frame in which the "mapping" takes place. It is this invariant element that is the metric of the four-dimensional continuum of spacetime. This continuum is so unique in the family of multidimensional mathematical spaces that requires, as well as deserves, specific comment. In *truly* Pythagorean multidimensional continua the *correct* quadratic form is

$$ds^2 = dx_1^2 + dx_2^2 + dx_3^2 + ... + dx_n^2, \tag{168}$$

namely, one in which the square terms enter *exclusively* with the plus sign in their front. Because of this, the nature of the quantity $(dx_m^2)^{1/2} = \pm (dx_m)$ retains a *"physical"* significance relative to the arbitrary origin of lengths in the x_m direction. *Not* so in relativity theory! For then, we have to assign *physical* significance to the quantity $(- c^2dt^2)^{1/2} = \pm icdt$.* Thus the concept of spacetime introduces an *imaginary* element that goes beyond the physically significant x, y, z, c and t. In Euclidean geometry, the quadratic form $h^2 = a^2 + b^2$ is significant not in itself *but only because the physically meaningful* lengths h, a and b are so related! How then are the lengths x, y, z and ct related in spacetime? If one writes

$$dx^2 + dy^2 + dz^2 = c^2dt^2 \tag{169}$$

he only expresses an identity of the length covered by light in time dt having started from the arbitrary three-dimensional origin at time t = 0, so that $ds^2 = 0$ is no longer a statement in four-dimensional space but only an identity of lengths

* H. Minkowski, in his public address of 1908 (see: *"The Principle of Relativity";* Dover Publ., 1952; p.88) that is widely regarded as a classic of relativity theory, stated: "... Thus the essence of this postulate may be clothed mathematically in a very pregnant manner in the mystic formula 3×10^5 km = $\sqrt{(-1)}$ sec", which states nothing other than that c = i (!). This despite the fact that in the beginning of the *same* paragraph, he had *already* stated that "We can determine the ratio of the units of length and time beforehand in such a way that the natural limit of velocity becomes c = 1" (!). Thus in the *same* paragraph, Minkowski set c equal *both* first to 1 and then to i, by way of the statement "If we then introduce, further, $[\sqrt{(-1)}]t = s$...", (where t is time and s the measure along the fourth dimension), which appeared immediately following the earlier statement just quoted! But all this is *neither* logical *nor* can it be construed to explain physically anything! Moreover, it is logically incomprehensible that the *physical* quantity of (the) velocity (of light) be defined as equal to a mere numeral (1 or i or both simultaneously, as there was attempted!) that is physically dimensionless! Clothing the whole thing "mathematically in a very pregnant manner in the mystic formula..." does not clarify anything, nor can it conceal this entire sequence of *logically absolutely forbidden* manipulation!

in three-dimensional space, measured on the left side of Eq. 169 in Cartesian co-ordinates and on the right side in polar co-ordinates. If on the other hand, one writes

$$dx^2 + dy^2 + dz^2 \neq c^2dt^2 \tag{170}$$

then the quantity $ds^2 \neq 0$ is again not a statement in four-dimensional space, but merely a statement in three-dimensional space of the difference in length which light has still to cover in order to reach the point (dx, dy, dz), or has overshot said point, in time dt. In neither physical case, therefore, does the quantity icdt enter the physical picture. Thus, to accept, under the auspices of relativity, as significant the quantity ds^2 is to make it permissible for icdt to enter the physical (nay, the *natural)* world from which all imaginary quantities are properly forbidden! To forbid such entry is to deny physical (nay, *natural)* significance to at least some of the quantities that enter the Lorentz transformations. *Not everything mathematical is necessarily physical*. Subtracting the non-natural, then, from all that enters these transformations is equivalent to returning to the three-dimensional continuum of ordinary space in which alone natural events properly occur, although its elements dx, dy and dz may, on occasion (Eq. 169), also be equal to functions of dt. For further discussion, see Addendum I.

Secondly, as regards the twin paradox mentioned above, the theory of relativity evades the issue by seeking recourse to distant stars to decide which of the twins travels and which stays in place. In reality, this is seeking recourse to a "deus ex machina". A correctly constructed theory should be self-regulating and not helpless without external assistance. There is nothing in the theory of relativity that forbids it to be applicable to a universe consisting solely of the twin brothers and the photons they choose to ride, or not ride, or exchange between them. In such a simplified universe, there are no "distant stars" and no frames other than the frames (one to each) of the twins. How is it to be decided *which of the two travels vis-à-vis the other*? *They both* see the other age by an *equal* amount (which they determine by exchanging messages), while *themselves* staying young! *The theory provides no resolution!* (See also Addendum I).

Thirdly, the Pound-Rebka shift, according to which a photon emitted from G at ground level with energy $h\nu$ arrives at height H with energy $h\nu - (h\nu/c^2)gH = h\nu(1 - gH/c^2) = h\nu'$, has been interpreted to imply that a standard (i.e. cosmic) clock at H (now, because of its positioning being called "proper") runs faster than an *identical* clock (also now being called "proper") on the ground ($\nu' < \nu$), and that the duration of reception $\delta t'$ is longer than the duration of emission δt. This is presented in Fig. 7, where the interval $\delta t' = t_D - t_C$ is thus depicted to be longer than the interval $\delta t = t_B - t_A$. In this depiction, we distinguish four events A and C, the beginning of emission and reception, respectively; and B and D, the end of emission and reception, respectively. Because these are four *different* events, there *necessarily* corresponds to each of them a distinct moment in time as measured by a cosmic clock, namely t_A, t_B, t_C, and t_D. Consider the time interval $t_D - t_A$. It is *necessarily correct* to write:

$$(t_D - t_A) = (t_D - t_B) + (t_B - t_A) = (t_D - t_C) + (t_C - t_A) \tag{171}$$

and to extract from this the statement that:

$$(t_D - t_B) - (t_C - t_A) = (t_D - {}_C) - (t_B - t_A). \qquad (172)$$

Now, if the relativistic interpretation be correct, the quantity on the right-hand side of Eq. 172, namely, $\delta t' - \delta t$ is positive. So too, then, must be the quantity on the left-hand side, which is the difference of the durations of flight of the end

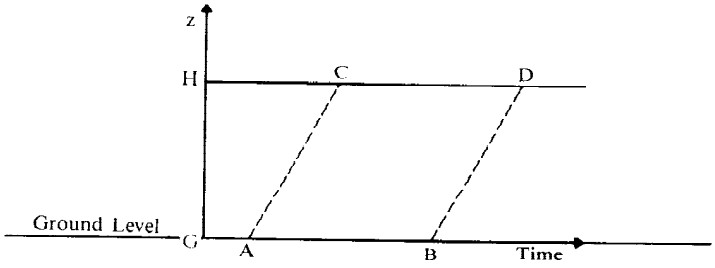

FIG. 7
Reception of a Message at a constant Height above Ground.

and the starting points, respectively, of the message sent. It is obvious, now, that the flight times (durations of flight) are *dynamically determined by the velocity of light and the properties of the medium over the distance H*, which, for the purposes of relativity theory remain *constant* (and have *absolutely nothing* to do with the durations of emission and reception as measured respectively at G and H), *thus in effect forbidding the existence of any difference* between the time intervals $(t_C - t_A)$ and $(t_D - t_B)$. Which proves that there is *no difference* between the quantities on the right-hand side of Eq. 172, *no time dilatation* as relativistically expected!

A relativist may argue here that the times t_A, t_B, t_C , and t_D as used above, are measured with a cosmic clock and not with the proper clocks at G and H. Yet, it is a central point of relativity theory that one cannot tell whether he is travelling or standing still *simply by watching his own clock*. As far as his readings of the latter are concerned, nothing ever changes! Accordingly, one's clock may now be synchronized with the cosmic clock, and then not, according to one's state of motion or position, but no such change is ever to be sensed, *because the operation of the "proper" clock remains unperturbed throughout*! Relativity theory *cannot* afford to abandon faith in the last italicized statement, because doing so would vitiate the internal consistency of the inertial frame. But keeping faith in the statement *in effect requires* that the proper clock *always operate identically* with the cosmic clock, if it can do so once (say, before departure) and if it is to remain faithful to itself at all times. It should then follow that the four time intervals entering Eq. 172 *are identical as measured by the proper clocks or by the cosmic dock*. As a result, the last italicized statement of the previous paragraph remains correct, even from the point of view of relativity theory itself, according to the central argument of this paragraph.

Consider now the reception of a message sent from G to a vehicle *travelling away* from G. It is a fair question whether the reception will now last longer than the emission; and if indeed so, whether this is due to dilatation of time as measured by the proper clock of the moving vehicle, or whether it is due to some other cause. Consider Fig. 8, where the times are still to be measured *parallel* to the x-axis. As measured by a cosmic clock, one is compelled to conclude that

$$(t_D' - t_C') > (t_D - t_C), \tag{173}$$

where the interval on the left side represents the interval of reception by the vehicle *as it moves away*, and the right side the interval of reception by the same vehicle *if it had remained stationary* relative to G (or even at a fixed polar distance from G in a homogeneous or a radially-away-from-G homogeneous medium). The difference of these two intervals is the interval $(t_D' - t_D)$, which is no other than the interval of time required by the end point of the message to cover the extra distance ΔH. Whereas the vehicle is allocated time $(t_D' - t_C') \equiv (t_D'' - t_C)$

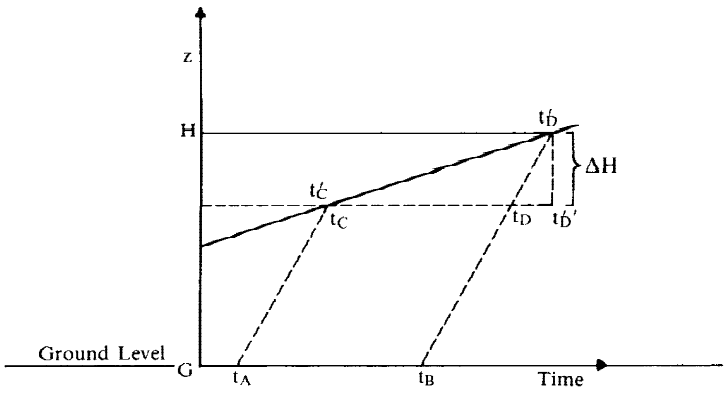

FIG. 8.
Reception of a Message at a non-constant Height above Ground.

[which is true because both statements $t_C' \equiv t_C$ and $t_D'' \equiv t_D'$ are true, since the first refers to the same event and since, for the second statement, times are always to be measured parallel to the x-axis] to cover the extra distance ΔH away from G, and since the same time is required for the completion of reception of the message by the vehicle stationary at H as for the sending station at G as per Fig. 7, the difference $(t_D'' - t_D)$ in the extra duration of reception caused by the motion away form G is nothing other than the *extra flight time* required by the end of the message to reach the moving vehicle. This *does not* imply that only the end of the message suffers this delay, but only that the *same* statement would have to be made if the message were subdivided into smaller sections. In other words, delay in this case is smooth and continuous and *only* due to the extra distance needed to be covered and the characteristics of motion of vehicle and light

in the medium over that extra distance. By the same arguments presented in the previous paragraph, there is absolutely no reason to expect that time intervals registered by the proper clocks are any different from those registered by the cosmic clock. *It should not be argued* that the moving "proper" clock may, in some hidden way, be affected by its own motion over the distance ΔH, because to the extent that it is so affected, it fails to meet the requirements of the theory of relativity regarding "proper" clocks (namely, that they remain true to themselves regardless of their state of motion) and as a result, its readings *cannot* be used in support of the theory.

In the case of the last paragraph, the paradox of the twins finds an at least partial explanation, to the extent that messages exchanged between the twins are affected by the times of flight, as those times are determined by the twins' relative motion away or towards each other. When they get together again, their "proper" clocks will, according to relativity theory, fall again into perfect synchronization. Yet, to the extent that they remained in full synchronization with the cosmic clock throughout their peregrinations according to the arguments made two paragraphs above, to the extent that the cosmic clock remains unaffected by the whims of wayward travelers, to the extent that relative to the cosmic clock the two brothers *never ceased to age identically,* upon their reunion, *they will be just as old,* not only according to the cosmic clock, but also according to their own proper clocks that they now can together observe *still (not* again) to be in perfect synchronization. If the two brothers should happen to *look* different, this can only be due to the effects of their intervening states upon their (biological) structures. The theory of relativity most definitely is not a theory of ageing of (biological) organizations due to motion. The study of the effects of motion upon the internal structure of bodies used as clocks must be seen as a totally distinct task and must include our findings in Sections 2.3.2.2.3 and 2.3.2.2.4.

There can be no question, then, that the Pound-Rebka experiment is better interpreted as given in Section 2.3.2.2.2 and as will be given in Addendum VII. The discussion to follow will show that there is indeed a time dilatation due to the expansion of the Universe, which, for $H = 22$ meters, amounts to only 1.9×10^{-25} sec., being 9 orders of magnitude lower than as measured by Pound and Rebka. Moreover, the expansional effect *is independent of the direction of messages:* reception always lasts longer than emission *regardless* of positioning in a gravitational *field*. As a *result, relativistic* dilatation and expansional dilatation *are* two completely different phenomena due to completely different causes, of which only the second is a real one.

In sharp contrast to the above, a Universe of constant G and M *provides an exceptionally simple and clear explanation* of the "problem of time". In the first place, we must recognize that just like G and M, so too T is a *universal* quantity. In other words, T *is not "time",* (measured by some "suitable" but otherwise undefined, or perhaps even strictly undefinable clock), that extends infinitely into the past. Rather, *it is the Age of the Universe itself,* that the Universe *somehow* manages to measure on its own behalf!* As such, the age of the Universe had a very definite beginning at $T = 0$, from which moment of Creation it began "to

* See, however, Section 2.6 and Part Four (especially, Section 4.5).

march forward in time", which means absolutely nothing other than to age. The Universe, in other words, delimits any operation within itself as to its duration in the past: *There was no time before T= 0*! Because, *what we call time and what we experience as time intervals, both in everyday life and in science, are nothing more than intervals of, pieces from, the Age of the Universe.*

Consider a pendulum of length L, operating in a field of gravity of acceleration $g = Gm/r^2$ at distance r from the center of mass m extending uniformly to a radius $r_o < r$. The period of the pendulum, as is well known, is

$$\tau = 2\pi(L/g)^{1/2}. \qquad (174)$$

In a Universe of constant G and M, the quantities L and g vary over time (the age of the Universe) in proportion, respectively, to $T^{2/3}$ and $T^{-4/3}$. As a result, τ varies in proportion to T. The periods of the *same* process at two different universal ages are thus related according to

$$\tau/\tau_o = T/T_o, \quad \tau = (T/T_o)\tau_o, = (1 + \delta T/T)\tau_o. \qquad (175a, b)$$

The same expression can also be derived from the elongation of planetary orbits (proportional to $T^{2/3}$) and the velocities of the planets (proportional to $T^{-1/3}$). One can safely conclude then, that the period of *any precise* mechanical clock will be similarly related to the universal age. Imprecise clocks need *additional* correction.*

One may ask whether "atomic clocks" are similarly dependent also; after all, they have supplanted the so-called mechanical clocks for good reason! To the extent that atomic clocks are also dependent upon length and velocity (even that of light) there is absolutely no reason to expect that they behave differently from other clocks. To the extent that the atomic processes they ultimately use are also subject to the gradual loss of energy due to the deceleration of light and to the expansion of the atom as a mechanical (albeit of atomic dimensions) system, one may again expect atomic clocks to behave like every other precise mechanical clock. What atomic clocks do not suffer from is mechanical friction. The real question is whether the universal law of expansion permits any system at all even temporary relief from compliance, around which one may build a truly universal clock of constant period. If the universal laws are universal in the sense also that they apply universally to *every* system in the Universe (and one may quite reasonably expect this to be truly the case), one is compelled to answer the last question negatively. Obviously, one will have to look at the basic construction and fundamental principles involved in any candidate clock to decide whether or not it meets the minimum standards of candidacy.

Still, it appears that we do *not* really need such a cosmic clock. Eq. 175 suffices. Assume that t is the *number* of periods of time also counted by a *precise* but otherwise ordinary clock between the universal ages T_o and T, i.e., in the period $\delta T = T - T_o$. This universal age period is equal neither to $t\tau_o$ nor to $t\tau$,

* See Note at the end of this Section.

where τ_o is the *assumed* unit period (or duration between two successive ticks, assumed of zero duration each, at T_o) and τ is the *assumed* unit period at T, but to

$$t\tau_{ave} = T - T_o, \tag{176}$$

where τ_{ave} is the *average* unit period of the stated clock over the entire time interval between T_o to T. It follows that

$$\tau_{ave} = (\tau_o + \tau)/2 = \tau_o(T_o + T)/2T_o = \tau(T_o + T)/2T, \tag{177a,b,c}$$

$$t\tau = 2T(T - T_o)/(T + T_o) \equiv t_T \tag{178}$$

where t_T is the *assumed* to be correct age T. (In assigning values to the above quantities, one must be careful not to divide by zero). It is immediately obvious that by setting $T_o = 0$ in Eqs. 177c and 178, one obtains, respectively

$$\tau_{ave} = \tau/2 \tag{179}$$

$$2T \equiv t_T \tag{180}$$

In other words, the period τ_{ave}, of a cosmic clock of *constant* unit period (*if* such a clock existed) would be *half the present* (at age T) period of our *precise ordinary* clock. The time t_T that we *think* has elapsed since the beginning of the Universe is actually *twice* the true universal age! Or, the age of the Universe is really *only one-half* of what we *think* it is based on our best clock! If the true universal age is, as has been taken in this work, 12 billion years, then, its measured age should be 24 million years and the fraction $\delta T/T_o$ entering Eq. 175b, namely, the fractional increase expressed in years of whatever period of time we use as standard today is $(12 \times 10^9)^{-1} = 8.33 \times 10^{-11}$ parts per part longer than the same period was last year. To put it differently, the year 1984 was about 2.63×10^{-3} sec. shorter, and the year 1605 (380 years ago) one full second shorter, than the year 1985. The period t_T of the year that we *think* has elapsed since last year is

$$t_T = (T - T_o)/(1 - \delta T/2T) \cong (T - T_o)(1 + \delta T/2T), \tag{181}$$

where T is the present age of the Universe and T_o the age of the Universe a year ago. These examples give an adequate idea of the corrections needed to convert current clock readings to the true present universal age.

We must note particularly that the retardation of the periods of time that we use as standards is such that they are always twice as long as the *average* period of the same process since the beginning, for all ages (Eq. 179). We must also note that the *number* t of periods counted in some manner suffers no change. In other words, if the Earth has always circled the Sun since the beginning of time (that is, *since Creation),* it has performed 12×10^9 revolutions so far. *It is* the *periods* that *are getting longer, not* their *number* that *is getting smaller* as the Universe ages. Put otherwise, at T = 0, all revolutions (were there any) had infinite frequency. As a result, revolutions or readings off a clock dial are *equal in number* whether counted by means of a cosmic clock of constant period (here called τ_{ave}) or an ordinary but *precise* clock having at *this* universal age period t_T .

By the arguments presented earlier, all precise clocks in the Universe be-

have identically to each other regardless of their motions. But now, in light of the present discussion, those earlier arguments find a new and very strong support: The fundamental photons out of which everything is made up age identically, and so, too, do the ponderable bodies that they happen to occupy at any given universal age.

Because the Universe and everything in it age *uniformly,* the notions of travelling backward or forward in time thus find their deserving reward, and one *is compelled* to conclude that so too do all theories that lend support to those notions. Because, one cannot both be ageing with the Universe of which he is an inseparable part and at the same time still go hither and thither in time through the ages past or future of the Universe. Total universal time for all precise clocks is nothing other than the age of the Universe, as objectively as can be measured given the universal expansion, and the sections of it that we regard as "ours" are co-passing with us, *to which we are locked and cannot escape from*!

NOTE ADDED TO SECTION 2.5

Mercury is an excellent example of a planetary clock. Its precession has been said to agree very well with the general relativistic prediction and thus to provide the best evidence so far in support of that theory. In all corrections, classical or relativistic, that have so far been applied to the orbit of Mercury, the effect of the expansion of the Universe *has been ignored*, and yet not only that.

Consider, first, the case of a *non-expanding two-body (Sun-Mercury) universe*. The Newtonian force holding the planet at T_o is $F_o = G{\cdot}m_S{\cdot}m_M/r_o^2$. In this case, the only logical definition of separation r_o is along the Euclidean straight line. Nothing ever changes regarding this force. The clock is exact. No precession is possible under the Law. But also, *no precession is possible to detect* in a two body universe. If it were possible to fix an imaginary direction in space, that of the major axis, exactness of the clock means that after a complete revolution, perihelion shall occur exactly in the direction established earlier.

Consider now *an expanding two-body universe*. The separation r still can only be defined along the same single natural Euclidean straight line, which however now increases with $T^{2/3}$. The separation r at T is related to the separation r_o at T_o by

$$r = r_o(T/T_o)^{2/3} \cong r_o(1+\delta)^{2/3} \cong r_o(1+2\delta/3), \qquad \text{(N.2.5/1)}$$

where $\delta = (T - T_o)/T_o$. The force of gravity operating at T is

$$F_{(\text{at T})} = G{\cdot}m_S{\cdot}m_M/r^2 = F_{(\text{at To})}(1+\delta)^{-4/3} \cong F_{(\text{at To})}(1-4\delta/3) \quad \text{(N.2.5/2)}$$

This force causes a departure from the elliptic motion established for the non expanding two-body universe: The planet shall continually describe a larger orbit and shall take longer to complete a complete revolution, than would have taken had there been no expansion. How is this "longer" to be decided? Without refe-

rence to the outside world, which is not possible at any rate in a two-body universe, only the moments of perihelia (or other equivalent) count: Principally, it is the time intervals between these moments that grow longer. The lengths also grow longer but in a more complicated way, of which in a moment. With reference to the imaginary direction fixed earlier (that can be passed by at fixed time intervals *only* in a two-body non-expanding universe) this means that the perihelia will occur *after* that direction has already been passed by; because the decreased attraction of the Sun will take longer to decelerate the planet (from a given velocity), aphelion will occur with delay, beyond the axis, and the decreased acceleration will take longer to bring the planet back to and around at perihelion, again beyond the axis. The orbit will precess relative to the imaginary direction fixed earlier for the non-expanding two-body universe. The semi-axes do *not* lie on a Euclidean straight line but form an angle exceeding the value of π.

According to the findings of this Section (2.5), the period (year) of Mercury will grow longer by

$$\tau = \tau_o(1 + \delta). \qquad \text{(N.2.5/3)}$$

If δT represents the universal age interval between two perihelia (0.2409 Earth years), currently each Mercury year grows longer by $\delta = 2.0075 \times 10^{-11}$ relative to the *previous* year. Relative to the period τ_o of 100 Earth years (about 415 Mercury years) ago, the current period is

$$\tau = \tau_o(1 + \delta)^{415} \cong \tau_o(1 + 415\delta) = \tau_o(1 + 8.33 \times 10^{-9}) \qquad \text{(N.2.5/4)}$$

longer. Relative to the *real but always impossible to fix* (as there is no background against which to position it) direction of perihelion 100 years ago, it now takes $2\pi(1+415\delta)$ radians between that and a present-time perihelion: The effect both increases and accumulates with each revolution. Over the last 100 years the cumulative angle described has been

$$\begin{aligned} 2\pi[(1+\delta)+(1+2\delta)+(1+3\delta)+...+(1+415\delta)] &= 2\pi(415+415\times416\delta/2) \\ &= 2\pi(415 + 1.7329\times10^{-6}). \qquad \text{(N.2.5/5)} \end{aligned}$$

The extra angle described thus is 2.25´´ or 5.2% of the presently classically unaccounted precession of 43´´. However, if the fractional increase per revolution is not averaged over 415 revolutions but its current value is assumed to be constant, then, the calculated precession will be twice the value just given. It is therefore *likely* that the currently calculated precession is twice as large as the correct precession of the planet.

In a multi-body expanding universe, separations are no longer necessarily along Euclidean straight lines. If the actual separation entering Newton's Law increases continually over time and becomes in fact $r(1 + \zeta)$, the law of gravity takes the form

$$F_T \cong F_{To}(1 - 2\zeta)(1 - 4\delta/3) \cong F_{To}(1 - 2\zeta - 4\delta/3) \qquad \text{(N.2.5/6)}$$

and an additional precession will be in effect, different from and greater than so far allowed for under the assumption of separations along Euclidean straight lines. Calculation of ζ lies beyond the scope of this work.

The classical description of Newton's Law (Eq. 1) in all probability is wrong, as it tacitly assumes not only the separation along a fixed Euclidean line, but also the Sun as always at the center of gravitational phenomena at least as they apply to the solar system. What these words mean must be made clear: Not only the Sun but *every* massive body is the center of its own field. As a result, it *is* in fact more accurate to write Newton's law in the form

$$F = G(m_1/r_1)(m_2/r_2), \qquad \text{(N.2.5/7)}$$

which permits the relationship $r_1 \neq r_2$, for the reason that the effects of a multi-body expanding universe are truly different as viewed from the two main bodies considered. Besides the phenomena described earlier, due to the effects of the rest of the Universe, a "test particle" sent from the Sun to the planet *shall generally follow a different, non Euclidean and unequal path* from the path of a "test particle" sent from the planet to the Sun, for the reason that the entire universe *is truly positioned dynamically differently* around each of the two principal bodies considered. This was what was meant under the code name "Law of Separations".

The relativistic expression of the angle described between perihelia is

$$2\pi\left[1 + 12\pi^2\alpha^2/T^2c^2(1 - e^2)\right], \qquad \text{(N.2.5/8)}$$

where α is the major semi-axis, T the period of revolution for an angle of 2π, c the velocity of light and e the eccentricity, all of which are considered to be time-invariable. It is obvious that the relativistic derivation of precession is totally unrelated to universal expansion that is heavily universal-age-dependent. Also, to the extent that relativistic precession depends heavily upon the measurement of angles, $3(2\pi)^3$, it in essence depends upon the existence of an outside world to establish a primary direction. Such a direction is *not and cannot* be defined internally in a non-expanding two-body universe. Having ignored (a) the continual universal expansion and its local effect upon the distance between Sun and Mercury and the period of the planet, as testified to by Newton's Law under constant G and M, (b) the constant loss of mass by both the Sun and Mercury, and (c) the cumulative effect of the whole Universe upon *every* interaction in it and thus also upon the *true natural* distance prescribed by a "test particle" for *each* of the two bodies entering Newton's Law (N.2.5/7), the general relativistic finding of (N.2.5/8) *cannot* constitute the final word on the matter! The final word *may not* ignore anything that *is* relevant! We *may not* pick out of the *Uni*verse only what we like and reject what does not fit our *willful and mostly pseudophilosophical quasi-religious* preconceptions dressed as "Science"!

2.6

RECAPITULATION

We have completed the examination of the eight cases, namely, the only eight combinations of the universal quantities G, T, D, M and V, that make sense as regards the constancy or variability of these universal quantities. The criterion for making sense was the *internal consistency* of each combination, given the applicability of the universal law expressed most simply by Eq. 2. When, internal consistency at this entry level was found to exist, we had to look deeper into the implications of the particular combination and to a comparison with what we already know of the Universe, or with what can most reasonably be expected to make the best overall sense of what we know or can know about the Universe, to decide whether or not our Universe fits at all any one of these combinations.

It was recognized early on that the nature of these five universal quantities is such, and the way they enter Eq. 2 is such, that if the latter were subsumed initially to be a universal law, *only one* out of the eight possible combinations could possibly be found to be supported by the physical evidence. It also was recognized early on that if the examination, thus carried out, showed that there is indeed one and only one such combination, this finding would be tantamount to a *simultaneous proof* of the applicability of Eq. 2 as a *true* universal Law and of *that* particular combination of constancy/variability of the five universal quantities as being the one obeyed by the Universe. If no such combination were to be found, one would be free to reject the notion that Eq. 2 is a universal law.

The examination presented shows that the particular combination of constant G and M, variable D, V, and T, examined at great length in Section 2.3.2, is indeed the *one and only* that applies to our Universe. All other combinations were shown either to contain internal inconsistencies at a deeper than entry level, or not to be supported by the physical evidence.

We thus also have the simultaneous proof of the universal Law expressed by Eq. 2, which under the universal constraints of constant G and M, appears in the form of the pair

$$6\pi GDT^2 = 1, \tag{22}$$

$$R = [(9/2)GMT^2]^{1/3}. \tag{17´}$$

The first indication of the existence of the Law of Eq. 2 was found when it gave (for $\alpha = 1$) a value for the average density of matter in the Universe within range of our best estimates. The second indication was found when the new Law, recast in the above expression for the universal radius, suggested that the Universe ex-

pands with the 2/3-power of the age of the Universe, which led directly to the velocity of expansion of the universal front. That velocity could be no other than the velocity of "First Light". When the value of the present velocity of light was fed in $dR/dT = c$ for the present age of the Universe, $T_2 = 12$ b.y., the value of the universal mass obtained, $M = 1.15 \times 10^{56}$ grams, and the value of the average density of matter, $D = 5.45 \times 10^{-30}$ grams/cm^3, now recalculated for $\alpha = (6\pi)^{-1}$, were so close to our best estimates of the values of these quantities based on observation that, in the mind of this author, *this would be a most unforeseen and a most improbable coincidence, if it were not true*! To the extent that such coincidence can be ruled out, one may indeed feel secure to accept the existence of the Law of Universal Expansion expressed by Eq. 17´.

The most remarkable fact emerges, then, that the Law of Universal Expansion follows *logically* from Newton's Law of Gravitation. Indeed, the simplicity of the latter and the *physical dimensions* that it imposes upon G leave us no option but to accept this relationship between the two laws as *logically necessary* under constant G and M. The universal gravitational constant, G, far from being solely a pure proportionality constant, entering "universally", that is, without exception, the pairwise gravitational interaction of ponderable bodies in the Universe, also represents a *key universal quantity and quality characteristic* of the Universe *as a whole*. *So* much so, that G along with the mass M and the *age* T of the Universe, determine its *state* at any moment.

It has been alleged that Newton's Law of Gravitation does not quite explain the facts, that general relativity does a better job at it, specifically as it includes Newton's law as a *limiting* case. In the mind of this author, it is most peculiar, indeed, that Newton's law, so "nearly universally obeyed" (as admitted even by the proponents of general relativity) that one has to look at second-order effects to find alleged discrepancies, is included in general relativity as a *limiting* case of the latter rather than as its *most absolute centerpiece*: On the evidence of the first-order effects, Newton's Law of Gravitation should be at the center, and most definitely *not* at the limit, of general relativity. In other words, this author finds it most peculiar that a theory can be accepted as valid when it so grossly misplaces a central physical fact to the limit of its own applicability. The history of the so-called cosmological constant (Einstein's self-confessed greatest error) should prove how *un*important within the entire context and framework of relativity the subject of Universal Expansion is regarded! That the latter as quite simply the "other face" of Universal Gravitation is so absolutely central to the Universe as a whole is so significant a finding and so totally missed by relativity that one can only wonder!

On the basis of this extreme simplification that Newton's Law allows, in the sense that the "gravitating" Universe is also eternally expanding in strict conformance to Logic, one is entitled to look elsewhere to find the explanation for the alleged failure of Newton's Law to explain the facts to a second-order approximation. This "elsewhere" is found in the denominator of Newton's Law: The distance between the two bodies has so far been considered to be constant and to be measured along the Euclidean straight line joining the centers of these two bo-

dies, to the utter neglect of the gravitational effect of the rest of the Universe upon that distance. When that effect is considered, it is found that the sides of the triangle formed by three bodies may *no longer* be regarded as a Euclidean straight lines but as curves (and thus longer than straight lines) causing the sum of the three angles to be *less* than π. The true explanation of the alleged failure of Newton's Law, then, lies in *our* failure to recognize that it is *along those curves* that the instantaneous separation is to be measured that enters the denominator of Newton's Law. Because this separation is thus found to be *longer* than the Euclidean straight-line separation, the gravitational force acting between two bodies in a Universe of at least three bodies is *smaller* than that suggested by the Euclidean straight line-separation. Mercury's elliptical orbit would not precess *only if* the Euclidean straight-line separation were the separation to use in the denominator of Newton's Law *and* the Universe did *not* expand! If the curved path separation is used there, however, one finds that it inevitably will take *longer* for the Sun to manage to turn the planet around at perihelion. As a result, Mercury, then, has to precess in strict conformity to Newton's Law, by an amount in *excess* of that calculated on the basis of corrections so far thought to be required in order to include the effect of the other planets, in which corrections the various separations are considered to be along Euclidean straight lines. Obviously, such corrections, as heretofore applied, have ignored the curved Sun-Mercury separation, as well as the curved separations of the other planets from the two principal bodies here considered, namely, Sun and Mercury. Moreover, no consideration has so far been given to the effect of universal expansion upon Mercury's orbital precession. Now, this is obviously a task that will tax the precision as well as accuracy of planetary astronomy. But one cannot feel *too* confident at this stage to expect that such recalculation, when correctly carried out, will inevitably reduce significantly if not totally the magnitude of the alleged discrepancy between Newton's Law and observation. The oblateness of the Earth should leave little doubt as to the oblateness of the Sun. The effects of the latter upon the precession of Mercury will be in addition to all other effects. It is well known that the general-relativistic calculation of the precession of Mercury leaves no room for the effect of the oblateness of the Sun to be included, when finally measured.

The Newtonian expanding Universe makes several and very important additional demands:

Firstly, no natural velocity can ever be constant, unless there exists a natural process by means of which it is especially compensated for the slowing caused by the universal gravitational field upon all velocities in the Universe. From this rule there can be no exception, not even for light. The law of expansion goes all the way back to zero universal age, $T = 0$. The velocity of the expanding front dR/dT was infinite at that age. The expanding universal front *cannot but be* made up of the First Light of Creation. So, in the very least, that light is slowing down. Therefore, if light, regardless of whether it is first or more recent, is to have a singular velocity, that velocity *must exhibit the same dependence* upon the universal age *everywhere* in the Universe. That on the basis of the *here and now* velocity of light and the present universal age, we were able to obtain the value of

the total mass in the Universe demonstrates beyond doubt that the velocity of light is *universal*ly identical and slowing down with every passing moment.

Secondly, the *Universe has a center,* the physical *and* mathematical point in space from which expansion began and *all* momenta sum up to zero! This makes it evident that there is indeed in the Universe *a preferred frame of reference,* the frame located at its center! Orientation here is unimportant. The important point is that the center of the Universe is unique in that it is the *only* place in the Universe that remains *motionless in place* through time. No other frame fixed on any other material object in the Universe resembles, in this most important respect, the central frame. Only the central frame is truly inertial, in the sense that it remains motionless. The infinity of physical non-preferred inertial frames admitted by special relativity are, therefore, non-existent in the Newtonian expanding Universe! Every material particle obeying the Hubble Law, other than the one at the center of the Universe, travels *radially away* from the latter with a velocity proportional to $T^{-1/3}$, a velocity retarded in proportion to $T^{-4/3}$. No inertial frames can, therefore, be fixed upon any such non-central particle(s). To insist upon the use, usefulness or usage of such frames is only to recognize their purely *theoretical, non-physical* characteristics. Physically, they do not exist.

Thirdly, the Newtonian expanding Universe compels us to abolish the idea of "rigid rods". At best, a "rigid rod" is a very transitory body without cosmological significance. In Section 2.3.2.10, we indeed entertained the thought that the continents out to their oceanic slopes taken together may have been the "first crust" of the Earth. At least, this is an intriguing thought. But there is no proof really to substantiate it as a fact that the totality of the continents have not grown for several billion years while the planet has! It may only be used as evidence of the fact that the crust and the interior expand differently, due to their different chemical compositions. The strength of chemical bonds may well retard the expansion of substances relative to the expansion observed in free space. Even if it should be so, *one must consider it certain* that the expansion of bodies *shall* at some point eventually speed up toward resumption of the universal pace as their energy content gets continually depleted with every passing moment, due to the decreasing velocity of light. More fundamentally, the Universe compels us to abolish the notion that length is a fundamental physical property. *It is not*. Only our failure to recognize the full effects of universal expansion has hidden this *dramatic* effect of expansion from us so far.

Fourthly, the Universe emerges as a place where three universal quantities G, M, and T determine all the rest. The first of these is constant and indivisible, a true physical unit. The second is constant but *quantifiably divisible* into *indestructible fundamental particles* of fixed mass, each of which carries forever its assigned mass. The third is a variable, infinitely divisible continuum extending forward from the moment of $T = 0$. T is not "time" as usually "understood". Rather, it is the universal age, and every effort was made in this work so to use the concept. Whenever the term "time" was used, it was used only in the sense of universal age or time lapsed between given universal ages. Time as a physical quantity extending forever back into the past is something for which we have ab-

solutely no physical basis on which to support any scientific discussion. The very best that the expanding Universe can do is to point back to its own *Genesis,* whether we like it or not! In other words, the "past time evidence" that the Universe gives us is only the evidence of its own age! Thus time relates to the age of the Universe in nearly the quasi-same sense that space relates to the volume of the Universe. As volume increases in space, so age increases in time. Yet, the physical quantities are the volume of the Universe and its age, and not the totality of the entity of space, nor the totality of the entity of time, existing indefinitely in the past, present and future. Space and Time are the regimes in which the Universe expands, but in themselves, they are *non-physical* quantities. No one ever set foot in space where the Universe has yet to expand. And no one ever "set foot" in anything but the present and one's *own* past. The march into the future is inexorable, forever fixed and identical for all bodies in the Universe. We all "fall" into the future with the same speed, as bodies gravitate in vacuum regardless of their mass. In other words, there has never been a measure outside the Universe to measure space, nor a clock in the "past" (before $T = 0$, careful: *not* $T < 0$!) or in the future to experience a time that was not also the age of the Universe. The Newtonian expanding Universe is a place where *events are indeed strictly and unconfusedly ordered in time,* through the universal age at which each one occurs. The special-relativistic notions about the absolute relativity of events in space and time *truly have no place in this Universe*, other than that they are illusions brought about by *our essentially self-imposed monocular vision and our failure to recognize the age of the Universe as the exclusive temporal context within which physical events can and do take place*.

The question must now be asked: Just because mirages occur in Nature are we justified in constructing a theory of mirages to explain the underlying physical phenomena? For it appears to this author that the theory of relativity, at least the special if not also the general, is precisely of this kind. It is being freely admitted that today, that is under the current understanding, we do not have a theory of the Universe: neither relativity nor, indeed, quantum mechanics have been of any help in this regard. Undoubtedly because neither theory considered the Universe in its entirety, and also because both theories are of hindrance rather than of help in such an undertaking. The study of the Universe undertaken here and the advances in our understanding that this work allows show that *it was absolutely necessary to reach outside both currently dominant theories* in order to obtain a deeper understanding of physical reality. So,

Fifthly, light is made up of photons. Light everywhere in the Universe is being retarded identically. Energy comes in photons. Energy as a concept is defined in terms of mass. The energy of a photon has no mass to refer itself to other than the mass of the photon itself. We are compelled to conclude that photons are indeed massive particles. The retardation of the velocity of light is due to the universal gravitational field. The velocity of light can be retarded identically everywhere *only if* the gravitational field is identical everywhere. Then, no matter where light is pointed, it is being retarded identically. This requires a unique distribution of mass in the Universe: $d = (9\rho\pi GT^2)^{-1}$. Light travelling under such an

absolutely uniform radial distribution of mass is compelled to travel along Euclidean straight lines. Uneven local mass distribution must inevitably affect light and cause it to travel along non-linear paths.

Sixthly, there is, however, a difference in the way the universal gravitational field affects photons and other material objects (ponderable bodies). There is no doubt that Hubble's law is in full accord with the universal expansion, here shown to be the "other face" of gravitation. Material objects other than photons expand away from the center of the Universe with velocities proportional to their distances from it. Only the universal front expands away from the center with the velocity of light. In this, therefore, there is a *great difference* between material objects expanding radially outward against the force of gravity and photons. Both are massive, but not both behave identically under $\mathcal{G}$. An effort, unsuccessful as it turned out, was made to see how the situation, discussed in detail in Section 2.3.2.4, could possibly be made any different. The full explanation of why this *has to be so* is given below at Eighthly.

Seventhly, energy in the Universe is indeed $\epsilon = mc^2$ or $E = Mc^2$, but not because it is so demanded by the theory of relativity. These equalities come out naturally from the ponderability of the photon and from the values of R and c obtained in this work which cause the product Rc^2 to be equal to 2GM, and therefore cause the kinetic energy of the photon, $mc^2/2$, to be always equal to its potential energy, GMm/R, even at distances from the center shorter than R, due to the particular distribution of mass that allows the velocity c to be constant everywhere at constant T. Thus we do not need the theory of relativity in order to accept the equalities $\epsilon = mc^2$ and $E = Mc^2$. After all, the spacetime of the special theory, which in fact is the exclusive subject-matter of the theory, can only have dimensions given in terms of length and time. *Without* the *physical dimension* of mass entering naturally and automatically with the spacetime concept (which the special relativity theory has *not* managed to bring forth), the notion of $E = mc^2$ is an *additional* postulate of the special theory totally independent of the concept of spacetime. Under the theory of relativity, $E = Mc^2$, where E and M are the universal energy and mass, respectively, *cannot* be written: Because, this expression and the separate laws of additivity of mass and energy assess uniquely defined amounts of energy and mass to each fundamental particle, and as a result, they assess an amount of mass to *every* energy-carrying particle, namely, also to the photons, whereas the photons are assumed by the theory of relativity, both special and general, to be massless! In this light, the equation $\epsilon = mc^2$ as used in the theory speaks loosely of the "inter-convertibility" of mass and energy, which has been taken to be the now refurbished relativistic dress of the first law of thermodynamics.

The Newtonian expanding Universe of constant G and M does not permit such loose use of words. M is constant forever. The fundamental particles, into which M is subdivided, or conversely, the fundamental particles the total mass of which sums up to M, are, therefore, forever given in number, and their mass is also constant forever. Mass is conserved. But the products $\epsilon = mc^2$ and $E = Mc^2$ are not conserved. The variability of the velocity of light destroys the conserv-

ability of energy and proves the strict inapplicability of the first law of thermodynamics. Only when no great error is introduced if we ignore the gradual reduction of the velocity of light may we accept as valid that law. The "inter-convertibility" of mass and energy is nothing other than an effort to transform ponderable bodies to their supposedly massless constituent photons, or the reverse. Photons are not created where none existed before. The constancy of mass m of the fundamental particles and the principle that where mass there too is the corresponding amount of energy $\epsilon = mc^2$, prevent the ex nihilo generation of massless, yet, able-to-carry-off-energy photons in energy-releasing reactions. In such reactions, that amount of energy and mass is released as (*always massive*) photons that is no longer containable in "ponderable" form within the bodies resulting from such reactions. The converse is true of energy-absorbing reactions. So:

Eighthly, this brings up the matter of the "photon in the bound state". Under the concept of mass- and energy-containing ($\epsilon = mc^2$) fundamental particle, to the extent that photons, too, are somewhere along the scale of masses, logically inevitably, they inhabit the "ponderable" bodies. The reexamination of the Michelson-Morley experiment showed that its null result was inevitable: The photon, whether in free flight or in the bound state, retains its velocity constant at c (at age T) as referred to the center of the Universe. The velocity of the bound photon relative to the body which it inhabits is no longer c but c´. If v is the velocity of the body relative to the center of the Universe, then the velocity c´ of the photon relative to the body is such than when the two velocities are added vectorially, they will always sum up to a vector of size c. As a result, $c´ + v = c$ when the two velocities are parallel or antiparallel and the null result of the Michelson-Morley experiment is fully explained as presented in Section 2.3.2.2.3. Yet, because of the difference between c´ and c, the photons in the bound state travel in orbits that are not perfect circles but ellipses relative to the center of the body, and the bodies are not truly spherical but ellipsoidal, as explained in Section 2.3.2.2.4. The shape of the bodies are in general more complex than as proposed by special relativity. The ellipses simplify in form to give exactly the relativistic contraction *only* when the principal axis of the interferometer coincides with the *total* vector of motion of the interferometer *relative to the center of the Universe*. This *has been ignored and never assured in any* interferometric study to date.

Thus the null result of such experiments is not due to the explanation provided by special relativity, but to this very deep-seated reason which allows us to write $c´ + v = c$ etc. and permits the interferometer to produce uniformly null results regardless of orientation.

It is this very deep-seated reason which causes the universal force of gravity acting on ponderable bodies to be the ρ-fraction of that acting on photons, and allows the recessional (expansional) velocities of the former to conform to Hubble's Law. And so:

Lastly, on the question of mass increasing with velocity, the Newtonian expanding Universe, indeed, *requires* such an increase: Since energy only comes as photons, and since photons are massive, an increase in velocity indeed requires an increase in mass by the amount of mass of the photons added, that cause the

increase in velocity. The magnitude of the increase, however, depends on how exactly the conservation laws apply in the case of addition of photons. This is not a matter that can be decided theoretically at present, as one reaches different results depending upon whether one chooses to conserve momentum, total energy, kinetic energy, or whether one begins with the notion of force. The last two approaches give very similar results. Only the last approach will reduce to the relativistic expression, and then only if one ignores the expansion of the Universe, as explained in Section 2.3.2.7. It is *not at all* that the principles of instantaneous conservation (at T) break down. Rather, it is a question of determining how much of the total momentum and energy of the photons added to the resulting body is expressed externally in the form of velocity v of the resulting body. More study and experimental work is needed on this point.

In closing Part Two of this work, it is probably very fitting to mention here the following comment made by D.W. Sciama ("*Modern Cosmology*", Cambridge Univ. Press, 1971, p. 110): "This completes our discussion of the Newtonian dynamics of a large gas cloud. The reader will have noticed one very important omission. We have not discussed the behavior of light in these models.... The reason for this omission is that Newtonian theory does not provide us with a satisfactory account of the behavior of light. Although the relativistic formula for the redshift is a very simple one, attempts to derive it in a Newtonian setting gives me the uneasy feeling that one is stretching the Newtonian concepts too far. As a result, one has no faith at all in the answer until it is checked by relativity". This, despite his own reservations regarding relativity (see his "*The Physical Foundations of General Relativity",* Doubleday & Co, 1969, p. 67-70, mentioned briefly later in the present work on pgs. 341 & 344). I myself have not made a study of the suppositions (and the order of their importance relative to each other) on which the efforts have been made to account for light in a Newtonian setting that have left Sciama feeling uneasy. Nor do I think that such a study could possibly lead to incontestable conclusions. Rather than accepting mere a priori suppositions and attempting to evaluate them, what truly *are* incontestable are the results of a *careful* dimensional analysis of Newton's Law of gravitation as it *truly* applies in the *universal* setting of Nature, as for the first time exposed in the present work. What had *not* been recognized before was the *natural fact* that *this* setting constitutes the *immovable cornerstone* on which the *correct* understanding of the Universe *must* be based, as indeed has been here presented. *Much too much had been supposed a priori, before scientists began considering the consequences of Newton's law, and those suppositions have not yet been critically re-examined*! My contacts with professors and astronomers have left me amazed with their near total incomprehension of the *fundamental significance* of the dimensional analysis of Newton's Law, that I had to explain in full detail to some of them, while others simply attempted to pass it over in *total* silence, *in order not to admit its irremovable significance*, *a practice that indeed has continued world-wide since 1985*! To put it otherwise, *what classical science had totally missed, and is stubbornly not yet admitted in becoming*

contrition, is the physical fact that under constant G and M, i.e., the only option available to this Universe, the Newtonian mechanics is nothing less than the complete mechanics of light itself, of which only the highlights was I here able to bring to full view!

The richness of *detailed, consistent and unambiguous* information about the Universe, obtained on the basis of Newton's Law of Gravitation, is indeed surprising and *without doubt not accidental*. This is in sharp contrast to other theories. Specifically important is the fact that *Newton's Law permits us to go far beyond relativity and to be restored in the belief in the objective existence in Nature of absolute certainty,* which, "developments" in thought during the twentieth century have tended to obscure. *Absolute certainty exists in Nature as relates to quantum phenomena as well*. This will be the subject of Part Three of this work.

PART THREE

THE RETURN OF CERTAINTY TO QUANTUM PHENOMENA

3.1

SOME PROBLEMS OF THE BOHR MODEL AND OF THE CURRENT QUANTUM THEORY

Quantum theory as pertains to matter began with the Bohr model of the hydrogen atom presented in 1913. The notion of quantum as pertains to radiation had already been introduced by Planck (1901) and as it pertains to the photoelectric effect by Einstein (1905). The notion of the nuclear atom had already been introduced by Rutherford (1911). The charge and mass of the electron were already known through the work of J.J. Thomson (1897) and of Millikan (1909). By setting the self-energy of the Coulomb field of a charge –e, namely, the quantity $(-e)^2/r_e$, equal to the relativistic rest energy $m_{e,o}c^2$, introduced with Einstein's special relativity of 1905, one obtained the so called "classical radius of the electron": $r_e = 2.82 \times 10^{-13}$ cm, which is about five orders of magnitude smaller than the radii of the atoms. The notion that the electron is a very small particle moving in some fashion about the nucleus thus took firm hold. Classical theory was, however, unable to explain why the atoms were stable spheres and had a radius of roughly 10^{-8} cm: According to it, the electron should emit electromagnetic radiation and should thereby lose energy and spiral inward, finally falling onto the nucleus. What prevented the electron from doing so? The answer was provided by Bohr who *postulated* that the angular momentum of the electron moving in an orbit of radius r, namely, the quantity $m_e\omega r^2$ is equal to $n(h/2\pi)$, where h is the Planck constant and n a dimensionless whole number multiplier (different from the number of unit charges present in the atom), the value of which remains constant while the electron is in a fixed orbit. Because n can assume only whole number values, so too is r "quantized" and does not assume a continuous spectrum of infinitesimally different values. Bohr's model succeeded in establishing a theoretical basis for the already known Rydberg law, namely, the experimentally observed fact that the spectra of hydrogen-like atoms obey the general expression

$$\nu = \lambda^{-1} = R(n_1^{-2} - n_2^{-2}), \tag{182}$$

where ν is the number of waves per cm, λ the wavelength, n_1 and n_2 ($> n_1$) whole numbers and R the Rydberg constant. This success gave great credence to the notions underlying the Bohr model, specifically to the notion that the electron is indeed a very small particle of order $\approx 10^{-13}$ cm and that it is *circling* the nucleus.

Although highly successful in explaining the spectra of hydrogen-like atoms, the Bohr model was totally unable to explain the spectrum of more complicated atoms. However, the need to develop a model good also for such atoms was soon

removed from sight with the development of Quantum Mechanics which incorporated the above two ideas about the electron from the Bohr model: More complicated atoms were seen as nuclei with swarms of electrons all circling about them while studiously avoiding each other. The notion of a fuzzy electronic cloud was born as the area within which the electron(s) finds(find) itself(themselves) while in the atom. The Heisenberg matrix algebra and the Schrödinger wave algebra were soon found to be mathematically equivalent and interchangeable. But no matter how the mathematics were manipulated, no information could be obtained as to what went on inside the electron cloud. This was seen as a *fundamental feature and weakness* of Nature, rather than as a direct outcome of the notions entering the particular quantum model of the atom thus developed and of the mathematics adopted for the model, and was eventually incorporated into quantum mechanics as the Heisenberg uncertainty principle. This principle, in an effort to explain that failure, attributed it to "observer" interference: When the "observer" is of about the same size as the object of observation, no clear and definitive picture of the object can emerge: The act of observation makes uncertain the *quantity* observed. So, according to currently established opinion, not even Nature can know what is going on inside the area of uncertainty! Man is absolved!

Quantum mechanics has succeeded very well indeed in always finding first-approximation solutions of the differential equations that are in good agreement with experimental results*. However, even some of its own developers and disciples (see e.g. P.A.M. Dirac: "*Directions in Physics*" J. Wiley & Sons, 1975, p. 20) feel that quantum mechanics as it now stands *cannot* be the whole answer. Specifically bothersome is the problem of infinities, recognized more than fifty years ago, which remains unresolved and is simply ignored (technically, "renormalized

* This, however, requires some explanation: There is nothing aprioristic about the theory. The exact mathematical formulation of the differential equations, which when solved give results in good first-order agreement with experiment, is not obtained as a logically inevitable conclusion flowing straight out of the premises of quantum theory as presently formulated. Rather, it is obtained by trial and error on the basis of "reasonable guesses". The equations are then solved and their results compared to the experimental findings. When agreement is poor, another guess of the form of the equations is made and the new equations are solved. The process is repeated until a "satisfactory" agreement is reached. Because all these are differential equations admitting of an infinite number of solutions, the difficulty of finding the exact final solution is compounded because not only the equations but also the integration constants must be guessed "right". Generally, no algebraic expressions, simple or complicated, are found, nor are they believed to exist! Numerical results are obtained only after a very great computational effort. Philosophically, this entire process leaves much to be desired. Integralists, those who believe that the true explanation of the facts of Nature lies in *exact* integral equations (and if *they* are simple, then, that *is* beautiful!), naturally expect and insist that physical theories make integral predictions and they are not much impressed by the simplicity (or, "mathematical beauty") of the second-order differential equations. The mathematical beauty has to do with the order of the equations. The higher the order, the greater the simplicity of the differential form, so that there is nothing unique about the second-order equations, except perhaps that they seem to be adequate for our present needs. But also, the higher the order, the greater the ambiguity of the final result sought. Thus once again, beauty is "in the eye of the beholder"! The pertinent point here is that when there was no other beholder but the One, He had to satisfy Himself that "*it*, that is, the *final outcome was good*"!!! Logically, this *includes* the *absence of all ambiguity, all* uncertainty!!! Precisely as is expected of the Least Set of Laws of Nature demanded by the Most Elegant Design Hypothesis. Because, it is in the Logical nature of things that *only unequivocal integral solutions can unequivocally be falsified, or accepted if they cannot be falsified*.

out") when one attempts to obtain second-order approximations and to apply the theory to very small distances and very high velocities. In the case of very small distances, this infinity problem is essentially (see Dirac, loc. cit. p.35) of the same nature as the one met with when one tries to integrate the Coulomb field for an electron assuming it to be a point charge. The problem of the infinities can be removed in a mathematically sensible manner by introducing a suitable cutoff point for making the integration. This, however, destroys the relativistic invariance of quantum electrodynamics and is seen, and correctly, as an obstacle to a successful combination of quantum theory and relativity. Dirac (loc. cit. p. 37) felt "that the change (of quantum theory) required will be just about as drastic as the passage from the Bohr orbit theory to the quantum mechanics".

With this background in mind, it is now time to examine some of the features that are common to both the Bohr model and quantum mechanics. This commonality most certainly is not accidental. Because quantum mechanics is purely mathematical, whenever a "picture" is required, one necessarily reverts to the Bohr model, which is the only "pictorial" model we have: For this reason, the theory took specific care to ensure that its results agreed with those of the Bohr model of hydrogen-like atoms.

It is commonly accepted that the orbital radius of the electron increases with the energy gained by it. Removal to infinity is regarded as identical to ionization. This already creates many and very serious problems: There is nothing, either in the Bohr model or in the quantum theory, indicating that the transition to infinite radius is not smooth and monotonic though quantized. The Bohr model at least is quite unequivocal in this regard. As a result, the electron must be considered still to be circling the nucleus even at infinity! There is nothing in the picture to suggest that an electron at infinity is free to move "away" from the atom, namely, to describe a path different from a circular one about the parent atom. As a result, an infinite orbital radius and ionization are *not* synonymous. Moreover, this idea of orbital radius becoming infinite may be acceptable in a one-hydrogen-atom universe. But in the presence of other atoms, one must expect to have serious problems as progressively more of those other atoms *must find themselves inside* the one atom the electron of which acquires more and more energy and increases its orbital radius to infinity! (See also below). Other atoms, or other pieces of matter *may not* find themselves inside that infinite radius any more than they can do so while the electron is still at ordinary orbital radii. *This must be recognized as basic*. Yet, no theoretical provision is made either in the Bohr model or in quantum mechanics for resolving this basic problem.

In the same regard, consider the dissolution in water of solid salts such as sodium chloride. In this first example of ionization, separation of positive and negative charges takes place in such a manner that the ions move totally independently of their closest neighbors while in the solid state: The lattice does not even expand to infinite dimensions, it is simply destroyed. Moreover, the volume of the solution *is smaller* than the sum of the volumes of solvent and salt before mixing. *The free motion of ions is obtained in the face of the fact that the atoms are closer together in the solution*. In solid electrolytes the ions *themselves* are closer together. But, perhaps, this is not a very good example, because no elec-

trons are present as such. But then consider the fact that under sufficient pressure all non-conductors become metallic conductors, while there is no possibility of removal to infinity. Since *high pressure* means *substantial decrease in volume, there is no avoiding the conclusion that electronic conductivity under extreme pressures takes place while, and in spite of the fact that, the electrons move closer to the nuclei*. Under these conditions, one may expect to observe a close relationship between the work of compression and the energy of ionization. In this case, the supply of energy to the system, in the form of work of compression, has resulted in the *opposite result,* namely, decreasing nucleus-electron distances, from that expected on the basis of the Bohr model.

Consider also the decomposition of a free neutron: it is carried out under *release* of energy. That is, the proton-to-electron distance *increases* as energy *is spontaneously* liberated. The opposite process *requires supply of energy to the system* in order to bring the electron closer to the proton. Formation of a neutron by supply of energy to a neutral hydrogen atom requires that the highly excited electron move much closer to the proton than it does in the unexcited hydrogen atom, totally contrary to the Bohr model! If supply of energy to the electron really meant that its orbital radius increase as per Bohr, *formation of a neutron could never be possible under supply of energy*.

No physical (i.e., *natural*) example can thus be cited where the electron absorbs energy *and* moves away from the proton at the same time, as predicted on the basis of the Bohr model. In point *of fact, the opposite is observed*!

The notion that the energy of the electron increases with the orbital radius has led inevitably *to additional problems*. Because $e^2/r = 0$ at $r = \infty$, we have been forced to conclude that the electron in the atom has negative energy! Then, once ionized and into the conduction band, namely at $r > \infty$(!), the electron can finally acquire a positive total energy! Thus the problem of infinities is not at all unique to quantum theory; it is already very much present in the Bohr model as well! It is inevitable that this problem be met again in the theory, since the latter was devised so that it fully agree with that model. It is logical, then, to demand that the resolution of the problem of infinities be such as to take care also of the problems just discussed arising from the notions entering the Bohr model*.

In fact, it is an unavoidable conclusion that quantum theory has been guilty

* The sharp exception taken in this work to the currently accepted but totally arbitrary and ill-advised treatment of electron energy has attracted the fire of some reviewers. They consider the whole thing as a matter of mere definition! It most certainly is not! Just as there is a least value of temperature positioned at absolute zero and no temperatures exist lower than that, so too there is an absolute zero of energy and no energies exist lower than that that are physically meaningful. The correspondence of these two zeroes has already been demonstrated in Sect. 2.3.2 to be imposed by the Universe as a whole under constant G and M, so that there can be no argument against this conclusion. The zero of energy as an absolute natural limit *must not* be confused with energy differences referred to some *arbitrary* level. Just as, similarly, "a ruler of zero length" signifies a *non-existent* ruler and there can be no physical meaning to "a ruler of negative length" despite the arbitrary referencing of distances. We must take care not to confuse *real* quantities and *mere* references to conventions. So, as a first requirement, given the existence of an absolute zero energy, it is necessary to keep *all* values of the *physically real* quantity of energy in the positive realm. [The sequel on the next page.]

of inexcusable freedom in using the notion of "negative energy". The whole thing has been confused further by associating negative energy with antimatter (see e.g. Dirac, loc. cit. p.11. et seq.) and by supposing that the vacuum is not just that, that is the *total absence of everything,* but something altogether different, like an ensemble of completely filled negative states of minimum total energy, where by supplying energy, we can create matter by picking up pieces as it were, while leaving behind "holes" which we immediately label "antimatter".

Now, the only *observed* difference between matter and antimatter is the reversal of sign of the electrical charge. Charge reversal, e into –e, is not at all mass reversal, m into –m, and the energy we use to create particle-antiparticle pairs is very much ordinary energy, i.e. positive energy: The masses of matter and antimatter sum up to the energy expended according to $\epsilon = mc^2$. Conversely, upon electron-positron annihilation, only their charges vanish; the energy obtained *is* equal to $2m_oc^2$! We have never used zero energy, $(\epsilon) + (-\epsilon) = 0$, to create anything and we have never come across truly negative energies, $-mc^2$! *There is no antiphoton!* As a result, not only must we remove the infinities, it is also necessary that we straighten out our understanding as regards this very fundamental problem. We must admit that this quantum-mechanical picture of the vacuum is merely an attempt to reconcile the irreconcilable! We believe that we "clearly" "create" "antimatter" which is not naturally present in Nature! (Or do we?). And yet, we do not want to abolish the principle of conservation of mass, or if not of mass as hereto understood, at least of something else from which matter and antimatter can be brought forth into visibility from a state of invisibility.

Whether one uses the Bohr model or the current quantum theory, as long as one continues to consider the electron as a particle of very small radius relative to the atom, one has to resolve additional problems. The general notion that the electron orbits the nucleus as the Earth orbits the Sun forces us to consider other analogies between the two pictures. There can be no question that provided that

As regards infinity, it is necessary to realize that it is *terminal* in the sense that there is no surpassing it. That the total energy of the electron at infinite radius of revolution even as given by the Bohr theory is zero is an *absolute fact and not one of convention*. This is so because an infinite radius *must* be considered as a physical, though terminal reality beyond which there is no going, *even though* the theory does not place the proton at the center of the world. So, as a second requirement, when the zero of electron energy is placed, even by the Bohr theory, at infinite radius, no energies beyond zero are permissible because no radii are, nor indeed space is, permissible beyond a geometrical infinity.

Under both constraints, we must accept it as an inevitable logical and physical (i.e., *natural*, *not* of "physics") fact that the electron whether in the atom or in the free state has only positive energies despite all man-made conventions, and that its energy, when in the atom, decreases with an increase in its radius (of revolution as in the Bohr model, or as shall be developed below in this work). Only this conception is in total agreement with the constraints imposed upon all aspects of physical reality by the Universe as a whole.

In conclusion, suffice it to say that given the fact that the Universe is finite in size and shall so remain for all finite values of its age, and given the fact that all parts of it, the hydrogen atom included, cannot extend beyond the finite limits of the Universe, *if* the current theories were correct and ionization occurred at an infinite radius of revolution, *no ionization should ever have been observed or expected ever to be observed except at an infinite universal age*!!! It is obvious that current notions and theories have ignored the constraints imposed by the Universe to which all physical reality is subject.

an object moves sufficiently slowly towards the Sun on the plane of the ecliptic, it is going to be intercepted by the Earth. But if it moves towards the Sun on another plane, it *cannot* to be intercepted by the Earth. If the analogy held inside the hydrogen atom, a free electron moving in a plane other than the plane of the orbital electron generally should have little difficulty reaching the proton: The mutual repulsion of the two electrons and the attraction between the free electron and the proton should guide the two electrons along paths clear of each other. Specifically, a free electron moving along the axis of the orbital plane should have *no* difficulty at all reaching the proton, because its attraction to the proton would always be greater than its repulsion of the orbital electron. These phenomena are never observed. No matter where a free electron comes from, the orbital electron is always in the way! How this is managed in reality, the Bohr model *cannot* explain; and the quantum theory, under the protection of the uncertainty principle, *refuses* to explain; as also, how the fundamental uncertainty it propounds for the small produces the certainty we all observe and are absolutely dependent on in the large!

We must never lose sight of the hard facts: Nature does *not* operate by casting dice, she *obeys hard* Laws! Relative to the surrounding space and the distance between them, *both the nucleus and the electron resemble more mere points than not*. The physical (i.e., the *natural*) electron is one thing, the so-called "electronic cloud" is totally another, and a mere conception within the theory! Just as much as anyone of us can by himself make a crowd, so too an electron can by itself make a cloud! The "electronic clouds" the theory speaks of are nothing more *than the totality of the spots in space* where, according to the mathematics deployed, the theory *believes* the electron can *haphazardly* find itself in *consecutive* moments in time! How *exactly* that is accomplished? *Unknowable,* according to the theory, that regards the Nature it "studies" fundamentally unknowable exactly as a result of the Heisenberg principle the theory *chooses to believe* to be holding in Nature! So, the clouds are nothing more than the spots in space where the theory considers the electron to have a *numerically quantifiable* probability to find itself.

The statistical distribution of probabilities the wave-mechanical theory produces does *not* provide a *naturally satisfactory* resolution of the problem: Nature orders the electron to surround *completely* the nucleus. The theory *cannot* evade the fact that it regards the electron *always at a spot at a time*. and the *probability* cloud to be spherical about the nucleus, but then again *only for the so-called 1s state*! The 2s and 3s states are *not* uniform spheres but contain spherical areas (one and two such, respectively) where the probability to find the electron there is near if not a total zero! And as for the so-called p and d electronic states, the probability cloud breaks up in "nodes" outside which the nucleus remains *totally naked* against evaders, as has *never* been observed in Nature! Just as it always remains a fact that when the electron is orbiting the proton on a definite plane, its probability to be in another position and especially a position on another plane is in reality zero and a free electron should have no difficulty reaching the proton by way of an unobstructed path. The current corpuscular/wave-mechanical pic-

ture of the electron *simply cannot explain* how the electron, if it truly is a particle of very small size, can be everywhere around the proton at the same time, to intercept other electrons coming in from every direction. This should be *just as impossible* for the electron as the corresponding motion of the Earth around the Sun: There is no internally-produced (from causes within the Sun-Earth system) way permitting the Earth to intercept *every* traveler going to the Sun. To hide behind the purely mathematical wave-mechanical picture of a spherically distributed "something", is to render the notion of the "classical radius" mentioned earlier useless and to sever even whatever feeble connection believed existing with relativity and an objectively concrete entity that we may identify with the electron. Of course, Dirac has provided a relativistic Schrödinger equation, but this has not brought about a comprehension of the physical (i.e., *natural*) quantity that we call the electron.

A *satisfactory and deterministic physical explanation of the behavior of the electron must resolve all problems* already mentioned in this introduction and probably other ones as well. Such an explanation can be provided *entirely naturally* within the framework of the Newtonian Universe that we have already developed. As Dirac anticipated (loc. cit. p. 10), we must pay for it by abolishing some of our current ideas. To take them in some order then:

(a) We must give up the quantum-mechanical notion of the vacuum and the notion of negative energies: What exists in the Universe is *by definition positive* as it has been brought forth ἐκ τοῦ μὴ ὄντος εἰς τὸ εἶναι, ἐξ ἀνυπαρξίας εἰς ὕπαρξιν, out of nothing (zero) into being (positive). There is nothing in what we have already discussed in this work to suggest the existence of negative energies. There is nothing in the derivation of Eq. 102 suggesting anything more than has already there been stated and the only conclusion that Eq. 102 leads to is the impossibility of bringing mass m to velocity c by supplying energy $(\delta m)c^2$.

(b)The electron has a higher energy the smaller its radius (or even its radius of revolution) is. At $r = 0$, it has (had) indeed infinite energy, and at $r = \infty$ it has (will have) zero energy (see below).

(c) The state of $r = 0$ obtained only at $T= 0$.

(d) The state of $r = \infty$ will obtain only at $T = \infty$.

(e) The energy of the electron at any other time in between the two extremes of universal age is indeed

$$\epsilon_{e,r} - \epsilon_{e,o} = -e^2\int r^{-2}dr \text{ (integrated from } r_o \text{ to } r) \equiv e^2/r - e^2/0, \qquad (183)$$

where

$$\epsilon_{e,r} = -e^2\int r^{-2}dr \text{ (at } r) \equiv e^2/r \text{ and } \epsilon_{e,o} = -e^2\int r^{-2}dr \text{ (at } r_o = 0) = e^2/0 \equiv \infty,$$

as the electron too, has expanded with the Universe (direction of expansion being positive), against the field of gravitation (being negative, as only thus are the natural quantities kept positive as the Universe expands). In other words, the electron, along with the Universe of which it is a part, *loses* energy. Its initial energy $e^2/0$ is no longer with it, it has vanished! Now, while it has radius r, it only has energy e^2/r.

(f) The electron is a hollow spherical particle of size equal to that of the atom. When more electrons are present in the atom, *the size of the outermost electron necessarily determines the size of the atom*. Consecutive electrons arrange themselves as concentric spheres. The "shells" can only be the spaces between the walls of the hollow spheres, *each of which is being occupied by one electron only:* It is physically incompatible for two electrons with identical characteristics to be present in the same space (the Pauli exclusion principle modified). An atom is ionized when an electron is removed, namely, torn *apart and away* from this arrangement so that the nucleus is no longer at its center—and *not* when the electronic orbital radius is increased to infinity. The electron removed is the one brought first to possess an energy that can no longer be sustained within the atom: In such an array of electrons, it is natural to expect that the *innermost* electron (r being the smallest) be by necessity the one to be removed first*. How all these ideas do indeed fit together *in fact* and agree with experiment, and how they modify quantum theory will be the subject of this Part of the present work.

* The exact mechanism operating in the helium atom will be discussed in Section 3.3.

3.2

THE ELECTRON IN THE HYDROGEN ATOM

The notion of the electron as a finite hollow sphere advanced in (f) at the end of Section 3.1 was first suggested by Lorentz but was later abandoned. It did not seem to be possible for a sphere believed to be of $\sim 10^{-13}$ cm in diameter to surround the nucleus of about the same size and still explain the size of the atom, some one hundred thousand times larger. Moreover, with an electron of fixed size, there was no way to accommodate a picture of a multi-electron atom. On the other hand, our current idea of the electron as a satellite of the nucleus has studiously avoided statements as to the precise geometry of the electron, other than that it is, relatively, a very small (quasi-point) particle.

The idea of the electron (while it is still in the atom) as a hollow spherical particle of variable size introduced in Section 3.1 (f) totally dispenses with the limitations imposed by the very small size of the "classical radius". That radius is *not* the radius of the electron while it is in the hydrogen or any other atom. It must be seen as the smallest radius within which mass equal to m_e and charge $-e$ can be constrained when freed from the atom at the present age of the Universe. Thus the equation $e^2/r = m_e c^2$ is not in principle unique to the electron.

Quantum mechanics requires that the electron possess "spin". This "spin" however, is seen to persist regardless of orientation of its axis: no matter what arbitrary axis one chooses, the electron "spins: about *that* axis! The principle of conservation of the direction of angular momentum *simply cannot be reconciled* with an arbitrary choice of axis. The geometrical notion of spin cannot be admitted as identical to quantum-mechanical "spin", and we are obliged to give up the idea of a very small sphere "spinning" about an axis while orbiting about the proton. "Spin" must be an artifact. To the extent that real effects exist, so far attributed to "spin", they must be caused by some other *natural* mechanism.

These difficulties can be avoided, if the picture of the electron already advanced is completed with the statement that the electron in the hydrogen atom undisturbed by external influences behaves like an ideal spherically symmetrically vibrating ["breathing"???!!!; is even *our* breath of such *deep* origin???] spring.

The object of the present Section is to show that this picture of the electron is fully compatible with the spectrographic results, and that it permits a complete understanding of the electron as a physical entity, in full agreement with classical notions and the principle we have advanced that what is objectively there, by the power of its very objectivity, is picturable in the classical manner.

Using the one-dimensional analogue, we regard the elastic tension of the spring at any radius r to be

$$F = k\cdot|r - r_o|, \tag{184}$$

where k is the elastic constant and r_o is the average ("equilibrium") radius of the electron. At $r = r_o$, the elastic tension is zero, but the electron possesses maximum kinetic energy. At the extremes $r = r_{max}$ or r_{min}, the elastic tension is at its maximum, but the kinetic energy is zero. As a spring, *the electron must always be under this force alone*. However, the electron as a whole is also always under the attraction of the nucleus

$$F_c = -Ze^2/r^2. \tag{185}$$

For the electron to behave like a perfect spring at all times, it is necessary that

$$F + F_c + F_b = 0, \quad \text{so that} \quad -F = F_c + F_b, \tag{186}$$

where

$$F_b = -k\cdot|r - r_o| + Ze^2/r^2 \tag{187}$$

is the required balancing force. If F were suddenly eliminated but not also the –F, the spring would recoil under the influence of the latter and move toward the position r_o experiencing an acceleration, γ, such that

$$-F = m\gamma. \tag{188}$$

Since $dr = vdt$ and $dv = \gamma dt$, it follows that

$$-F = m_e vdv/dr = -k\cdot|r - r_o| \tag{188a}$$

and

$$m_e vdv = -k\cdot|r - r_o|dr. \tag{188b}$$

Upon integration between $r = r$ and $r = r_o$, to which there correspond, respectively, velocities $v = v$ and $v = v_o$, we obtain

$$m_e v^2 = m_e v_o^2 - k(r - r_o)^2.$$

Setting $(r_{max} - r_{min})/2 = \delta r/2$, the extreme positions are equal to

$$r_{max} = r_o(1 + \mu) \quad \text{and} \quad r_{min} = r_o(1 - \mu) \tag{189a, b}$$

where,

$$\mu = \delta r/2r_o. \quad \text{or} \quad \mu r_o. = \delta r/2 \tag{190a, b}$$

In the extreme positions, $v = 0$. The elastic constant is

$$k = m_e v_o^2(\delta r/2)^{-2} = m_e v_o^2(\mu r_o)^{-2}, \tag{191a, b}$$

so that

$$v = v_o\left[1 - (r - r_o)^2(\delta r/2)^{-2}\right]^{1/2} = v_o\left[1 - (r - r_o)^2(\mu r_o)^{-2}\right]^{1/2}. \tag{192a, b}$$

Consider now the energy change experienced by the electron falling from position $r_o(1 + \mu)$ to position $r_o(1 - \mu)$ in the field of the nucleus of charge Ze. This energy (of the *half* cycle) is given by

$$\begin{aligned}\delta E &= Ze(-e)\int r^{-2}dr \ [\text{integrated from } r_o(1+\mu) \text{ to } r_o(1-\mu)] \\ &= Ze^2 r_o^{-1}[(1-\mu)^{-1} - (1+\mu)^{-1}] = Ze^2 r_o^{-1}\cdot 2\mu(1-\mu^2)^{-1}.\end{aligned} \tag{193}$$

There is intuitive appeal to the notion that the total *quarter* cycle energy of the

electron (at $r = r_o$, that energy is purely kinetic, since the potential energy due to the elastic tension is zero there) is equal to one-half the energy given by Eq. 193. [In fact, one may say that the kinetic energy gained on moving from position $r_o(1 + \mu)$ to position r_o is equal to the potential energy released by falling to r_o. It is easily seen however that one-half of the energy (193) is not equal to the kinetic energy gained by the free-falling electron; so the analogy should not be pushed too far.] At this stage, the notion just expressed must be treated as a postulate. It cannot be proven to be correct a priori, but only from the results to which its adoption will lead. Accordingly, we *postulate* that the kinetic *quarter* cycle energy is

$$(1/2)m_e v_o^2 = (1/2)(\delta E), \tag{194}$$

leading to

$$(1/2)m_e v_o^2 = Ze^2 r_o^{-1}[2\mu/(1-\mu^2)]. \tag{194´}$$

The average velocity of the oscillating electron is given by

$$v_{ave} = [1/(\delta r)]\int v dr \ [\text{from } r_o(1+\mu) \text{ to } r_o(1-\mu)] \ . \tag{195}$$

Integration is simplified by changing variable. Setting

$$y = (r - r_o)(\delta r/2)^{-1}$$

results in

$$dr = (1/2)\delta r \cdot dy.$$

For $r_o(1 + \mu)$ we substitute $y = 1$, and for $r_o(1 - \mu)$ we substitute $y = -1$. It follows that

$$v_{ave} = (1/4)v_o\left[y(1-y^2)^{1/2} + \arcsin y\right]\Big|_1^{-1} = (1/4)v_o\left[\arcsin(-1) - \arcsin(1)\right]$$

The general solution requires that

$$\arcsin(1) = (\pi/2) + 2n_1\pi = (4n_1\pi + 1)\pi/2,$$
$$\arcsin(-1) = (3\pi/2) + 2n_2\pi = (4n_2\pi + 3)\pi/2,$$

so that

$$\arcsin(-1) - \arcsin(1) = \left[2(n_2 - n_1) + 1\right]\pi.$$

For an always positive or zero result it is necessary that

$$2(n_2 - n_1) + 1 \geq 0, \quad \text{or} \quad n = (n_2 - n_1) \geq -(1/2).$$

Since both n_1 and n_2 are whole numbers, the solutions permitted are

$$n = 0, 1, 2, 3, \ldots \quad \text{or} \quad \pi, 3\pi, 5\pi, 7\pi, \ldots .$$

On the other hand, if

$$\arcsin(-1) = (\pi/2) + 2n_2\pi = (4n_2\pi + 1)\pi/2,$$
$$\arcsin(-1) - \arcsin(1) = \left[2(n_2 - n_1) - 1\right]\pi,$$

and for an always positive or zero result, it is necessary that

$$2(n_2 - n_1) - 1 \geq 0, \quad \text{or} \quad n = (n_2 - n_1) \geq (1/2),$$

which leads to

$$n = 1, 2, 3, \ldots \quad \text{or} \quad \pi, 3\pi, 5\pi, 7\pi, \ldots .$$

Thus the general solution is

$$\arcsin(-1) - \arcsin(1) = (2n + 1)\pi, \quad n = 0, 1, 2, 3, \ldots .$$

It follows that

$$v_{ave} = (2n + 1)\pi v_o/4.$$

Now, since $0 \leq v_{ave}/v_o < 1$, it follows that

$$0 \leq (2n + 1)\pi/4 < 1 \quad \text{and} \quad -(1/2) \leq n < (1/2)(4/\pi - 1).$$

The single whole number satisfying these inequalities is $n = 0$, so that

$$v_{ave} = \pi v_o/4. \tag{195´}$$

The time required for the electron to get from radius $(r_o + \delta r/2)$ to radius $(r_o - \delta r/2)$ thus is

$$\delta t = \delta r/v_{ave} = (4/\pi)(r/v_o) = (4/\pi)(2\mu r_o/v_o) = (8\mu r_o)/\pi v_o . \tag{196}$$

Now, we note that between radii $(r_o + \delta r/2)$ and $(r_o - \delta r/2)$, there is a change in the polar moment of inertia given by

$$|\delta I| = m_e [(r_o + \delta r/2)^2 - (r_o - \delta r/2)^2] = 2 m_e r_o(\delta r) = 4\mu m_e r_o^2. \tag{197}$$

We also note that *the rate of change of moment of inertia, namely, the quantity* $|\delta I|/\delta t$ *has the dimensions of action,* and in the present case the value

$$|\delta I|/\delta t = (1/2)\pi m_e v_o r_o.. \tag{197a}$$

We also note that the product (energy) × (time) also has dimensions of action. In the present case the pertinent product is

$$(\delta E)(\delta t) = m_e v_o^2(8\mu r_o/\pi v_o) = (8\mu/\pi)m_e v_o r_o . \tag{198}$$

In light of the discussion in Section 3.5, we are fully justified in writing

$$I_o \cdot |\delta I|/\delta t = (\delta E)(\delta t) = nh, \tag{199}$$

where n is necessarily a whole number* and I_o a dimensionless constant the value of which remains to be determined. Introducing the values from Eqs. 190, 193, 194, 194´, 196, 197a and 198, we find

$$I_o \cdot (\pi/2)m_e v_o r_o = (8\mu/\pi)m_e v_o r_o = (Ze^2/\pi v_o)(16/2)[\mu^2/(1 - \mu^2)] = nh \tag{200}$$

leading at once to

$$\mu = (\delta r/2r_o) = (\pi^2/16)I_o . \tag{201}$$

* Actually, this is a conclusion based on comparison with the experimentally derived Eq. 182. Originally, n in Eq. 199 is a mere numerical factor, the value of which remains to be determined. (See also page 195).

It is physically necessary that

$$r_o - \delta r/2 \geq 0 \quad = \quad r_o(1 - \delta r/2r_o) \geq 0,$$

namely that

$$0 < \mu \leq 1. \tag{202}$$

From Eqs. 200 we find

$$I_o(\pi/2)m_e v_o^2 r_o = \pi Ze^2\left[(16/\pi^2)\mu^2/(1-\mu^2)\right],$$

$$I_o(\pi/2)m_e v_o r_o = nh,$$

so that

$$v_o = (2\pi Ze^2/nh)(1/2)\left[(16/\pi^2)\mu^2/(1-\mu^2)\right], \tag{203}$$

$$r_o = \left[(nh)^2/(4\pi^2 m_e Ze^2)\right](\pi^2/2\mu)\left[(16/\pi^2)\mu^2/(1-\mu^2)\right]^{-1}, \tag{204}$$

The quantity $(^1/2)m_e v_o^2$ is the energy change associated with a one-quarter cycle. The energy change associated with a half-cycle for which Eq. 199 was written is twice that, or

$$E = m_e v_o^2 = \left[(2\pi^2 m_e Z^2 e^4)/(nh)^2\right](1/2)\left[(16/\pi^2)\mu^2/(1-\mu^2)\right]^2, \tag{205}$$

which is constant while the electron retains the mode of oscillation just described, namely, while it retains a constant r_o, to which there correspond a constant v_o and a constant n. Consider now a change in oscillation, involving a change in r_o. The velocity v_o also changes and so does n and the energy of the electron, so that

$$\delta E = \left[(2\pi^2 m_e Z^2 e^4)/h^2\right](1/2)\left[(16/\pi^2)\mu^2/(1-\mu^2)\right]^2(n_1^{-2} - n_2^{-2}) . \tag{206}$$

The wave number of the associated radiation is

$$\nu_\omega = \delta E/ch = \left[(2\pi^2 m_e Z^2 e^4)/(ch^3)\right](1/2)\left[(16/\pi^2)\mu^2/(1-\mu^2)\right]^2 (n_1^{-2} - n_2^{-2}), \tag{207}$$

which is identical to Eq. 182. However, since only the quantity

$$R_\infty^* = (2\pi^2 m_e Z^2 e^4)/(ch^3) \tag{208}$$

for Z = 1, is the Rydberg constant in the spectroscopically derived expression, it follows that

$$\xi^2 \equiv (1/2)\left[(16/\pi^2)\mu^2/(1-\mu^2)\right]^2 \equiv 1. \tag{209}$$

This gives the value

$$\mu = \left[2^{1/2}\pi^2/(16 + 2^{1/2}\pi^2)\right]^{1/2} = 0.6825790146, \tag{210}$$

which satisfies the constraint (202) and permits the value of I_o to be obtained from Eq. 201 as

$$I_o = 16\mu/\pi^2 = 1.106555419. \tag{211}$$

Thus this model of the electron is in full accord with the spectroscopic data.

* On the basis of the present model, it is no longer necessary to continue using the subscript. We shall do so, however, only to avoid possible confusion.

It only assumes that the energy of the oscillating electron is given by Eq. 194, while its action, given by Eq. 199, comes in exact (see, however, footnote on p. 180) multiples of h and is equal to I_o times the rate of change of the polar moment of inertia. For the price of these two assumptions, all shortcomings associated with the Bohr model are avoided altogether. Most important of all, a classical and fully determinate picture of the electron is obtained, namely,

(1) The electron is a thin-walled hollow sphere. In an unperturbed system, this sphere is centered on the nucleus and oscillates between the extreme values

$$r_o(1 + \mu) \text{ and } r_o(1 - \mu), \text{ where } \mu = 0.682579\ldots .$$

(2) The maximum velocity of oscillation is

$$v_o = [(2\pi Ze^2)/(nh)]_B \cdot (^{-1/2}) = v_B \times (2^{-1/2})(Z/n).$$

(3) The average radius of the electron is

$$r_o = [(nh)^2/(4\pi^2 m_e Ze^2)]_B \cdot (2^{-3/2}\pi^2/\mu) = r_B \times (n^2/Z)(2^{-3/2}\pi^2/\mu).$$

(4) The period of oscillation of the electron is

$$2\delta t = 2\delta r/v_{ave} = (16\mu/\pi)(r_o/v_o) = [(nh)^3/(8\pi^3 m_e Z^2 e^4)]_B \times (8\pi)$$
$$= \tau_B \times 8\pi(n^3/Z^2).$$

(5) The frequency of oscillation is the inverse of (4).

(6) The energy of the electron in a "stationary" state is given by

$$E = m_e v_o^2 = (2\pi^2 m_e Z^2 e^4)/(nh)^2, \qquad (206')$$

which, except for the sign, is identical to that obtained from the Bohr model. No energy is exchanged while the electron remains in the stationary state n.

(7) The wave number associated with an exchange of energy is given by

$$n_w = [(2\pi^2 m_e Z^2 e^4)/(ch^3)](n_1^{-2} - n_2^{-2}), \qquad (207')$$

and the frequency of the emitted or absorbed radiation is now as closely related to the two associated *vibrating* states as it is possible at all to conceive, which is something that the Bohr theory never succeeded in obtaining. The spherical symmetry of the field around the atom follows naturally out of the present model; it could *not* be explained on the basis of the Bohr model.

The above expressions as written give directly the conversion factors relating the present and the Bohr models of the electron, except in the case of the period and the frequency, where the ratio r_o/v_o is used in the Bohr model. [In fact, the Bohr model suggests *two* internal frequencies associated with a stationary state: $(2\pi r/v)^{-1}$ and $(2\pi r/nv)^{-1}$].

For n = 1 and Z = 1 the values (and the Bohr values shown as x_B) are as shown in the list at the top of the next page, where it is clearly seen that ionization obtains at a radius just short of the so-called ground state. This state, therefore, is *not* the state of the lowest energy as per the Bohr model, but rather the state of

$r_o = 5.112\, r_B$	$= 2.704$ Å
r_{max}	$= 4.550$ Å
r_{min}	$= 0.858$ Å
$v_o = 0.707\, v_B$	$= 1.547 \times 10^8$ cm/sec
	$= 5.160 \times 10^{-3}\, c$
$2\delta t$	$= 6.0794 \times 10^{-16}$ sec
f	$= 1.6449 \times 10^{15}$ sec^{-1}
$E = 2.1799 \times 10^{-11}$ erg	$= 13.606$ e.v.

maximum energy, just before the electron is liberated from the radial attraction of the nucleus. The vibration of the electron, in addition to an external perturbation that causes the electron to cease being centered around the nucleus, must be instrumental in the ionization thus set about. When set free, the electron *is in effect emptied* of the positive nucleus it contained while in the atom. Ionization can, however, be prevented, if the energy is supplied spherically symmetrically and the electron is not allowed to leave, in which case the radius of the electron must keep on decreasing until it reaches the proton and forms a neutron, in full accord with the arguments presented earlier (Section 3.1). The present model of the electron allows us to see the classical radius of the electron and the spontaneous disintegration of the neutron in a totally new light as two *related* concepts. The energy of the "electron" while in the neutron and its vibration frequency are so high that they cannot be sustained by the neutron in the free state: The electron overcomes *spontaneously* the attraction of the proton. The quotation marks in "electron" used just above are only meant to indicate our current ignorance of the internal structure of the neutron.

3.2.1

REFINEMENT OF THE MODEL OF THE ELECTRON

The value of I_o, being non-unity, is certainly arbitrary and inexplicable, if the electron is truly a hollow sphere of negligible wall thickness, in which case, I_o should have the value of unity. The non-unity value, therefore, suggests very strongly a finite wall thickness. The problem must thus be reworked. A refined model must also allow for the variation of mass with velocity. This is necessary if a complete picture of the electron is to be obtained, specifically when the electron is accelerated to very high velocities of oscillation, yet, is prevented from flying off but is sent to "crash" onto the proton to form a neutron. Here we shall not use the Einstein relationship. That relationship was found to be only one out of four possible mass-velocity relationships, as discussed in Section 2.3.2.7. Instead, and in agreement with arguments made there, we shall use Eq. 101. In the

case of the electron, that equation takes the form

$$m_e v^2 = (m_{e,o} + \delta m)v^2 = (\delta m)c^2. \tag{212}$$

Accordingly,

$$(\delta m) = m_{e,o}\cdot\beta^2(1-\beta^2)^{-1} \tag{213}$$

and

$$m_e = m_{e,o}\cdot(1-\beta^2)^{-1}, \tag{214}$$

where $\beta = v/c$. We will use this value of m_e in Eq. 188a. The quantity vdv must now be replaced by its proper equivalent $(1/2)c^2d(\beta^2)$ and the equation of spring tension becomes:

$$-F = (1/2)m_{e\,o}c^2(1-\beta^2)^{-1}d(\beta^2) = -k(r-r_o)dr. \tag{215}$$

Upon integration between $r = r$ and $r = r_o$, to which there correspond respectively values $\beta = \beta$ and $\beta = \beta_o$, we obtain

$$m_{e,o}c^2[\ln(1-\beta_o^2) - \ln(1-\beta^2)] = k(r-r_o)^2.$$

At the extreme positions $r = r_o \pm \delta r/2$, the velocity is zero: $\beta = 0$, so that

$$k = m_{e\,o}c^2[\ln(1-\beta_o^2)]/(\delta r/2)^2 \tag{216}$$

and the value of β in position r is given by

$$\ln(1-\beta^2) = [1-(r-r_o)^2/(\delta r/2)^2]\cdot\ln(1-\beta_o^2).$$

For $0 < x << 1$, one develops the series

$$\ln(1-x) = -x + x^2/2 - x^3/3 + x^4/4 - \ldots .$$

which for $x = \beta^2, \beta_o^2$ and to a second approximation permits writing

$$(-\beta^2 + \beta^4/2) = (-\beta_o^2 + \beta_o^4/2)\cdot[1 - (r-r_o)^2/(\delta r/2)^2]$$

Solving for β^2, one finds

$$\begin{aligned}\beta^2 &= 1 - \{1 + (-2\beta_o^2 + \beta_o^4)[1 - (r-r_o)^2/(\delta r/2)^2]\}^{1/2}\\ &\cong \beta_o^2(1-\beta_o^2/2)[1 - (r-r_o)^2/(\delta r/2)^2]\end{aligned}$$

$$\begin{aligned}\beta &\cong \beta_o(1-\beta_o^2/2)^{1/2}[1 - (r-r_o)^2/(\delta r/2)^2]^{1/2}\\ &\cong \beta_o(1-\beta_o^2/4)[1 - (r-r_o)^2/(\delta r/2)^2]^{1/2}\end{aligned}$$

so that to a second-order approximation,

$$v = v_o(1-\beta_o^2/4)[1 - (r-r_o)^2/(\delta r/2)^2]^{1/2}. \tag{217}$$

Eq. 195 now reads

$$\begin{aligned}v_{ave} &= (1/\delta r)\int v\,dr \quad [\text{integration from } r_o(1+\mu) \text{ to } r_o(1-\mu)]\\ &= [v_o(1-\beta_o^2/4)/\delta r]\int(1-y^2)^{1/2}\,dy \quad [\text{integrated from 1 to } -1]\end{aligned} \tag{195´´}$$

where y is given as before. Following the same arguments as before, we now find

$$v_{ave} = (\pi/4)(1 - \beta_o^2/4)v_o, \tag{218}$$

so that the time required for the electron to go from radius $(r_o + \delta r/2)$ to radius $(r_o - \delta r/2)$, namely, its half-period of oscillation is now given by

$$\delta t = \delta r/v_{ave} = 8\mu r_o/[\pi v_o(1 - \beta_o^2/4)]. \tag{219}$$

Eq. 194´ is now replaced by

$$m_e v_o^2 = m_{e,o} v_o^2/(1 - \beta_o^2) = Ze^2 r_o^{-1} [2\mu/(1 - \mu^2)] \tag{220}$$

and the product $(\delta E) \times (\delta t)$ becomes

$$\begin{aligned}(\delta E)(\delta t) &= 8\mu[\pi(1 - \beta_o^2)(1 - \beta_o^2/4)]^{-1} m_{e,o} v_o r_o \\ &= \pi Ze^2 v_o^{-1} [(16/\pi^2)\mu^2/(1 - \mu^2)](1 - \beta_o^2/4)^{-1}\end{aligned} \tag{221}$$

The polar moment of inertia of a hollow sphere of finite wall thickness $(\delta r)_w$ and uniform wall mass density δ is given by

$$\begin{aligned}I &= \int r^2 dm = \int r^2 4\pi(\delta) r^2 dr \quad \text{[integrated from } r_{out} \text{ to } r_{in}\text{]} \\ &= (4/5)\pi r^2(\delta)\cdot[(1 + \rho^5) - (1 - \rho^5)],\end{aligned} \tag{222}$$

where r is the average wall radius at any one time, $r(1 + \rho) = r_{out}$ the outer wall surface radius, $r(1 - \rho) = r_{in}$ the inner wall surface radius and

$$\rho = (\delta r)_w/2r^{-1} = (1/2)(r_{out} - r_{in})/(1/2)(r_{out} + r_{in}) = (\delta r)_w/2r, \tag{223}$$

$$0 < \rho \leq 1, \tag{224}$$

the lower limit being set for $r_{in} = r_{out}$ and the upper for $r_{in} = 0$. The mass of the wall is given by

$$m = (4/3)\pi r^3\cdot(\delta)\cdot[(1 + \rho^3) - (1 - \rho^3)] \tag{225}$$

so that,

$$I = (3/5)mr^2\cdot[(1 + \rho^5) - (1 - \rho^5)][(1 + \rho^3) - (1 - \rho^3)]^{-1}. \tag{226}$$

In the position of maximum expansion, the average wall radius is given by $r_1 = r_o(1 + \mu)$; and in the position of maximum contraction by $r_2 = r_o(1 - \mu)$, where $\mu = (\delta r)_n/2r_o$ and $\delta r = r_1 - r_2$, r_o being the average-over time radius of the electron while in the "stationary" state n.

Assuming that ρ remains constant, the absolute change of the moment of inertia between the two extreme positions thus is

$$\begin{aligned}\delta I &= (3/5)\, mr_o^2[(1 + \mu)^2 - (1 - \mu)^2][(1 + \rho^5) - (1 - \rho^5)][(1 + \rho^3) - (1 - \rho^3)]^{-1} \\ &= 4\mu I_o\, mr_o^2\end{aligned} \tag{227}$$

where,

$$I_o = [(1 + \rho^5) - (1 - \rho^5)][(1 + \rho^3) - (1 - \rho^3)]^{-1}. \tag{228}$$

In view of Eq. 224, the corresponding limits for I_o are

$$1 < I_o \leq 2.4. \tag{229}$$

For the electron constantly in state n, it is necessary to assume that its mass remains constant at $m_e = m_{e,o}\cdot(1 - \beta^2)^{-1}$, so that the average rate of change of its moment of inertia over the half-cycle, from position $r_o(1 + \mu)$ to position $r_o(1 - \mu)$, be

$$|\delta I|/\delta t = (\pi/2)(1 - \beta_o^2/4)(1 - \beta_o^2)^{-1} I_o m_{e,o} v_o r_o.. \tag{230}$$

Instead of Eq. 199, we now write:

$$|\delta I|/\delta t = (\delta E)(\delta t) = nh, \tag{231}$$

and introducing Eqs. 221 and 230:

$$\begin{aligned} |\delta I|/\delta t = nh &= (\pi/2)(1 - \beta_o^2/4)(1 - \beta_o^2)^{-1} I_o m_{e,o} v_o r_o \\ &= 8\mu\left[\pi(1 - \beta_o^2)(1 - \beta_o^2/4)\right]^{-1} m_{e,o} v_o r_o \\ &= \pi Z e^2 v_o^{-1} \left[(16/\pi^2)\mu^2/(1 - \mu^2)\right](1 - \beta_o^2/4)^{-1} \end{aligned}$$

from which we obtain

$$\mu = (\pi^2/16)(1 - \beta_o^2/4)^2 I_o \quad \text{or} \quad I_o = 16\mu\left[(\pi^2)(1 - \beta_o^2/4)^2\right]^{-1}, \tag{232a, b}$$

$$v_o = \beta_o c = (2\pi e^2/h)(Z/n)(1/2)\left[(16/\pi^2)\mu^2(1 - \mu^2)^{-1}\right](1 - \beta_o^2/4)^{-1}, \tag{233}$$

$$r_o = (h^2/4\pi^2 m_{e,o} e^2)(n^2/Z)(\pi^2/2\mu)\left[(16/\pi^2)\mu^2(1 - \mu^2)^{-1}\right]^{-1}(1 - \beta_o^2/4)^2(1 - \beta_o^2), \tag{234}$$

$$E = (2\pi^2 m_{e,o} e^4/h^2)(Z/n)^2(1/2)\left[(16/\pi^2)\mu^2(1 - \mu^2)^{-1}\right]^2(1 - \beta_o^2/4)^{-2}(1 - \beta_o^2)^{-1}, \tag{235}$$

which characterize the electron in the "stationary" state n. For an electron of infinitely thin wall ($I_o = 1$) and zero velocity ($\beta_o = 0$), Eq. (232a) gives

$$\mu = \pi^2/16 = 0.6168502751.$$

For a finite wall thickness, μ increases and for increasing velocities it decreases. Using the values $m_{e,o} = 9.1095 \times 10^{-28}$ grams, $e = 4.8032448 \times 10^{-10}$ cgs, $c = 2.99792458 \times 10^{10}$ cm/sec, $h = 6.6262 \times 10^{-27}$ ergsec, one finds the values of R_∞ and of the fine structure constant, given respectively by

$$R_\infty = 109{,}735.9286 \text{ waves/cm}. \tag{236}$$

$$\alpha = 2\pi e^2/ch = 7.2973313 \times 10^{-3}. \tag{237}$$

The current estimate of the value of the Rydberg constant for the hydrogen atom ^1H (109,677.58 waves/cm) based on Eq. 182, differs from the value just given. So far, the differences observed have been attributed to the "reduced" mass arising from the realization that the electron according to a more refined Bohr model does not revolve around the proton, but rather around the center of mass of proton and electron. In the present model, in no way can such a notion of reduced mass be introduced. A free and unperturbed hydrogen atom will always vibrate with the electron centered around the proton. Differences between observed and

theoretical values of R_∞ must be accounted for solely on the basis of Eq. 235. (In perturbed atoms, the electron will not be so centered and the notion of "reduced" mass, though differently defined now, may be re-introduced. Its effect will, however, be totally transitory as the electron gets variously perturbed, and it must be treated only as a component of "noise").

The "rest" mass $m_{e,o}$ of the electron used in the present model is the mass of a perfectly restful, non-vibrating, electron. For such an electron, v_o is zero and so is E. The non-zero value of E given by Eq. 235 must thus be attributed solely to the absorption of photons of total mass (δm) such that

$$E = 2\pi^2 m_{e,o} e^4 (Z/nh)^2 \xi^2 \equiv (\delta m)c^2 = (m - m_{e,o})c^2 = m_{e,o} (\beta_o^2/(1 - \beta_o^2)c^2, \quad (238)$$

where m is the mass of the electron of energy E, and ξ^2 is given by (cf. Eq. 235)

$$\begin{aligned} \xi^2 &= (1/2) \left[16\mu^2/\pi^2(1 - \mu^2)\right]^2 (1 - \beta_o^2/4)^{-2} (1 - \beta_o^2)^{-1} \\ &\cong (1/2) \left[16\mu^2/\pi^2(1 - \mu^2)\right]^2 (1 - 3\beta_o^2/2)^{-1}. \end{aligned} \quad (239)$$

Accordingly, the correct terms associated with the various states of the electron are given by

$$R_n = R_\infty \cdot (Z/n)^2 \xi_n^2 \quad (240)$$

and the wavelength associated with the transition between states m and n is

$$\lambda = \left| R_m - R_n \right|^{-1}. \quad (241)$$

For the n = 1 state of the hydrogen atom, one writes

$$R_H = R_\infty \xi_1^2, \quad (242)$$

where $R_H = 109678.758\ cm^{-1}$, and for the n = 2, 3, ... states, using the Lyman series wavelengths

$$\lambda_n = \left[R_\infty (\xi_1^2 - \xi_n^2 n^{-2})\right]^{-1}. \quad (243)$$

The value of ξ_n^2 is thus obtained from

$$\xi_n^2 = n^2(\xi_1^2 - 1/\lambda_1 R_\infty) . \quad (244)$$

The values thus calculated using the wavelength tabulation of Stringanov and Sventinskii ("*Tables of Spectral Lines of Neulral and Ionized Aloms*", IFI/Plenum, Washington, 1968) are tabulated in Table 5, Column 2. It is obvious from an examination of values in that Column that the values of ξ^2 decrease with increasing n, but the correlation coefficient is a poor 0.56. By eliminating the data marked with an asterisk as being abnormally high relative to their immediate neighbors, a better fit is obtained having an improved correlation coefficient of 0.928 and a slightly increased slope. The recalculated values of ξ^2 are shown in Table 5, Column 3.

Calculated (on the basis of Eq. 241) and observed wavelengths are compared in Table 6. There is no question that the present model fully accounts for the observed data, without calling for the notion of reduced mass as does the Bohr model. The values of ξ^2 in Table 5 were obtained from the Lyman series

wavelengths. A much better approach is to apply a linear, or monotonic curvilinear, least squares normalization using the entire spectrum, since at present it cannot be decided whether the dependence of ξ^2 on n should be linear or monotonic curvilinear. The values of ξ^2 calculated in this fashion can then be used to reproduce the entire spectrum and to compare the various deviations from the observed data. This will not be undertaken here. To be most profitable, such an attempt must use improved values for R_∞ and R_H (specifically bearing in mind that the notion of reduced mass is no longer the only reasonable option, and in fact it must be rejected as it implies all the shortcomings of the Bohr model), as well as improved wavelengths. The model will need improvement only in case systematic deviations are found after such normalization.

It should be noted that selecting an $R_{o,H} = 109708.4791\ cm^{-1}$, essentially wipes out the difference between measured and calculated wavelengths for the (4,5) transition (40511.4Å) and reduces the difference between measured and calculated wavelength for the (3,4) transition (18751.1Å) to 0.1Å, from about 11Å and 5Å respectively. There can therefore be no doubt whatever that the least squares normalization scheme described above is fully capable of producing an R_H value compatible with the entire spectrum. Provisionally, one may use the R_H value given above, which of course suggests that the reduced mass notion arising from the Bohr model is no longer required for the explanation of the spectrum. The ratio $\xi^2 = R_{o,H}/R_\infty = 0.9997498586$ can be used in the calculation of the values of the various parameters of the electron. Using Eq. 238, one finds

$$\xi^2 = (1/2)(2n/\alpha Z)^2 [\beta^2/(1-\beta^2)] \tag{245}$$

$$\beta_o = [(1/2)\alpha^2(Z/n)^2\xi^2]^{1/2} [1 + (1/2)\alpha^2(Z/n)^2\xi^2]^{-1/2}, \tag{245a}$$

and using Eq. 239, that

$$\mu = \left[[(2^{1/2}\pi^2)/16]\xi((1-3\beta_o^2/4)\right]^{1/2} \left[1 + [(2^{1/2}\pi^2)/16]\xi(1-3\beta_o^2/4)\right]^{-1/2}. \tag{246}$$

Using the value of ξ^2 given above and n = 1, one finds:

$$\begin{aligned} \beta_o &= 5.1592784 \times 10^{-3} \\ \mu &= 0.6825525748 \\ I_o &= 1.106527284 \\ (2\delta t) = 8\pi\xi^{-2}\tau_B &= 6.082439 \times 10^{-16}\ \text{sec} \\ f &= 1.6444942 \times 10^{15}\ \text{sec}^{-1}. \end{aligned}$$

The non-unity value of I_o allows the determination of the wall thickness of the sphere comprising the electron. Using Eq. 228, one finds

$$\rho^4 + [10 - (5/3)I_o]\rho^2 - 5(I_o - 1) = 0, \tag{228´}$$

yielding the value

$$\rho = 0.2545447679.$$

One notes that the volume ratio

$$R_{v,\rho} = (V_{max} - V_{min})/V_o = (1+\rho)^3 - (1-\rho)^3, \tag{247}$$

TABLE 5
VALUES OF FOR THE LYMAN SERIES OF THE HYDROGEN ATOM

State number, n	ξ^2	ξ^2 Adjusted
1	0.999 739 4712	0.999 744 9742
2	737 6987	741 6335
3	736 4502	738 2928
4	738 3185	734 9521
5	735 5545	731 6115
6*	745 4432	728 2608
7	728 0287	724 9301
8*	744 3443	721 5894
9	717 9250	718 2488
10	728 1998	714 9081
11	705 2722	711 5674
12	702 3485	708 2267
3*	768 5605	704 8861
14	714 2590	701 5454
5*	750 9474	698 2047
16*	728 0674	694 8640
17	678 3081	691 5233
18	768 7123	688 1827
19	694 8917	684 8420
Average:	0.999 724 9895	
Slope:	–0.000 002 3937	–0.000 0033407
Correlation Coefficient:	0. 5595	0. 9281

TABLE 6
PREDICTED AND OBSERVED WAVELENGTHS, Å

1	2	3	4	5	6
Transition	From Table 5 Column 2	From Table 5 Column 3	Using R_H and Bohr Equation	Observed	% difference between Columns 3 and 5
(2,3)	6564.636	6564.562	6564.626	6562.849	0.026
(2,4)	4862.705	4862.643	4862.686	4861.332	0.027
(3,4)	18756.277	18755.957	18756.074	18751.1	0.026
(4,5)	40522.076	40522.266	40522.381	40511.4	0.027
(4,7)	21660.888	21661.040	21661.055	21655.2	0.027

where V_{max}, V_{min} and V_o are respectively the volumes of spheres of radii $r_o(1 + \rho)$, $r_o(1 - \rho)$ and r_o, assumes the value

$$\begin{aligned} R_{v,\rho} &= 1.560254066 \\ &= 0.4966442941\pi, \end{aligned}$$

which is only 0.671% less than $\pi/2$. The corresponding difference

$$R_{v,\mu} = (1 + \mu)^3 - (1 - \mu)^3 \tag{248}$$

for the spheres of respective radii $r_o(1 + \mu)$, $r_o(1 - \mu)$ and r_o, assumes the value of

$$\begin{aligned} R_{v,\rho} &= 4.731287929 \\ &= 1.506015722\pi, \end{aligned}$$

which is only 0.401% more than $3\pi/2$. So, these values of $R_{v,\rho}$ and $R_{v,\mu}$ *cannot* be coincidental [the sum of $R_{v,\rho}$ and $R_{v,\rho}$ is 2.00266π!] and an improved model or better constants might be possible to conceive that would yield the exact $\pi/2$ and $3\pi/2$ values for the above volume ratios in all cases. This would mean that μ and ρ are in fact constant. In designing such an improved model, cognizance must be given to the fact that in a perturbed atom, the proton is in general not located at the center of the electron. This, naturally, affects the values of I_o and E, the latter through ξ^2. Such an effect is, of course, already present in the experimentally determined wavelengths and must account for part of the difference between measured and calculated wavelengths shown in Table 6. No such correction (for, the equivalent effect is, of course, present there also) has to date been considered for the Bohr model.

Using the above parameters, one finds the values of the various radii: r_o (overall average), $r_o(1 + \mu)$ (maximum expansion average), $r_o(1 - \mu)$ (maximum contraction average), $r_o(1 + \mu)(1 + \rho)$ (outer wall radius at maximum expansion) and $r_o(1 - \mu)(1 - \rho)$ (inner wall radius at maximum contraction):

$$\begin{aligned} r_o &= 2.7061 \text{ Å} \\ r_o(1 + \mu) &= 4.5532 \text{ Å} \\ r_o(1 - \mu) &= 0.8590 \text{ Å} \\ r_o(1 + \mu)(1 + \rho) &= 5.7121 \text{ Å} \\ r_o(1 - \mu)(1 - \rho) &= 0.6404 \text{ Å}. \end{aligned}$$

At its average radius, the volume of the wall is about 1.29510^{-22} cm^3 and the mass density about 7.036×10^{-6} grams/cm^3, which is about 180 times lighter than air and 13 times lighter than hydrogen gas.

Heavier Ionized Atoms

The corresponding data for the last remaining electron in helium, lithium, and beryllium (assuming for simplicity their ξ-s to be equal to unity) are shown on the next page for the n = 1 states. The data show very clearly the decrease of radius and the increase of velocity and frequency of vibration of the electron with increasing atom number Z. They also show, however, the slow change in the values of the quantities μ, ρ, and I_o; thus it is not unlikely that these three parameters may be found to be constant within a fully developed model.

		Helium	Lithium	Beryllium
r_o	Å	1.3526	0.9017	0.6762
$r_o(1+\mu)$	Å	2.2758	1.5171	1.1377
$r_o(1-\mu)$	Å	0.4293	0.2862	0.2147
$r_o(1+\mu)(1+\rho)$	Å	2.8554	1.9038	1.4280
$r_o(1-\mu)(1-\rho)$	Å	0.3200	0.2133	0.1599
β		1.03194×10^{-2}	$1\ 54781 \times 10^{-2}$	2.06356×10^{-2}
μ		0.6825693086	0.6825571773	0.6825401961
I_o		1.1066557533	1.106785173	1.106963864
ρ		0.2547024535	0.2548568903	0.2550729473
$(2\delta t)^{-1}$	sec^{-1}	6.5796×10^{15}	1.4804×10^{16}	2.6318×10^{16}.

The picture of the electron in hydrogen-like atoms obtained here satisfies fully the spectroscopic data, yet, has none of the drawbacks of the Bohr model. Very much more important, however, is the fact that the present model *does not demand that we renounce* our desire to know in precise classical terms exactly what the electron is, at least as a whole. Modeling the electron as a perfect spherically oscillating spring allows us complete knowledge of its position and motion at any moment in entirely the same sense that an ordinary spring permits us to calculate its whereabouts. Our inability to pinpoint, say, the exact moment of r_o (which, in light of the present model of the electron, remains the only reason that prevents us from making a statement such as: "at the exact moment T, the electron has the exact radius r_T") is *not due to a defect of Nature,* in the sense that its ordinary Laws break down, but rather to the *fact* that it imposes a constraint in that it does not provide us [yet?] with a sensitive or fast enough probe, such as would allow us to pinpoint the moment of r_o. Our failure so far to realize this distinction, and the excellent reason for the existence of this constraint (of which, later) which is anything but whimsical, capricious or malicious, has prevented us from seeking possible ways to deepen our understanding despite the existence of this constraint.

It is very likely that this vibratory characteristic is not unique to the electron, but a quite general one common to all very small systems, including the photon. Yet, when two such systems, (say, two hydrogen atoms, as we now are certain) bounce off each other, their whereabouts immediately following bouncing (that result therefrom) are precisely calculable on the basis of the same classical laws we are familiar with in ordinary systems: Consider a table of billiards*. The game is possible to play because the radius of the balls and the periphery of the table are fixed during the time interval required for the particular strike to be completed and all balls to come again to rest. Imagine now that the balls vibrate *but slowly* and the periphery of the table flexes *also slowly* relative to the same time interval. The game is now certainly more complicated, but still, it *is not in principle impossible to play,* specifically if one is fast enough! The player has to allow for the vibrations and their velocities, which will impart additional components to the motions of the balls on top of those ordinarily consid-

* See also Addendum IV.

ered. As the vibrations become faster, so does the game become more difficult to play. *Yet, there is nothing at all in the picture to suggest that the classical laws have met their end.* The electron in the hydrogen atom at least, as the present model now shows, is fully analogous to such billiard balls and thus basically no different from any other classical mechanical system.

The only deviation from classical mechanics is in the introduction of the quantum effect, which enters the picture by assigning only whole number values to n, which *appears* to be contrary to the classical view which, as it is now clearly seen, held *wrongly* that energy in any amount can be supplied to or removed from a system. In retrospect, it seems to this writer very odd that no classicist *predicted the need* for the existence in Nature of the so-called "quantum". But then, it is even odder that no quantum-mechanician has discussed that need either! (Why emphasis was placed on *wrongly* above will be made clear later in Section 3.5). At this time we can only say that the development of the whole calculus of quantum probabilities that goes by the name of quantum mechanics was without doubt partly based upon the failure to realize that need and upon the willingness to accept without serious scrutiny as fundamentally correct the philosophical underpinnings of the basically inadequate Bohr model of the hydrogen atom. The earlier discussion of the Bohr model and a comparison with the model developed here now show quite clearly that the success of the Bohr model was probably entirely coincidental. The undeniable success of quantum mechanics is not due to its underpinnings on the Bohr model (from which it has taken over the notion of orbital motion, from which the notion of reduced mass also derives), but to the flexibility of the Schrödinger equation that permits an essentially infinite adaptability to experimental data. For example, Hylleraas in 1930 used the variation method with 14 parameters to obtain a calculated energy for the entire ionization potential of the two electrons in the helium atom in agreement with the experimental value of about 79 ev. (One can only wonder as to the number of parameters needed in order to account fully for the uranium atom!). Without such adaptability, the many-body problem, which itself is introduced as a result of our notion of the electron as a very small particle (upon which notion the Bohr model was also based), would have been totally impossible to tackle, and quantum mechanics could *not possibly* have been as successful as it has been.

There is little question that it was this adaptability of the Schrödinger equation and the successes it led to that allowed scientists to forgo their scientific curiosity to know the inner workings of the atom in classical terms. In this light, it was inevitable that the probabilistic quantum-mechanical interpretation of Nature took a decisive turn towards a priori denying not so much the possibility of practical knowledge of very small systems (see discussion above about pinpointing the moment of r_o), but of the existence itself of even the theoretical grounds for our natural desire to know all details in full! The model of the hydrogen atom developed here restores our faith in the basic knowability of Nature (at least, perhaps, until a deeper and more impenetrable barrier is reached), based upon the very same classical laws that we are familiar with from ordinary systems.

In this light, Einstein was fully justified in his belief that "God does *not* play dice!". It certainly took faith on his part to hold to such a view in the face of the "overwhelming success" of probabilistic quantum theory. It was on this belief

that he abandoned work on quantum mechanics. It is not known whether Einstein, or anyone else, made any *really concerted* efforts to develop a *physical* quantum theory (as distinct from a probabilistic one). As B. Russell has pointed out, it is the probabilistic nature of quantum mechanics and the claimed fundamental inability even of Nature to glimpse at the inner workings of very small systems that have prevented so far a union of quantum theory and relativity. In the face of the barrier to knowledge erected by probabilistic quantum mechanics, those who believed along with Einstein in a "no-dice" world should have rallied to develop a physical quantum theory. Why this did not happen is not yet known. The dispute of "Einstein versus everybody else" was, perhaps, only a dispute about whose uncertainty is obeyed by Nature!!! For, relativity too introduces its own and arguably even more unacceptable uncertainty (there, it simply hides under the same name: "relativity") with its abolition of an absolute frame, the direct result of which is the complete and unavoidable blurring of cause and effect on the universal scale! For, what can be certain in a world where the measurement of both length and time is relative and *nobody* can be absolutely certain of what comes first and what follows because everything is *objectively relative* as the theory demands? Thus, to have decided to tackle the stumbling block erected by probabilistic quantum mechanics and to have succeeded in removing that block *necessarily should have called for re-examination of all perceived uncertainties*. The relativists having in fact their own version of uncertainty, certainly could not summon themselves first to the philosophical and only then to the scientific rigors of such re-examination.

Perhaps, it also required a much greater faith in a *Personal* God and *Creator to* persevere in such an effort to see how it all binds together: Whereas a lesser faith is sufficient simply to assert that the "Lord" or "Nature" is not by nature malicious as to demand the playing of dice, it takes a much greater faith to assert that such a notion must be rejected as an affront to a Personal God and Creator, for it calls into question His Omniscience, Power, Wisdom, as well as His Ability and Desire to affect at all a world that He has created: Consider first the possibility that this world behaves as called for by the outcome of the throw of *perfect dice* without benefit whatever of any other law*. If God has created the world, He has created those dice, or He plays them mentally, which is perhaps the same thing. The outcome of the throw thus is totally indeterminate even in a purely statistical sense and no "order" can emerge other than that of *such* "statistical averages". However small or large, *every conceivable system* is at the mercy of these "statistical averages", that must be seen as determining *everything*: Natural Law *and* the laws of physics *are not antedating those averages, but fol-*

* We must take care to draw the following very important distinction: The perfect dice referred to here *are totally different from the ordinary* perfect dice shaped in the form of a cube. The outcome of a throw of the latter, the statistical averages thus obtained, can be predicted from the geometry of the perfect cube, namely, from laws antedating the game. In the present case, no law preexists and no prediction is possible in principle, *all* law must be construed as taking shape based on the "outcome" (whatever this now means) of the game: In the absence of all preexisting law, the perfect dice resembles a body of an indeterminate number of faces, each face having an indeterminate probability to be drawn and an indeterminate significance, for even to pre-ascribe significance to those faces is to admit to the preexistence of *some* law. There is no question that the outcome of such a game will be completely jumbled, the "statistical averages" obtained will point to nothing other than totally inde-

lowing from them! Surely, we know enough of both science and statistics to realize that even the blind chance of *perfect* dice [that *must based on the strict law of total honesty regarding their construction* in order to be *perfect*, a law that most definitely is *not* a product of blind chance!] *cannot* bring about the order that science demonstrates to exist in the underlying laws of Nature. Just record the outcome of consecutive throws of *perfect* dice: you will find it to be totally chaotic, to contain no meaningful sequence! Realize that with imperfect dice you simply *cannot* have the science of statistics! With these given, the indisputable order of Nature compels us to reject outright the possibility of lawless chance creating and controlling the world; and along with it the possibility that anyone out there may be called God while depending on the outcome of blind chance for the reliable operation of *His* world! [This for those utter fools who "believe" both in God *and* relativity *and* the current quantum mechanics!]. If *no* casino owner relies on pure chance (for his profits but rather *tilts* the chances to *his* favor), *how could He do it in building His perfect world*??? Then, consider the possibility that the dice are not perfect but doctored, *necessarily then,* according to *some* underlying law(s). If the doctoring is "subtle", the outcome can only be equally "subtly" different from the outcome of the perfect dice and it would be extremely difficult to discern the operation of the underlying law(s). If the doctoring is more severe, more of the Law(s) will be apparent through the jumbled outcome. To say that God is the prime cause of such doctoring, even the atheists must admit, is an imperfect, cumbersome, totally inelegant and unreliable way to build a Universe: Would *they* create such a scheme of doctoring dice and then relying on the outcome of their throw in order to build their own houses? Where, then, does probabilistic quantum mechanics stand in the face of this dichotomy? In the face of the current interpretation of the uncertainty principle and in order to keep *some* semblance of honesty, "arguments" have appeared stating that only perfect dice can be at the root of it all. But then, there is also the realization that things *cannot and are not* really that bad, that much beyond hope, or else, science is the greatest illusion of all!!! Are we then prepared to charge Nature, or even God Himself, with the full implications of the *doctored* dice? Perhaps, to an unconscious Nature, any charge that we may bring against it may well be and probably is totally without import. But to a Conscious, Personal God and Creator, no other

terminate chaos. *All* natural and physical law, *and* the subsequent continued appearance of the thus *seeming* to be "*statistical* averages" *must* then result spontaneously from this jumble. *This is* the "law without law" concept. In the present light, it is now clear that this concept logically defies *any* possibility of logical explanation. Since Logic itself *must* then obtain out of the jumble, the denial of all preexisting law extending even over the very laws of Logic, at least as the latter must then be approached solely from the direction of objective physical reality and physics, destroys the possibility of relying on what we since ancient times have called "hard Logic" in B. Russell's terms! The notion of "hidden variables" seeks to deliver us from this impasse; but the "scientific establishment" *forbid all* talk about such variables! Thus the Heisenberg relationship as a principle of indeterminacy delimits the very indeterminacy of the "law without law" concept out to infinity, thus leaving *nothing* out of its purview, and thus it *must* itself be construed as a law *preexisting* the quantities it is supposed to regulate, *not* just arising from the jumble! As such, it certainly *cannot* itself be ascribed to pure blind chance and it calls for its own independent Logical explanation, which Science has *not* provided! Science most definitely has *not* examined everything out to infinity and has *no* right talking in such terms! So, *no* scientist of some repute may place so highly the principle of total lawlessness and insist that the Nobel prize represents something truly important: The principle destroys *all* importance!

notion can possibly constitute a greater affront: Not to know better, not to will more, not to apply Himself more to His own task! Or, to do it all this way but for no good reason! (see Matthew 12, 31-32 and Mark 3, 29). To a personal builder, it is folly, paid in precious sweat, to build according to a complicated and inelegant plan, if a simpler plan will do just as well or better, and an elegant plan will establish him as a great builder! Of the Creator, creating also creatures to whom He instills the ability to reason and the desire to know, it is without the slightest doubt malicious in the extreme to make the acquisition of this particular knowledge by His own creatures so extremely difficult, unless there are very excellent reasons for it, of which, however, none has so far been proposed! Thus, the notion of dice, undoctored or doctored, is a direct attack against the Lord's Kindness as well as His Wisdom and Power. That philosophers did not take *any* exception to the current quantum theory and to all kinds of fundamental uncertainty in the Universe on these grounds also [as it now is even more obvious that the Least Set of Laws of Nature demanded by the Most Elegant Design Hypothesis can contain no ambiguity whatever, let alone a fundamental uncertainty], thereby guiding science away from such an intellectual and philosophical, *and thus also ethical and moral* cul-de-sac, is doubtless testimonial of the kind and quality of philosophy practiced in the present age!

The existence of a model of the hydrogen atom that removes both the physical and philosophical stumbling blocks posited by the present quantum theory points the way towards new advances in knowledge. The Bohr model could not account for the spectrum of the helium atom, let alone of more complicated atoms. If the model developed here is indeed superior to that of Bohr, it must, in the very least, be capable of advancing our knowledge of the helium atom as well. That it can indeed do so will be shown in the next Section.

Before going there, however, we must discuss two findings of this work of very great philosophical importance:

Firstly, in the Bohr theory, the quantum number n (analogous to the number n used in Eq. 199, but of a totally different physical origin, being the *integral number* of waves *fitting exactly* in the orbit of the electron) was at the very heart of the quantum principle introduced a priori. Without n coming in integers, the Bohr theory could not have succeeded, because no "stationary states" could have resulted. The later matching of the Bohr theoretical result to the experimentally derived Rydberg equation showed that a human aprioristic idea could find correspondence in Nature. This must have impressed students of Nature (including Bohr) as too good a coincidence to have been fortuitous and must have helped blur the sharp distinction between the objective and the subjective, between the physical reality and the human concept, because it appeared that though each was introduced independently of the other, they were identical. In the present model, in Eq. 199, quantities of action are equated and n *need not* be introduced as an integer but merely *as a* numerical constant *of proportionality,* the value of which remains at this stage to be determined, as has already been pointed out very briefly in the footnote on page 180. The later matching of the here theoretically derived Eq. 207 to the Rydberg equation suggests *without question* that n comes indeed in integers, but now *the emphasis is totally different:* Now, *no* a priori theoretical commitment has been made. *Only* Nature shows that n is an in-

teger! Nature, therefore, *clearly proves itself to obey a quantal law, not* to match human will. Whatever human "intuition" may have been involved, which cannot have been much, was restricted in the *logically forced obligation* to seek out a classical model that removes *all* earlier existing logical and physical objections. The success of this effort shows the continuity of the Laws of Nature, even in the realm inside the atom. Now, however, we are forced to recognize, which had been missed before, that these laws truly possess *both classical and quantal* characteristics. These characteristics reveal themselves *automatically* in the scale of the "atomic springs". The Laws of Nature continue the same; they do not change abruptly when we arrive at the scale of the atom; they *remain classical* as before. But now we recognize a mistake: we recognize that the earlier assumption that totally arbitrary amounts of energy can be supplied to, or removed from, a system in a continuous fashion was simply that, an assumption that *has no place* in the Laws of Nature! We also recognize that this being the case, no additional principles (such as Bohr's correspondence principle) need be introduced to obtain agreement between the supposedly different classical and quantal laws. Moreover, this now clear line of thought demonstrates that the objective may no longer be confused with the subjective. In any scale, Man is not needed for Nature to make sense!

Secondly, the model developed here confines definitively the electron into a sharply delineated finite volume of space. In juxtaposition, integration in quantum mechanics is carried out over the whole of space, out to infinity. *Only through the there necessary* probabilistic interpretation of the Schrödinger wave function does it become "tangible" that the electron is confined to move randomly (while forces that permit or induce this random motion remain stubbornly unspecified) "most of the time" inside a space of nearly atomic dimensions surrounding the nucleus. Much heated debate has concentrated on the distinction and the possible connection between the atomistic nature of matter "suggested" by the "quantum hypothesis" on the one hand and the "continuum hypothesis" lying at the heart of general relativity on the other. When the Schrödinger function permits the electron even a minute probability to be found anywhere at all, given the further blurring allowed on the grounds of the uncertainty principle and the particle-wave duality, certainly there is some room at least for an attempt to be made to bridge the logical gap between the "atomistic" and "continuum" notions. *No such bridge* can possibly exist in light of the present model: In the first place, no "quantum hypothesis" has been made as already shown in the last paragraph, and in the second place, the electron is now clearly seen definitively to be confined within sharp borders, and with it so is the atom. Whatever hopes may have existed before for bridging the gap between the discontinuous and the continuous must now be considered to have been dashed; logic can no longer be construed to support them. Here, Nature *proves itself* to be "atomic" and discontinuous, when it comes to matters of matter (mass and energy). The hypothesis of a "continuum" that partakes of properties of matter is now shown to be a mere human abstraction. We no longer have grounds to justify the belief that such a continuum exists in Nature.

3.3

THE ELECTRONS IN THE HELIUM ATOM

In view of the failure of the Bohr model to explain the spectrum of the helium atom, the problem was attacked on the basis of the three-body mechanics and attempts at solution culminated in Hylleraas' succeeding to adjust 14 parameters to account for the *sum* of the ionization potentials of the two electrons in the atom. Yet, a moment's thought shows that this is a non-physical solution! Because, *it is clear that the two electrons are not simultaneously brought to ionization*: When the energy of the helium atom is increased to 198310.8 term values per cm (or, briefly, tv/cm), the first electron is ejected. From then on, further increase in energy can only affect the remaining electron. When the energy reaches 438908. 67 tv/cm, that electron goes too, but by then, the first electron is long gone! The two electrons, therefore, *can only exist together* in the helium atom up to the energy of 198310.8 tv/cm and it is *only that* portion of the spectrum that it is physically meaningful to try to explain on the basis of the two-electron atom.

A second objection is also justified, pertaining to the fashion according to which the energy is thought to be distributed among the electrons in atoms other than hydrogen-like ones: The energy leading up to the first ionization is generally thought to be absorbed by one electron, the other ones remaining largely unaffected, until their own turn comes up. This view is unjustified: Regardless of whether the electrons are viewed as point charges or as vibrating hollow spheres, when the energy of one electron increases, it is bound to affect the motion of the other ones as well: Because, increased energy of the one electron means increased velocity, or, which is the same thing, increased ability to be in more places in the same interval of time, places from which all other electrons must be excluded, *necessarily at the same rate* as the rate of the (supposedly) more energetic electron at which the latter reaches those places. The conclusion is inevitable: *The many-electron system is a tuned system* in which all electrons share the total energy available to them in such a way as best and always to avoid each other, except perhaps near ionization, which may reasonably be viewed as brought about by the inability of the electrons to tolerate each other in close proximity as their energy increases. As a result, the energy of the many-electron atom is shared by all electrons present, something that no theory has so far fully allowed for, or successfully managed to account for the respective spectra observed. It is the task of a successful theory to give the correct distribution of energy among the electrons present, a distribution that necessarily leads to the spectra observed, as well as supply maximum, if not complete, information about the motions of all electrons present.

Closely associated with shared increases (or generally, changes) in energy is the question of whether the exact whole quantum number n, in the Bohr or the present model of the hydrogen atom, is to be regarded as such for each electron in a many-electron atom, or whether only *the sum* of the entire energy comes in whole number multiples while the fraction of energy of each electron comes in any fractional numbers and not only in exact fractions of whole numbers. To be clearer, if we assign two quantum numbers, n to the one electron and q to the other electron in the helium atom, the question is: Are both n and q whole numbers or only their sum (n + q)? Theory *must* be open on this issue and let the experimental results point out how Nature works. The correct theory, along with the experimental data, *must* provide a satisfactory answer as to what n and q can be individually, as well as relate the fraction q/n to the energy distribution between the two electrons.

The model of the hydrogen-like atom developed in the previous Section provides all the basic building materials for, and also suggests the way in which it itself can be expanded to explain, the operation of electrons in the helium atom. Those building materials are the quantum number n, here assigned to the one electron, and the quantum number q (equivalent in function to n), here assigned to the other electron*. Also, the respective numbers μ_1 and μ_2, relating to the vibration amplitudes of the two electrons and the numbers ρ_1 and ρ_2 relating to the wall thicknesses of the two electrons. The requirement that the two electrons behave as a tuned system is introduced by demanding that their frequencies of vibration be identical. That those frequencies be in phase is left to the mutual repulsion between the electrons that automatically sees to it that they always (except perhaps near ionization) stay in exact phase.

Without the latter requirement, and apart from the problem of repulsion, the mere geometrical accommodation of untuned electrons requires at all times that $r_{o,k}\cdot(1 + \mu_k)(1 + \rho_k) < r_{o,k+1}\cdot(1 - \mu_{k+1})(1 - \rho_{k+1})$, where k + 1 is the immediate outer neighbor of the kth electron. Such a rule, if it truly applied ought to make the many-electron atom much larger than is at present observed as the energy values known for H, He^{+}, Li^{++} and Be^{+++} do truly suggest. With tuned electrons, such a rule is not needed, the electrons can be packed closer to, yet always stay clear of, each other and the entire atom be correspondingly smaller, as in fact is observed.

* In an earlier attempt to put all these ideas together, n was assigned to the "first or innermost" electron and q to the "second or outermost" electron. It was three painful weeks of frustration, before it was realized that such assignment was in fact based on as yet unsubstantiated presuppositions as to which of the two electrons is to be regarded as first and which as second and as to the exact packing order of the two electrons! Planetary motions suggest that for two planets of masses m_1 and m_2 at radii r_1 and r_2 to be revolving with equal periods, it is necessary that their velocities v_1 and v_2 be such that $(v_1/v_2) = (r_1/r_2)$. Now, if they also are to have equal kinetic energies, $m_1v_1^2/2 = m_2v_2^2/2$, it is then necessary that $m_1/m_2 = v_2^2/v_1^2 = r_2^2/r_1^2$, namely, that the inner planet have the greater mass. It is only by extrapolation from planets to electrons, by substituting nuclear attractive force for mass and by ignoring the issue of equal periods, that we can arrive at the conclusion that the inner electron "*must* be facing" the greater "attractive force" of the nucleus. Yet, the moment we require that the two electrons have equal energies (a requirement that may not be rejected a priori from consideration

The idea of tuned vibrating electronic spheres, each one surrounding onion-like its immediate inner neighbor, is a greatly simplifying and therefore highly appealing model for many-electron atoms. It will be left to the theory and experiment to decide for themselves, as the sequel will show, whether in such a model it is the innermost electron that is hydrogen-like, the next one helium-like, the third one lithium-like and so on out, or whether the order is perhaps reversed, as in fact it is, as indicated in the last footnote, and what the terms "hydrogen-like" and so on really mean.

It is because of the effects of tuning that the first ionization potential of helium, say, is not equal to the ionization potential of hydrogen, and so on, as should have been if such tuning were not in effect and each electron acted as if totally alone and on its own. To current theory, dealing in probabilistic electronic clouds, an onion-like atom and tuned electrons are totally foreign ideas. It was inevitable that elaborate schemes had to be developed to "explain" the lack of identity of first ionization potentials to that of the hydrogen atom.

With this introduction behind us we now are ready to consider the two electrons in the helium atom: In fashion fully analogous to that developed for the hydrogen atom, here, without implying a specific packing order by the use of subscripts 1 and 2 (they could just as well have been, say, x and y), and using the approximations (a) $(1 - x^2)^2 \cong 1 - 2x^2$, where $x = (\beta/2)$, so that $(1 - \beta^2/4) \cong (1 - \beta^2/2)$ and (b) $\sqrt{(1 - y)} \cong (1 - y/2)$ where $y = \beta^2$, so that $\sqrt{(1 - \beta^2)} \cong (1 - \beta^2/2)$, by which we may write $(1 - \beta^2/4) \cong (1 - \beta^2)^{1/2}$, we write for the two electrons the following, based on Eqs. 232 to 235:

A. Electron "One": $Z = 2$, $n = n$

$$\mu_1 = (\pi^2/16)\, I_{o,1}\cdot(1 - \beta_{o,1}{}^2/4)^2 \cong (\pi^2/16)\, I_{o,1}\cdot(1 - \beta_{o,1}{}^2)^{1/2} \qquad (249a)$$

$$v_{o,1} = \beta_o c \cong (2\pi e^2/h)(2/n)\left[(1/2)(16/\pi^2)\mu_1{}^2(1 - \mu_1{}^2)^{-1}\right](1 - \beta_{o,1}{}^2)^{-1/4}, \qquad (250a)$$

$$r_{o,1} \cong (h^2/4\pi^2 m_{e,o}e^2)(n^2/2)\left\{(\pi^2/2\mu_1)\left[(16/\pi^2)\mu_1{}^2(1 - \mu_1{}^2)^{-1}\right]^{-1}\right\}(1 - \beta_{o,1}{}^2)^{3/2}, \qquad (251a)$$

$$E_1 \cong (2\pi^2 m_{e,o}e^4/h^2)(2/n)^2\left\{(1/2)\left[(16/\pi^2)\mu_1{}^2/(1 - \mu_1{}^2)^{-1}\right]^2\right\}(1 - \beta_{o,1}{}^2)^{-3/2} \qquad (252a)$$

by an open-minded theory), namely, in the case of the helium atom $2e^2/r_1 = e^2/r_2$, we realize that $r_1 = 2r_2$, that the electron at r_1 facing what we have assumed to be the greater attractive force $2e^2/r_2$, (not only on account of the factor 2 in the numerator but *also on the assumption* that $r_1 < r_2$, especially in view of the fact that "radii" appear in their squares in the denominator), must be at a radius twice as large as the radius r_2 at which we have assumed that the electron facing the lesser attractive force $e^2/r_2{}^2$ is located! Besides, and even ignoring the model here being developed, the fact that the inner electron, so very much more strongly, than the other ones, "attracted" by the nucleus, does not at all crash onto it as classical electromagnetic theory requires, that was interpreted by Bohr to be due to the existence of "stationary" energy states, suggests that perhaps even the entire idea of nuclear attractive force as currently understood to apply to the electrons of a many-electron atom may have to be re-examined ab initio. For all these reasons, and in striving to design a correct theory, it is therefore necessary to reject all potentially misguided and misleading presuppositions that are not fundamental to the theory and to let the logically forced conclusions of the theory and the experimental results decide what the "attractive force" on each electron really is and what is their packing order and radii of "revolution" (according to the current theory; of *vibration* according to the present model).

B. Electron "Two": Z = 1, n = q

$$\mu_2 = (\pi^2/16)\, I_{o,2}\cdot(1-\beta_{o,2}^2/4)^2 \cong (\pi^2/16)\, I_{o,2}\cdot(1-\beta_{o,2}^2)^{1/2} \quad (249b)$$

$$v_{o,2} = \beta_{o,2}c \cong (2\pi e^2/h)(1/q)\left[(1/2)(16/\pi^2)\mu_2^2(1-\mu_2^2)^{-1}\right](1-\beta_{o,2}^2)^{-1/4}, \quad (250b)$$

$$r_{o,2} = (h^2/4\pi^2 m_{e,o}e^2)(q^2)\left\{(\pi^2/2\mu_2)\left[(16/\pi^2)\mu_2^2(1-\mu_2^2)^{-1}\right]^{-1}\right\}(1-\beta_{o,2}^2)^{3/2} \quad (251b)$$

$$E_2 = (2\pi^2 m_{e,o}e^4/h^2)(1/q)^2\left\{(1/2)\left[(16/\pi^2)\mu_2^2(1-\mu_2^2)^{-1}\right]^2\right\}(1-\beta_{o,2}^2)^{-3/2} \quad (252b)$$

And we require that (δt) be identical for both electrons. Therefore (cf. Eq. 219):

$$\delta t = \delta r/v_{ave} = 8\mu_1 r_{o,1}\left[\pi v_{o,1}(1-\beta_{o,1}^2/4)\right]^{-1} = 8\mu_2 r_{o,2}\left[\pi v_{o,2}(1-\beta_{o,2}^2/4)\right]^{-1}$$
$$\cong 8\mu_1 r_{o,1}\left[\pi v_{o,1}(1-\beta_{o,1}^2)^{1/2}\right]^{-1} = 8\mu_2 r_{o,2}\left[\pi v_{o,2}(1-\beta_{o,2}^2)^{1/2}\right]^{-1} \quad (253)$$

or

$$(r_{o,2}/r_{o,1}) = (\mu_1/\mu_2)\,(\beta_{o,2}/\beta_{o,1})\left[(1-\beta_{o,2}^2)/(1-\beta_{o,1}^2)\right]^{1/4}. \quad (253')$$

From Eqs. 250a and 250b we now get

$$(\beta_{o,2}/\beta_{o,1}) = (1/2)(n/q)\left[\mu_1^2/(1-\mu_1^2)\right]^{-1}\left[\mu_2^2/(1-\mu_2^2)\right](1-\beta_{o,1}^2/4)(1-\beta_{o,2}^2/4)^{-1}$$
$$\cong (1/2)(n/q)\left[\mu_1^2/(1-\mu_1^2)\right]^{-1}\left[\mu_2^2/(1-\mu_2^2)\right](1-\beta_{o,1}^2)(1-\beta_{o,2}^2)^{-1/4}. \quad (254)$$

From Eqs. 251a and 251b

$$(r_{o,2}/r_{o,1}) = 2(q/n)^2(\mu_1/\mu_2)\left[\mu_1^2/(1-\mu_1^2)\right]\left[\mu_2^2/(1-\mu_2^2)\right]^{-1}$$
$$\times (1-\beta_{o,2}^2/4)^2(1-\beta_{o,1}^2/4)^{-2}(1-\beta_{o,2}^2)(1-\beta_{o,1}^2)^{-1}$$
$$\cong 2(q/n)^2(\mu_1/\mu_2)\left[\mu_1^2/(1-\mu_1^2)\right]\left[\mu_2^2/(1-\mu_2^2)\right]^{-1}$$
$$\times (1-\beta_{o,1}^2)^{-3/2}(1-\beta_{o,2}^2)^{3/2}, \quad (255)$$

and from Eqs. 252a and 252b

$$(E_2/E_1) = (1/4)(n/q)^2\left[\mu_1^2/(1-\mu_1^2)\right]^{-2}\left[\mu_2^2/(1-\mu_2^2)\right]^2$$
$$\times (1-\beta_{o,1}^2/4)^2(1-\beta_{o,2}^2/4)^{-2}(1-\beta_{o,1}^2)(1-\beta_{o,2}^2)^{-1}$$
$$\cong (1/4)(n/q)^2\left[\mu_1^2/(1-\mu_1^2)\right]^{-2}\left[\mu_2^2/(1-\mu_2^2)\right]^2$$
$$\times (1-\beta_{o,1}^2)^{3/2}(1-\beta_{o,2}^2)^{-3/2}. \quad (256)$$

From Eqs. 253´ and 255 we obtain

$$\left[\mu_1^2/(1-\mu_1^2)\right]^{-1}\left[\mu_2^2/(1-\mu_2^2)\right] = 2(q/n)^2(\beta_{o,1}/\beta_{o,2})(1-\beta_{o,1}^2)^{-5/4}(1-\beta_{o,2}^2)^{5/4}, \quad (257)$$

and introducing to Eq. 254

$$\beta_{o,2}^2/\beta_{o,1}^2 = (q/n)(1-\beta_{o,1}^2)^{-1}(1-\beta_{o,2}^2). \quad (258)$$

Eq. 257 is now re-written as

$$\left[\mu_1^2/(1-\mu_1^2)\right]^{-1}\left[\mu_2^2/(1-\mu_2^2)\right] = 2(q/n)^{3/2}(1-\beta_{o,1}^2)^{-3/4}(1-\beta_{o,2}^2)^{3/4}. \quad (257')$$

Introducing Eq. 257′ to Eq. 256 we now obtain

$$E_2/E_1 = q/n, \tag{259}$$

so that

$$E_1 = 2\pi^2 m_{e,o} e^4 h^{-2} (2/n)^2 \xi_1^2, \tag{260a}$$

$$E_2 = 2\pi^2 m_{e,o} e^4 h^{-2} (1/q)^2 \xi_2^2 = 2\pi^2 m_{e,o} e^4 h^{-2} (2/n)^2 (q/n) \xi_1^2 \tag{260b}$$

$$E_{total} = E_1 + E_2 = 2\pi^2 m_{e,o} e^4 h^{-2} (2/n)^2 (1 + q/n) \xi_1^2 \tag{261}$$

where

$$\xi_1^2 = (1/2)\left[16\mu_1^2/\pi^2(1-\mu_1^2)\right]^2 (1-\beta_{o,1}^2)^{-3/2} \tag{262a}$$

$$\xi_2^2 = (1/2)\left[16\mu_2^2/\pi^2(1-\mu_2^2)\right]^2 (1-\beta_{o,2}^2)^{-3/2} \tag{262b}$$

$$\xi_2^2 = 4(q/n)^3 \xi_1^2 \tag{262c}$$

The energy of the electron in state s (in excess of its energy at true rest that is taken as equal to zero) is assumed to be acquired by the absorption of photons of the corresponding total energy $(\delta m)c^2$. For the electron in state n, this means that

$$(\delta m)_n / m_{e,o} = \beta_{o,1}^2 (1-\beta_{o,1}^2)^{-1} = (1/2)\alpha^2 (2/n)^2 \xi^2 = 2\alpha^2 \xi^2 / n^2 \tag{263a}$$

$$\beta_{o,1} = \left[2\alpha^2 \xi^2 (n^2 + 2\alpha^2 \xi^2)^{-1}\right]^{1/2}, \tag{264a}$$

where in these and the following equations we simplify somewhat by setting $\xi = \xi_1$, so that for the electron in state q:

$$(\delta m)_q / m_{e,o} = \beta_{o,2}^2 (1-\beta_{o,2}^2)^{-1} = (1/2)\alpha^2 (2/n)^2 (q/n) \xi^2 = 2\alpha^2 \xi^2 q/n^3 \tag{263b}$$

$$\beta_{o,2} = [2\alpha^2 \xi^2 q (n^3 + 2\alpha^2 \xi^2 q)^{-1}]^{1/2}, \tag{264b}$$

The following expressions are thus obtained

$$1 - \beta_{o,1}^2 = (1 + 2\alpha^2 \xi^2 / n^2)^{-1} \quad \text{and} \quad 1 - \beta_{o,2}^2 = (1 + 2\alpha^2 \xi^2 q/n^3)^{-1}, \tag{265}$$

$$(1-\beta_{o,1}^2)^{-1} (1-\beta_{o,2}^2) = (1 + 2\alpha^2 \xi^2/n^2)(1 + 2\alpha^2 \xi^2 q/n^3)^{-1} \cong 1 + 2\alpha^2 \xi^2 (1 - q/n)/n^2, \tag{265′}$$

$$\beta_{o,1}^{-1} \beta_{o,2} = (q/n)^{1/2} (1 + 2\alpha^2 \xi^2/n^2)^{1/2} (1 + 2\alpha^2 \xi^2 q/n^3)^{-1/2} \cong (q/n)^{1/2} [1 + \alpha^2 \xi^2 (1 - q/n)/n^2] \cong (q/n)^{1/2}, \tag{266}$$

$$[\mu_1^2/(1-\mu_1^2)]^{-1} [\mu_2^2/(1-\mu_2^2)] = 2(q/n)^{3/2} \left[1 + (3/2)\alpha^2 \xi^2 (1 - q/n) n^2)\right] \cong 2(q/n)^{3/2}, \tag{267}$$

$$(\mu_1/\mu_2)^2 \cong \left[1 + (2(q/n)^{3/2} - 1)\mu_1^2\right] [2(q/n)^{3/2}]^{-1}. \tag{268}$$

Introducing Eqs. 266 and 268 to Eq. 253′ we obtain

$$(r_2/r_1)^2 \cong (\mu_1/\mu_2)^2 (\beta_{o,2}^2/\beta_{o,1}^2) \cong \left[1 + (2(q/n)^{3/2} - 1)\mu_1^2\right] [2(q/n)^{1/2}]^{-1}, \tag{269}$$

where, from Eqs. 262a, b, c:

$$\mu_1 = \left[\left(\pi^2\xi(1-\beta_{o,1}{}^2)^{3/4}\right)\left(8\cdot 2^{1/2} + \pi^2\xi(1-\beta_{o,1}{}^2)^{3/4}\right)^{-1}\right]^{1/2}$$
$$\cong \left[\pi^2\xi\left(8\cdot 2^{1/2} + \pi^2\xi\right)^{-1}\right]^{1/2} \qquad (270a)$$
$$\mu_2 = \left[\left((q/n)^{3/2}\pi^2\xi(1-\beta_{o,2}{}^2)^{3/4}\right)\left(4\cdot 2^{1/2} + (q/n)^{3/2}\pi^2\xi(1-\beta_{o,2}{}^2)^{3/4}\right)^{-1}\right]^{1/2}$$
$$\cong \left[(q/n)^{3/2}\pi^2\xi\left(4\cdot 2^{1/2} + (q/n)^{3/2}\pi^2\xi\right)^{-1}\right]^{1/2} \qquad (270b)$$

We are now ready to investigate the permissible values of n and q. These will be determined by the geometrical constraints of the model:

(a) Vibrational Constraint:

$$0 < \mu_1 , \mu_2 \leq 1 \qquad (271)$$

(b) Wall-thickness Constraint:

$$0 < \rho_1 , \rho_2 \leq 1 \qquad (272)$$

(c) Expectation for $\xi_n{}^2$: Using Eq. 249a for $I_o = 1$ (infinitely thin wall) and introducing to Eq. 262a we get

$$\xi^2 = \left[128\pi^4(1-\beta_{o,1}{}^2)^{1/2}\right]\left[16^2 - \pi^4(1-\beta_{o,1}{}^2)\right]^{-2}$$
$$\cong 128\pi^4\left[16^2 - \pi^4\right]^{-2} \cong 0.4957387688 \qquad (273)$$

This number is only indicative. A finite wall thickness ($I_{o,1} > 1$) will increase μ_1 and correspondingly ξ^2. A finite velocity, as always is the case, will decrease ξ^2 even beyond the value just given, without necessarily implying an infinitely thin wall. The ultimate limits for ξ^2 are 0 for $\mu_1 = 0$ or $\beta_{o,1} = 1$; and infinity for μ_1, $\beta_{o,1} \neq 1$.

(d) Insisting upon the requirement that the radius r_2 of electron "Two" be larger than the radius r_1 of electron "One" implies that (cf. Eq. 269):

$$\mu_1{}^2 \geq \left[2(q/n)^{1/2} - 1\right]\left[2(q/n)^{3/2} - 1\right]. \qquad (274)$$

The value of $\mu_1{}^2$ (Eq. 270a) for the value of ξ^2 given above is

$$\mu_1{}^2 = 0.3805042618, \qquad (275)$$

so that

$$(q/n)^{3/2} - 2.628091457\,(q/n)^{1/2} + 0.\,8140457286 \geq 0, \qquad (276)$$

which is satisfied for

$$(q/n) \leq 0.104014 \quad \text{and} \quad (q/n) \geq 2.061065. \qquad (277)$$

Without insisting that $r_2 > r_1$, no constraint exists as to the values permissible for (q/n). Thus, in the range

$$0.104014 \leq (q/n) \leq 2.061065,$$

including interestingly the value $q/n = 1$ at which the two electrons have equal energies, electron "Two" (of quantum number q) will be *inside* electron "One" (of quantum number n), *contrary* to current opinion that the electron "facing" the higher attraction ($2e^2/r^2$) is closer to the nucleus than the electron "facing" the lower attraction (e^2/r^2). For values $(q/n) < 0.104$, electron "Two" will be outside

electron "One", while having an energy less than 0,104 of that of the latter, in broad agreement with the Bohr model. For values $(q/n) > 2.06$, however, electron "Two" while larger than electron "One" will have more than 2.06 times the energy of electron "One", which is the one closer to the nucleus. (In this analysis, the energies are considered as being positive for all radii, as discussed in the beginning of the previous Section, rather than as regarded by current theory, according to which they have negative values increasing towards zero as the electron grows larger).

The important thing to realize is that the *total* energy of the two electrons must be considered in trying to fit the spectroscopic data to a Rydberg-type expression. The present model produced the expression

$$E_{total} = E_1 + E_2 = 2\pi^2 m_{e,o} e^4 h^{-2} (2/n)^2 (1 + q/n) \xi^2. \qquad (261)$$

The question to be settled then is whether or not the helium spectrum obeys this law and what values it suggests for n and q.

The Spectrum of the Helium Atom.

That the above law is indeed obeyed is shown in Table 7, compiled on the basis of wavelengths tabulated by Stringanov and Sventinskii (S&S), and the term values $R_{He} = 198310.8\ cm^{-1}$ and $R_\infty = 109737.312\ cm^{-1}$ for the ionization potential of the first electron in the helium atom and the Rydberg constant, respectively.

Careful examination of the values of wavelengths tabulated by S&S shows that the published data are neither complete nor free of error. Energy levels, exclusively for the purposes of the present discussion, have been numbered as shown in Table 7, Column 1. Level 1 is simply the ionization potential given above. Spectral lines correspond to wavelengths of transition between levels m and n according to Eq. 241. For m = 1, the Principal Series is produced when n goes through the values 2, 3, 4, ...etc. The Second Series is produced when m =2 and n goes through the values 3, 4, ... etc. The wavelengths 625.3463Å and 612.7247Å are not listed by S&S. Yet, their presence is required by the presence of other wavelengths listed. Table 8 shows the calculation of Level 2, and Table 9 the calculation of Level 3. The wavelengths of the First, Second and Third Series were matched for least scatter in the value of the calculated unlisted energy levels. If the data were perfect, the various pairs of lines matched would have produced identical values for the levels sought. The standard deviations of the average values obtained, namely, $85.326\ cm^{-1}$ and $101.551\ cm^{-1}$ represent respectively 0.222% and 0.290% of their respective levels. It follows that the internal consistency of the complete list is much less than implied by the presence of many decimal places in the values of the wavelengths listed. Moreover, it appears that the errors increase absolutely, though perhaps not relatively, at higher wavelengths. In addition, the gradually shifting values calculated for Level 2 show that a systematic error exists in the values of wavelengths between 3187.745Å and 2644.802Å listed by S&S, causing both the uncertainty in the value of

TABLE 7
ENERGY LEVELS OF THE HELIUM ATOM

$$R_n = R_\infty \cdot (2/n)^2 \cdot (1 + q/n)\xi^2$$

Level	R_n, cm^{-1}	Primary Series in Å	Quantum Numbers m	n	q	ξ^2
1	98310.8		1	2	6	0.451 785 2598
2	38399.4125	625.3463	2	4	8	0.466 561 6070
	35061.2167	612.5590	2	4	7	0.464 729 2008
4	32033.2505	601.4041	2	4	6	0.467 053 5472
5	29223.8509	591.4117	2	4	5	0.473 435 2591
6	27125.7984	584.3340	2	4	4	0.495 288 2105
7	12101.3248	537.0296	3	6	6	0.496 239 2505
8	6817.9833	522.2128	4	8	8	0.497 040 2977
9	4368.2089	515.6165	5	10	10	0.497 575 6271
10	3025.7531	512.0982	6	12	12	0.497 948 7432
11	2231.5612	509.9979	7	14	14	0.498 219 3334
12	1709.2930	508.6431	8	16	16	0.498 439 1732
13	1350.9928	507.7178	9	18	18	0.498 601 0683
14	1094.5469	507.0576	10	10	20	0.498 712 2595
15	904.7939	506.5702	11	22	22	0.498 827 8728
16	760.4247	506.2000	12	24	24	0.498 923 9677
17	648.0435	505.9122	13	26	26	0.499 006 8973
18	558.8442	505.6840	14	28	28	0.499 071 2263
Limit		504.2590				

Level 2 and the not insignificant differences between listed and calculated wavelengths for the Second Series. Bacher and Goudsmit ("*Atomic Energy Levels as derived from the Analysis of Optical Spectra*", Greenwood Press, New York, 1968) list a level at 38454.682 cm^{-1} which lies within one standard deviation of the value obtained here for Level 2. There is little doubt that we are talking here of the same energy level.

The Fourth, Fifth and Sixth Series of spectral lines produced respectively by transitions between Levels 4, 5 and 6 on the one hand and other levels on the other are easily identified in S&S and listed here in Table 10. The errors and uncertainties associated with these levels are much smaller than those for Levels 2 and 3, as demonstrated by the much better agreement between wavelengths calculated from energy level values and those listed by S&S.

TABLE 8
CALCULATION OF THE ENERGY LEVEL "2" OF THE HELIUM ATOM

		SECOND SERIES		
Level	R_n cm^{-1}	Tabulated Wavelength in Å	Calculated x_2	Calculated Wavelength in Å
2	x_2			
3	x_3			29956.0065
4	32033.2505			15708.0515
5	29223.8509			10898.5155
6	27175.7984			8909.7860
7	12101.3248			3802.5579
8	6817.9833	3187.745	38188.1211	3166.4178
9	4368.2089	2945.106	38322.8441	2938.4797
10	3035.7531	2829.076	38382.9831	2827.7615
11	2231.5612	2763.804	38413.5770	2764.9964
12	1709.2930	2723.191	38430.9185	2725.5294
13	1350.9928	2696.119	38441.3438	2699.1705
14	1094.5469	2677.135	38447.9116	2680.6155
15	904.7939	2663.271	38452.6064	2667.0494
16	760.4247	2652.848	38455.7619	2656.8196
17	648.0435	2644.802	38458.0573	2648.9106
18	558.8442			
Average Value:			38399.4125	
Standard Deviation:			85.3258	
Series Limit:				2604.2065

There is little doubt that other energy levels exist near ionization, transitions to, from, and between which the lines in the infrared portion of the spectrum are due. It appears that transitions between these unlisted levels and Level 1 (at ionization) are very rare: No other explanation can be offered for the absence of the respective lines in the Principal Series, since the presence of a line depends on both the magnitude of the energy released or absorbed per event and the number of events occurring simultaneously.

Yet, the accuracy of the energy levels listed in Table 7 is sufficient to demonstrate the objective of the present exercise. Besides energy levels, Table 7 shows the respective wavelengths of the Principal Series and the values of the quantum

TABLE 9
CALCULATION OF THE ENERGY LEVEL "3" OF THE HELIUM ATOM

		THIRD SERIES		
Level	R_n cm^{-1}	Tabulated Wavelength in Å	Calculated x_2	Calculated Wavelength in Å
3	x_3			
4	32033.2505			33025.4688
5	29223.8509	17002.38	36105.3805	17131.0151
6	27175.7984	12527.51	35158.2307	12681.6356
7	12101.3248	4387.929	34891.1192	4355.4212
8	6817.9833	3536.809	35092.0575	3540.6711
9	4368.2089	3258.275	35059.2954	3258.0711
10	3035.7531			
Average Value:			35061.2166	
Standard Deviation:			101.5506	
Series Limit:				2852.1543

numbers n and q. The important difference is that whereas in hydrogen (and hydrogen-like atoms, generally) n takes the values 1, 2, 3, ... in the 2-electron helium atom, it takes the values n = 2m with m = 1, 2, 3, ...There is little doubt that the factor 2 in n = 2m represents the number of electrons present in the atom. The quantum number q assumes the value q = n for all Levels 6 through 18. The value of ξ^2 calculated from Eq. 261 for each level is also shown in Table 7. It is the smoothness in the change of ξ^2 from one level to the next and the proximity of calculated ξ^2 values to the value calculated above (Eq. 273) that demonstrates that Eq, 261 is indeed obeyed or, in other words, that the model developed here adequately describes the 2-electron helium atom.

Table 7 shows that the series m = 2 through 14, q = n, is in fact complete in the spectrum as listed by S&S. It follows that at the respective levels (6 through 18), the two electrons have *equal* energy. Levels 5 on up to 2 exhibit constant m = 2 and n = 4, but q increasing from 5 through 8. It follows that at the very highest energy levels, the one electron begins to acquire more energy than the other, in effect anticipating and preparing for ionization, at which only one electron, obviously the more energetic one, ionizes, rather that both! Nothing could be more reasonable! Nothing could be more expected! Two-thousand six-hundred years ago, Pythagoras spoke of the Harmony of the Celestial Spheres. About

TABLE 10
ADDITIONAL WAVELENGTH SERIES OF THE HELIUM ATOM IN Å

FOURTH SERIES		FIFTH SERIES		SIXTH SERIES	
Calculated	Observed	Calculated	Observed	Calculated	Observed
35594.7940					
20586.9246	20581.30	48826.873			
5017.0767	5015.678	5840.2597	5875.621	6633.7308	6678.151
3965.8513	3964.729	4463.1166	4471.479	4912.1185	4921.931
3614.6701	3613.643	4023.2314	4023.973	4384.5054	4387.929
3448.5735	3447.586	3818.5286	3819.758	4142.4943	4143.761
3355.5145	3354.550	3704.7617	3705.005	4008.9420	4009.268
3297.7226	3296.773	3634.4596	3934.369	3926.7264	3926.534
3259.2126	3258.275	3587.7196	3587.270	3872.2640	3871.791
3232.1975	3231.266	3555.0115	3554.415	3834.1718	3833.554
3212.4946	3211.568	3531.1910	3530.491	3806.4780	3805.740
3197.6643	3196.742	3513.2805	3512.512	3785.6742	3784.862
3186.2144	3187.745	3449.4637	3498.645	3769.6368	3768.784
3177.1846		3488.5741	3487.723	3757.0039	3756.107
Series Limits:					
3121.7563		3421.8626		3679.7447	

four-hundred years ago, Kepler showed that Pythagoras' spheres were in fact circles. Now, it appears that Pythagoras was right after all, albeit at an altogether different level—inside the chemical atom!

In the original examination of the data, Levels 4 and 5 readily produced quantum numbers q = 6 and 5 respectively. Level 2 was introduced to explain the Second Series and was found to represent q = 8. The quantum number q = 7 was still missing. Searching for it led to the matching of lines shown in Table 9. There is little question then, that the Tables of S&S do in fact contain solid information about the states q =7 and 8. States of higher q values were not sought.

The Tables presented here leave little doubt that when the data for the Second Series are corrected, the line at 3187.745Å will be found to belong both to the Second Series as well as to the Fourth, suggesting that it arises from both transitions (2,8) and (4,17). An exact match, however, is unlikely, as this involves the values of $(1 + q/n)\xi^2$ of the four levels involved. Multiplet lines are most likely arising in this manner. A detailed study of the many doublets in the

infrared portion of the spectrum cannot be undertaken before the levels near ionization, to which the lines in the infrared are due, have been identified. This will not be undertaken here.

It is of the utmost importance to realize that for all levels 2 through 18 shown in Table 7, the ratio q/n is 2 or less. According to the earlier analysis, this means that electron "Two" namely, the electron expected according to current theory to be the one farther away from the nucleus is in fact the inside electron! Thus the present model provides information about the ordering of the electrons in the helium atom, which is found to be the reverse of that currently believed. "Attractive force" acting upon the electron has nothing to do with proximity to the nucleus: ordering and "attractive force" are decided on the basis of the total energy available to the two electrons and the need that they be tuned to each other in a unique manner that prolongs the stability of the structure the longest, despite acquisition of higher and higher energy. Obviously, there exists a limit: ionization. What happens near and at the limit requires further elucidation, as does the question as to why the data result in ξ^2 values (for levels q/n = 4/4 and higher) less than about the value 0.4957... (see Eq. 273), which result in I_o values (through Eqs. 270, 264a and 249a for electron "One" decreasing from 0.999860 (at n = 4, q = 4) to 0.985602 (at n = 2, q = 6), which are physically unacceptable, since as we have seen (Eq. 228), the minimum permissible value for I_o corresponds to ρ = 0. Obviously, (see Eq. 273), the velocity of the electron increases substantially near ionization to permit ξ^2 to fall well below the value 0.4957... without violating the constraint (272). (On the other hand, some error in the data at these energy levels cannot be excluded). In this light, the increasing q/n values as the limit is approached are only the first insight. Current theory is totally unable to provide comparable information. That the electron "facing" the higher attraction ($2e^2/r^2$) is closer to the nucleus is not a conclusion of current theory, but rather one of its presuppositions. It took this author nearly three weeks to realize that this need not necessarily be so, and to free himself of an obviously unfounded presupposition so deeply instilled by currently accepted ideas. The solid information provided by the spectrum about the energy levels of the helium atom demands that we reject this presupposition, that can only be matched to one of the conditions (277). Those conditions quite simply do not fit the spectrum of the stable atom: Only above $q/n > 2.06$ and at ionization (q/n = 3) does the electron "facing" the lower attraction (e^2/r^2) get to be on the outside of the other electron. In fact, the increase in the radius of the former electron relative to that of the latter is only gradual, following the increase of q/n, and we may conclude that the atom becomes unstable and ionizes *only after* electron "Two" passes on the outside. Thus, the currently accepted picture which places electron "Two" permanently on the outside of electron "One" is not at all the picture of the stable atom, but rather the picture of the atom in stages of advanced instability.

At ionization, the energy must split between the two electrons in such a way as to permit the remaining electron *to fit exactly* one of the energy levels of the resulting new one-electron helium atom. The electron remaining obviously has the portion $1/(1 + 6/2) = 1/4$ of the ionization energy, or 49577.7 cm^{-1}. The $n' =$

3 state of the resulting atom has the energy of about 48772.14 cm^{-1}. The two differ by about 1.64% from their average. No other pair of simple quantum numbers matches as well as this. If this difference cannot be explained by the ξ'^2 of the resulting atom, it will have to be due to errors associated with the values of the first ionization potential of helium and of the Rydberg constant.

It is interesting to note that the product $(1+q/n)\xi^2$ for Levels m = 2 through 14, for which q/n = 1, is between 0.991 and 0.998, resulting in the helium atom having *nearly the same* energy levels as the hydrogen atom in states n = 2 through 14. That the two spectra do not show this any more directly is of course due to the different ionization potentials, namely, to the top energy levels available to the two atoms.

In conclusion, and despite the needed re-examination of the infrared portion of the spectrum, we see that the physical non-probabilistic quantum theory permitted by the present model, that has already been found in Section 3.2 to apply so well to all hydrogen-like atoms, also applies to the helium atom. Were it not for our ignorance of additional levels near ionization, it could safely be said that the interpretation of the spectrum of the helium atom is now complete. As things stand at present, this interpretation is nearly complete, yet, permits a most significant advance in our understanding of the *physical* structure of the atom. Current theory, with its acceptance of probabilistic notions, electronic clouds of totally probabilistic nature, positions of zero probability splitting, logically, the electron into distinct and permanently non-communicating areas of non-zero probability, and with its demand that we accept all this on faith, in view of its additional claim of indeterminacy, has willingly forfeited any claim on even the theoretical possibility of obtaining additional knowledge (or, so one is logically compelled to conclude) and as a result, it has long since abandoned the effort to obtain *a wholesome and physically meaningful* understanding of the internal structure of the atom, since, under the principle of indeterminacy, knowledge of the one half-picture precludes knowledge of the conjugate half-picture. *The success of the present model shows that concrete additional knowledge is indeed possible, that classical mechanisms extend beyond the limits set by current theory, that such mechanisms are fully compatible with the idea of action coming in exact whole multiples of a fundamental "constant" h, that blind chance and probability do not rule the world*. The model of the electron advanced here, together with the discussion and re-interpretation of the quantum of action to follow, *fully restore causality,* despite counter claims of, and on behalf of, the current probabilistic quantum theory.

3.4

THE FREE ELECTRON

The questions of what happens upon ionization and how exactly the energy possessed by the excited atom a moment before ionization is carried away a moment after, have certainly *not* received the attention they deserve: The Bohr theory deals with the electron in the atom, as does the current quantum theory of spectra. The electromagnetic theory begins with the assumption that the electron is *already* free. Study of the photoelectric phenomenon begins with the assumption of "free" electrons being *already* present in the metallic material of the cathode. And so on. The exact physical processes associated with the event itself of ionization of a previously neutral atom, or an atom from a lower to a higher state of ionization, have not been recognized as interesting and important, nor has the question been resolved as to whether or not the so-called free electron is any different from the electron in a bound state.

With the electron perceived as a quasi-point particle in some kind of orbit around the nucleus, one may say that the above questions have very little content: when the electron is accelerated sufficiently in its orbit in the bound state, it simply escapes: We, tacitly, have taken the aprioristic view that no difference exists between bound and free electrons. This *unstated in detail* view of the electron is totally inadequate in light of the now revealed *fact* that the electron in the atom *is* as a hollow sphere of finite wall thickness! Upon ionization, that sphere must somehow be "ruptured", "emptied of its contents" and subsequently "repaired"; the quotation marks intending to suggest our present ignorance of the exact meaning of these terms and the *specific physical mechanisms* involved.

It will be the object of this Section to present some early ideas on this subject, for obviously, the transition of an electron from a bound to the free state is *not at all* a trivial one.

Experiment has shown that all electrons in the free state are "alike" in that they carry equal mass and have a fixed charge-to-mass ratio. On the other hand, the matter waves associated with electrons according to the deBroglie theory depend upon the energy of the electrons: Those waves get shorter as the electrons become more energetic. It is certainly *not* coincidental that the wavelengths of matter waves of not-too-energetic electrons are of the order of magnitude of the radii given in Section 3.2 and the distances between the centers of atoms in the crystalline lattice. Under the belief that the electron is a quasi-point particle and absent the thought of its internal structure, no attention has been given to the *fact* of the *huge* discrepancy between the size of its classical radius and its size when viewed as a wave: Tacitly, that difference is simply attributed to the "mystery" of the electron. This mystery is essentially resolved in light of what has al-

ready been presented here: One is compelled to conclude that the "wavelength" is no other than the diameter of the electron. Its "wave nature" is either due to the emission/absorption characteristics of electrons as "pearls on a string", or due to the frequency of radiation emitted/absorbed by free electrons, or due to both of these processes "mixed" in some proportion. There can be little doubt that these are all interrelated phenomena. Exchange of energy by bound electrons affects their size. If the free electron is not drastically different from the bound electron, then it, too, must suffer changes in relation to the energy exchanged. So, the "similarity" of (free) electrons is *not* absolute: it must always be seen in this light.

Since emission/absorption of energy $(\delta m)c^2$ implies the emission/absorption of mass δm, it becomes extremely important to resolve the question of whether or not it is the $e/m_{e,o}$ or the $e/m_e = e/(m_{e,o} + \delta m)$ ratio that remains constant. In the latter case, the charge must vary with the mass, but then, upon an electron-positron annihilation, unless the two particles happen to be *identically energetic,* one must expect to see a net charge difference being left over. This has never been observed. The two γ-rays produced upon annihilation are equivalent to $2m_{e,o}\,c^2$ and the two opposite charges are totally destroyed. Thus to the extent that experiment can be relied upon, one is compelled to conclude that electron-positron annihilation involves only the destruction of charges, *producing no additional energy,* and that it is the ratio $e/m_{e,o}$ that remains constant, which is identical for both electrons and positrons.

The charge, then, must be nothing more than, or arise from, the particular configuration in space of the mass $m_{e,o}$ alone. The electron, then (as also the positron), must be able to distinguish between its "rest" mass $m_{e,o}$ and the additional mass δm it has acquired. Since according to the arguments of this work, mass always comes in elementary photons, we must conclude that elementary photons of total mass $m_{e,o}$ are uniquely coordinated in space (within the wall of the electronic sphere) in such a manner as to give rise to what we on the outside (of that wall) world notice as the elementary charge. This dynamical arrangement of mass $m_{e,o}$ in space must be exactly mirrored in the positron. The electron-positron annihilation only manages to destroy those two mirror-imaged arrangements. Mass is not destroyed, only rendered in the new form of the resulting γ-rays.

In light of all this, then, what is involved in the transition of the electron from the bound to the free state? We have seen that the bound electron is vibrating under the influence of spring tension F, the opposite of which is

$$-F = F_c + F_b\,, \tag{186}$$

where

$$F_c = (Ze)(-e)\,r^{-2} \tag{185}$$

is the "attractive force" of the nucleus and

$$F_b = -k|r - r_o| + Ze^2\,r^{-2} \tag{187}$$

is the "balancing" force. In this light, one is tempted to conclude that upon ionization, the "attractive" force vanishes, that the free electron is left only under the influence of

$$-F = F_b \tag{278}$$

and that it will "relax" and vibrate around a new radius r_f such that

$$k \mid r_f - r_i \mid + Ze^2 r^{-2} = 0, \tag{279}$$

where r_i is the radius at ionization. If this is a valid view, the value of r_f will depend on the origin of the electron which is specified by the values of r_i and Z. From Eqs. 190, 191 and 194′, one finds that

$$k = 2Ze^2\left[\mu(1-\mu^2)\cdot r_i^3\right]^{-1}. \tag{280}$$

Eqs. 279 and 280 thus result in

$$r_f^2\,(r_f - r_i) - (1/2)\mu(1-\mu^2)\cdot r_i^3 = 0, \tag{281}$$

Which, for $\mu = \mu_i = 0.6825525748$ (obtained from Eq. 246), is satisfied for

$$r_f = 3.0855 \text{ Å}.$$

What is the vibrational energy of the electron around this radius? This cannot be answered with certainty at present. If one assumes that energy $2Ze^2/r_i$ (corresponding to the vanishing "attractive" force of the nucleus) reappears upon ionization as the sum kinetic energy of the free electron and the proton (the recoil kinetic energy of which will be m_p/m_e times smaller than the kinetic energy of the electron under the principle of conservation of momentum), one must conclude that the difference (cf. Eq. 193)

$$E_f = -Ze^2\Lambda/r_i, \quad \text{where} \quad \Lambda = 2\mu_i\cdot(1-\mu_i^2)^{-1} - 1, \tag{282a,b}$$

is the internal (vibrational) energy of the free electron. For the value of μ_i given above, one finds

$$\Lambda = 1.55579286 = 0.495224\pi,$$

which is only 0.955% less than $\pi/2$. Thus, E_f is 0.6087 times the ionization potential, or 8.28 ev. More cannot be said of the free electron without additional, and possibly riskier, assumptions.

The above discussion applies to the electron leaving the hydrogen atom. In the case of the helium atom, we have seen that only 3/4 of the ionization energy is carried by the about-to-depart electron; so, the above discussion must be modified accordingly.

There are additional arguments to be made in favor of the free electron having a radius of a few angstroms, rather than a radius of order 10^{-13} cm. If the electron truly were that small, the internal space of the most compact conductor at ordinary pressures is essentially empty. A free electron, unpreoccupied with motion around fixed centers, according to current ideas, should have little difficulty travelling around at very high speeds, thus permitting electronic conductivity to be very high indeed, especially in the case of metallic conductors, which according to currently accepted notions have one free electron per atom. This is not observed and elaborate theories have been developed to account for the absence of the expected very high conductivity. In light of the present findings, the passage of the free electron (probably as it itself vibrates about its average radius) through the lattice cannot but be very severely constrained on account of its size alone.

As has already been mentioned, it is an established fact not easily explained otherwise, that all materials under sufficiently high pressures become metallic conductors. The interatomic distances decrease slowly with the 1/6 power of the work of compression (see e.g. R. Swalin, "*Thermodynamics of Solids*", *J*. Wiley & Sons, New York, 1964, p. 68-70). However, as we have seen, the energy of the electron increases in proportion to the energy absorbed (namely, the work of compression), and its radius decreases inversely to that work (cf. Eq. 193 where μ changes slowly). Under these conditions, the ratio of electronic radius to interatomic distance becomes proportional to the –7/6 power of the work of compression, resulting in decreased lattice resistivity as compression increases. On the other hand, increased pressures, resulting in increased energy absorbed, facilitate ionization and decrease the diameters of the electrons still bound to atoms, so that when the electron ionizes under pressure, it has to compete progressively more with lattice vibrations determined by temperature, and less with the size of the bound electrons determining the size of the atoms.

This last statement leads directly to the elucidation of superconductivity (which is not easily explained, even by recent advances in current quantum theory): Below a certain temperature, the vibration amplitude of the lattice decreases sufficiently and provides a clear distance between the quieted down atoms that is larger than the (maximum) radius of the (vibrating?) free electron, such as to allow the latter an essentially uninhibited passage. It is precisely the abrupt appearance of superconductivity, totally unforeseen on the basis of current quantum theory (which assumes the electron to be very small) that is so difficult to explain by that theory.

The data we have presented in this work permit two more questions to be answered. The first of these refers to the relationship between charge and mass of the electron. Using the definition of charge as given by Coulomb's Law, one may write the dimensional equation for charge,

$$Q^2 = FL^2 = ML^3T^{-2}, \tag{283}$$

and introducing the values $m_{e,o} = 9.1095 \times 10^{-28}$ grams, $v = 1.2948076 \times 10^{-22}$ cm^3 (the volume of the electronic wall in the hydrogen atom, see page 190) and $\delta t = 3.0412194 \times 10^{-16}$ sec (the half-period of vibration, see page 188) one may write

$$x^2 e^2 = m_{e,o} v(\delta t)^{-2} \tag{284}$$

to find that

$$x = 2.3510801 = 0.7483720\pi,$$

which is only 0.217% less than $3\pi/4$. One wonders: Is this yet another coincidence, compared to that mentioned on p. 190?

The second question refers to the variability of electric charge with the universal age. In light of the findings in Sections 2.3.2 and 2.5, it is seen that the quantity $v(\delta t)^{-2}$ remains time-invariable, and by Eq. (284), that the charge of the electron remains constant. In terms of the universal quantities, the charge has simply the dimensions of $G^{1/2}M$, which, again, remains independent of the universal age under constant G and M.

3.5

ACTION AND THE SIGNIFICANCE OF h

Since Heraclitus, about 2500 years ago, stated that τὰ πάντα ῥεῖ (everything is in motion and ever changing), not only philosophers but more importantly scientists also have been on notice, namely, under obligation to show, or to disprove, how it is possible at one and the same time for everything to be moving and changing and yet everything, and the world as a whole, to give the impression of stability, or in the very least the outward continuity of more or less fixed form for what are obviously fairly long periods of time. Change and continuity of form are apparently contradictory. Was Heraclitus wrong? If not, how is this apparent contradiction to be reconciled? It does not appear that this question has received sufficient attention. It will be the object of this Section to throw light upon this problem and to show that far from being a philosophical one of dubious scientific value, *it is instead a question crucial to the operation of all processes in the Universe*.

The development of science until the beginning of the twentieth century had been based on the rather uncritical assumption that Heraclitus' change was to be conceived as *continuous*. *So,* the classicists were certainly upset when the idea of the "quantum" came along which clearly implied that at least some kinds of motion and change are not continuous but subject to discontinuities and jumps: Particularly upsetting to them was the notion that Bohr's electron appeared to jump from one orbital radius to another *without going through the logically necessary intermediate orbital distances*. On this last issue, certainly, the classicists can hardly be blamed for demanding a logical explanation, which the Bohr model was at a loss to provide and rather took it as one of its postulates. This notion, clearly associated with orbital momentum, has been taken over by the current probabilistic quantum theory. Yet, to date, no logical explanation has been provided by that theory either.

The ideas we are presenting here would perhaps be worth very little if they could not (perhaps, properly amended or extended) be brought into consistent reconciliation with these logical questions and objections.

To take the last objection, which is the easiest one to dispense with first: the model of the electron presented in Section 3.2 certainly satisfies the classicists' demand for continuity between spatial locations traversed during change of state: The values of r_o, $(1 + \mu)$ and $(1 - \mu)$ for the hydrogen atom already presented (see Section 3.2) show that,

$$n^2 r_o(1 - \mu) < (n + 1)^2 r_o(1 - \mu) < (n^2 r_o(1 + \mu),$$

namely, that contiguous states of vibration *have* the required overlap. Thus transitions between states do *not* have the mysterious quality endowed them starting with the Bohr model. In this sense, the quantum condition as used here fully satisfies the demands of the classicists.

To take now the more difficult question of the quantum itself. Since the middle nineteenth century, when the notions relating to energy as used in thermodynamics were fairly well understood, the notion has been established that energy change is central to any kind of transition. The classical theory, up until it was faced with atomic and subatomic processes, had never met a case where energy change could not be administered in any arbitrarily decided amount. Quantum theory introduced the notion of quanta of energy $\epsilon = \nu h$, where ν is the frequency of the radiation used to supply the energy. The photoelectric phenomenon showed that unless a minimum threshold energy $\nu_o h$ were supplied, no photoelectron was emitted. Various metals had different characteristic ν_o values. The notion of energy coming in distinct quanta of values $\nu_o h$ thus was the sole, yet, crucial modification to the classical notion of energy introduced by quantum theory. The Bohr model was seen in the same context in light of the Rydberg Law (Eq. 182) as explained by Bohr: In other words, the quantum theory initially only advanced the idea that energy is not supplied in any arbitrary amount but only in amounts that are exact multiples of some fundamental (however, yet *to be specified)* quantity. In this it "demonstrated" the classicists to be "wrong".

Subsequently, the theory developed enough to incorporate the quantum probability notions, fundamental among them being the Heisenberg uncertainty principle. A curious thing thus happened: While the quantum theory absolved the "observer" of responsibility for the perceived indeterminacy, it however reintroduced him centrally into the picture of the world that we now think we possess or can ever hope to obtain, in direct contravention of the unseating of the Earthian observer from the center of the Universe around him forced by the discoveries of Copernicus. The "observer", wherever he may now be, is inseparable from the picture of the world he can ever hope to have. In this, there appears that a serious confusion has entered the philosophy underlying quantum theory, in that the "observer" is assumed to be equipped with measuring tools, whether he be human, or perhaps only a "knife", electron, or some other particle. As if the latter could not do without such tools and still obey deterministic laws, but had to resemble the former in all respects and obey Nature exclusively in the way that those tools "indicated" when in the hands of human quantum mechanicians. Thus, anthropomorphicism was extended even to the inanimate nature and returned to the pre-Copernican center-of-stage position.

The model of the electron already here developed and the example of the game of billiards discussed in Section 2.3 (p. 191), clearly show that the classical perception need not be upset: At the moment of impact, the electrons in the atom being fully classical systems, do have precisely defined properties (radii, energies, momenta) and they *will* bounce off according to the momentary values of those properties and in strict agreement with the classical laws. Thus the physical quantum ideas advanced in this work totally dispense not only with proba-

bilistic notions, but also with the Heisenberg relationship *as a principle of uncertainty. Nature does not need either of them*! *Yet, the Heisenberg relationship is central in regulating all processes in Nature:* What the classicists failed to predict and the quantum mechanicians have not realized is the *Need* in Nature of the Heisenberg relationship freed from the chains of uncertainty with which it has been bound since inception, as has already been alluded to in Section 3.2.

To explain what this means, we go back to Heraclitus's τὰ πάντα ῥεῖ. Here, we have gone to the ultimate extreme: We have advanced the idea that everything in Nature is made up out of fundamental photons, that nothing else exists but fundamental photons, which upon "combination" with each other produce all observed Variety and Stability of Form. Thus more than anyone else before, we now are obliged to submit to the notice and obligation placed upon us all by Heraclitus. To make matters worse for us, the law of conservation of mass that we have advanced clearly dispenses with the idea of particles containing (being made up of) other particles heavier than themselves. The fundamental photon thus is the smallest quantity of mass and energy available $\epsilon_o = m_o c^2$. All bodies are progressively being made up of fundamental photons: the heavier they are the more photons they contain; the sum mass is exactly equal to its constituent masses. Thus we have to explain the Variety and Stability of Form while accepting that all is made up of the most ῥευστὴ (fluid) substance of all: fundamental light!!!

Although we cannot show how small it is (for we can only obtain a lowest estimate of its "size"), it is quite likely that the fundamental photon is so small that no classicist would hesitate to equate in practice ϵ_o to $d\epsilon$, the infinitesimal amount of energy used in continuous classical calculus. At the limit, then, classical and quantum theory could be brought together: The smallest amount of energy $\epsilon_o \cong d\epsilon$ objectively available is also now allowed to participate in a reaction. The real question is: "What kind of world would this produce?"

To answer this question, we can imagine a room with opaque, yet totally reflecting walls containing various ordinary objects. An electric light lights up the room. In other words, fundamental photons are added to the contents of the room, each one of which is free to participate in an energy exchange process under what we may prescribe as the quantum condition $\epsilon_o = \nu_o h$,where $h \cong 0$. If after a time, an observation window were opened up to allow examination of the contents of the room, *one should not be surprised at all to see that all contents of the room had vanished from view as such, while the room weighed as much as before and a bit more (by the mass of the photons added)*! What had happened? And why do ordinary rooms not routinely turn out to be like that? What really happened to *that* room *was the condition $h \cong 0$, under which no amount of energy, however small, is barred from effecting a change of state of another object*. As a result, all the contents of the room *thus having lost their natural resistance to change, or, in other words, their protection from arbitrary attack,* had themselves reverted to being photons!!! That an ordinary room does not revert to that state is *solely and exclusively* due to the fact that $h \neq 0$. Under this condition, the so-called canonically conjugate quantities $(\delta\epsilon)(\delta t) = (dp)(dx)$ will

be unable to effect a change as long as

$$(\delta\epsilon)(\delta t) = (\delta p)(\delta x) < h, \tag{285}$$

and the world is protected against all change that does not meet the now necessarily perceived as minimal requirement

$$(\delta\epsilon)(\delta t) = (\delta p)(\delta x) \geq h!!! \tag{286}$$

Now, this is nothing else than the Heisenberg expression, that is nothing other than the reformulation in exact terms of the old Principle of Least Action! Heraclitus was absolutely right: All is in (the fastest) motion (possible)! Yet, the Wisdom of Divine Providence has endowed the World with Shape and Form, by instituting the Law of Least Action *as an additional, independent and indispensable Law* that alone saves the World from the absolute chaos that the condition h = 0 guarantees! The Principle of Least Action was, it appears, first discovered by Leibnitz and later rediscovered by Maupertuis. It was in all probability the latter's arrogance and unwillingness to accept second place in this discovery, possibly also the inexactitude of Leibnitz's understanding and expression of the Principle, that produced so much rancor in the court of Frederick the Great. Voltaire's *La Diatribe du Docteur Akakia* was only meant to ridicule Maupertuis's arrogance. Voltaire certainly knew better than entangle himself in disproving the Principle. Yet, Voltaire's *La Diatribe* has been taken as the "demolition" of the *purposeful* Teleology now seen as *unerringly implied* by the Principle of Least Action. This, evidently, is the opinion of those who still have not thought through *all* the logical consequences of the non-existence of the Principle as well as of its existence, and of those who have seen it only in its variational mathematical form, have categorized it away as just another mathematical expression and have totally ignored its physical import. Despite all this, the Principle of Least Action has remained valid and is one of the most important principles of physics: Now, it is seen to possess additional significance of the very highest order: (a) Not only is Nature able to choose amongst the infinity of paths the particular path that calls for least action; (b) Nature is also capable of setting up a mechanism, by establishing a finite value of least action, h, that protects *any* substance from what may well be called "trivial" change; (c) Nature also accomplishes (b) within limits, so as not to make impossible all change as would clearly in the limit be the case if $h = \infty$, thereby providing a mechanism for the simultaneous inhibition of "unwanted" as well as permission of "desirable" change; (d) Moreover, Nature sets an *identical* threshold least action value, h, *for all processes* as demonstrated by the uniqueness of the value of h. Any one of these feats would be amazing even if it stood by itself. *All four together reveal a great deal more than an "amazing coincidence"*. Will those who have hastened to dismiss the teleological implications of the Principle of Least Action perhaps be willing to produce an example of a protective-regulatory mechanism that *is not teleological in objective?* There is only *so much* that can be charged to the "intelligence" of inanimate, purposeless Nature *without overcharging credulity*. What universal chance mechanism can produce another universal protective-regulatory mechanism that is fully teleological in practical scope, yet, in reality not teleological

at all, if those who dismiss Teleology are correct??? To deny the Design of it all is to deny the scientist the only truly legitimate purpose of his efforts: to enjoy the uncontrollable rapture when faced with the "Music of the Laws" . One only has to think of a very much easier task: What chance event, what random noise generator could have produced the

> *O Freunde, nicht diese Töne!*
> *Sodern lasst uns angenehmere anstimmen*
> *und freudevollere!*
>
> Freude, schöner Götterfunken,
> Tochter aus Elysium,...
>
> Froh, wie seine Sonnen fliegen
> Durch des Himmels prächtgen Plan,
> laufet, Brüder, eure Bahn,
> Freudig, wie ein Held zum Siegen.
>
> Bruder! Über'm Sternenzelt
> Muss ein lieber Vater wohnen.
> Ihr stürzt nieder Millionen?
> Ahnest du den Schöpfer, Welt?
> Such' Ihn über'm Sternenzelt!
> Über Sternen muss er wohnen.

of *deaf* Beethoven's Choral Symphony? If Beethoven in his total deafness could still hear the Cosmic Symphony of Law and rejoice at the mystical bliss it so richly and freely bestows upon those who would only listen to the Eternal Harmonies, how deaf must those be who are perfect of hearing yet do not listen (cf. Matthew 16, 23)? It is with them that Beethoven pleads: O Freunde, nicht diese Töne! Friends, enough of infidelity!

The photoelectric phenomenon shows clearly how the Law of Least Action applies: That different metals exhibit different characteristic energies $\epsilon_x = \nu_x h$ demonstrates conclusively that what is truly important is not this quantity of energy, characteristic of each metal, but rather the quantity $\epsilon_x \nu_x^{-1} = h$, which is common to all metals and indeed to all processes. The general form of this expression:

$$(\delta\epsilon)(\delta t) = (\delta p)(\delta x) = h, \tag{287}$$

thus constitutes the exact formulation of the Law. The prompt photoelectric emission, occurring the very moment Eq. 287 is just satisfied, proves beyond doubt that it is Eq. 287 and *not* Eq. 286 which expresses the Law. Accordingly, the Law, in reality, allows *any* amount of energy $\delta\epsilon$ (limited only by the energy of the fundamental photon and being an exact multiple thereof at any universal age, see below) to effect a change, *provided* that associated with the process there exists a time interval δt such as to satisfy the condition (287).

In this sense then, the classicist view was definitely correct. What had (has) been missed was (is) not that Nature does not recognize very small quantities of energy: Nature recognizes *all* quantities of energy, *because the law of conser-*

vation of Universal mass requires that not one fundamental photon (unit of mass) ever be ignored. But the fact that Nature imposes the threshold of action.

Without realizing it, the classicists had assumed that h has the value of zero. In discussions of quantum theory, the condition $h \rightarrow 0$ is recognized as one of the conditions permitting quantum mechanics to have (under the additional principle of correspondence, which however has not yet been proven rigorously) a classical limit in agreement with, say, classical mechanics or Maxwell's electromagnetic theory, since such theories describe accurately macroscopic phenomena. That the condition $h = 0$ truly destroys the World as we know it, and thus is *inadmissible* even as a limit in any theory aspiring to describe this World, has not however been made part of the entire quantum-mechanical concept.

In terms of momentum, again, any momentum δp brought to a process will effect a change, provided that associated with the process there exists a length δx such as to satisfy condition (287). It is the fact that the products $(\delta\epsilon)(\delta t)$ and $(\delta p)(\delta x)$ always have the value h that permits us to characterize the individual quantities pairwise as canonical conjugates of each other. What all this means is made explicit with the following example: Imagine two identical spheres capable of interpenetration, in effect two atoms, set to collide head-on with each other. Ignore all attractive-repulsive phenomena. It is easily seen that the distance of contact of the two spheres is the distance of the two diameters from the point at which the two spheres first make contact at time t_o to the point at which they break contact altogether at time $t_o + \delta t$. This is in effect the length along the "reaction coordinate" that characterizes the process. If the two spheres travel each with absolute velocity v, relative to the center of the Universe, and each have mass m, they together bring to the process a total energy $(\delta E) = mv^2$. The maximum period of time the two spheres remain in contact, evidently, is $(\delta t) = 2d/2v = 2r/v$, which also characterizes the process. The maximum action associated with this (potential reaction) process is $(\delta E)(\delta t) = 2mvr$. If this quantity is less than h, the two spheres will go straight through each other without any reaction occurring. The reaction will occur *the very moment* that the product $(\delta E)'\cdot(\delta t)'$ already supplied to the process up to that moment equals h, according to Eq. (287). The reaction *is guaranteed* to occur whenever $(\delta E)(\delta t) = 2mvr \geq h$, according to Eq. 286. What matters is *not* the separate quantities δE, δt, δp, and δx, but the product of their canonical conjugation.

What evidence do we have that Eq. 287 truly applies? For an order-of-magnitude calculation for a collision involving two identical masses m colliding with identical velocities v, we use Eq. 287, where

$$\delta E = m_o v^2 \cdot \left[1 - (v/c)^2\right]^{-1/2} \qquad \text{and} \qquad (\delta p) = 4mv$$

represent, respectively, the total energy brought to the reaction process and the total algebraic momentum change involved, assuming that the two particles eventually reverse course. It follows that

$$v^2 = (\delta p)^2 \left[16m_o^2c^2 + (\delta p)^2\right]^{-1} c^2 = h^2 \left[16m_o^2c^2(\delta x)^2 + h^2\right]^{-1} c^2, \quad (288a)$$

$$\delta E = h^2c \left[4(\delta x)\left[16m_o^2c^2(\delta x)^2 + h^2\right]^{-1/2}\right]^{-1}. \quad (288b)$$

If we use $m_o = 1.67252 \times 10^{-24}$ grams, the mass of the proton, we find the following correspondence:

(δx), cm	(δE),	(δt), sec
10^{-13}	97.2 Mev	4.255×10^{-23}
10^{-14}	3.1 Bev	1.334×10^{-24}
10^{-15}	31.0 Bev	1.334×10^{-25}
10^{-16}	310.0 Bev	1.334×10^{-26},

which covers the range of energies and distances encountered in nuclear phenomena. Again, if we use $m_o = 1.67343 \times 10^{-24}$ grams, the mass of the hydrogen atom, we find the following correspondence:

(δx), cm	(δE), cal/mol	(δt), sec
1.00×10^{-8}	236.0	4.040×10^{-13}
5.00×10^{-9}	943.9	1.101×10^{-13}
2.50×10^{-9}	3775.4	2.525×10^{-14}
1.25×10^{-9}	15101.7	6.314×10^{-15},

which covers the range of distances and energies encountered in chemical reactions. The reaction times shown above are also in the range of those estimated for nuclear and chemical phenomena. Thus, there is no question that the entire scale of observed energies is proportional to $h/(\delta t)$, where (δt) is the critical reaction time, characteristic of the reaction attempted, for the energy supplied. At the same time, however, for the reaction to be effected, it is necessary that the two particles find themselves at the critical reaction distance $(\delta x) = h/(\delta p)$.

In our scientific and otherwise preoccupation with energy and power, we have all but completely overlooked the physical importance of action. We have seen it only in the context of the least resistant path and, lately, in the context of the uncertainty principle. The presence of h in Planck's explanation of the blackbody radiation remains quite mysterious. In the context of the logical arguments presented here, h is *both* the unit of action *and* common to all processes. In that sense it partakes of the properties of an intensive quantity, like temperature and pressure, that are "common" to all members of an ensemble. However, by its very nature, action is in reality an extensive quantity in the sense that the actions of individual ensemble members can be summed up, very much like their energies. The question then arises as to the minimum mass, the action of which is represented by h. If that mass, call it, m were greater than the unit mass m_o of the fundamental photon, then actions *smaller than h ought also to be found*, representing those masses lying between m_o and m. Otherwise, such masses would be barred from ever participating in a reaction, contrary to the earlier argument. Since no such actions are observable, h being the smallest amount of action observable, not only is h the unit of action, it also is *necessarily* the action of the fundamental photon! Since the photon has been around since Creation, it *necessarily* follows that the quantity

$$m_o c^2 T = h \tag{289}$$

also represents the action performed, executed or accumulated by the fundamental photon since Creation. The *total* action performed by the entire Universe thus *cannot* be other than

$$(n_o m_o)c^2T = Mc^2T = n_o h = H \tag{290}$$

Accordingly,

$$n_o \cong 5.891 \times 10^{120} \quad (\textit{exact to the last digit}), \tag{290a}$$
$$m_o \cong 1.947 \times 10^{-65} \text{ gram} \quad (\textit{exact to the last digit quantity of matter}), \tag{290b}$$
$$H \cong 3.904 \times 10^{94} \text{ erg sec} \ (\textit{a continuous function of the universal age}). \tag{290c}$$

Eq. 289 can be obtained in another way also: The longest wavelength possible in the Universe is the wavelength of a photon that began being emitted at age T = 0, the emission of which is only just now being completed. Since this is a single process, it *must* obey the Law of Action (Eq. 287), in which $\delta t = \nu^{-1} = T$. It follows that, $m_o c^2 T = h$ (*a continuous function of the universal age*).

Eqs. 289 and 290 lead directly to the dependence of action upon the universal age. Action (both h and H) is proportional to c^2T, namely, to $T^{1/3}$. At age T = 0, both the fundamental photon and the entire Universe had performed zero action, since they were just then beginning their act. The action of both increases ever since in proportion to $T^{1/3}$. Accordingly, the value of m_o derived as in the *last* paragraph above remains constant regardless of the age at which the emission is finally completed of a photon which began being emitted at age T = 0: the quotient h/c^2T is independent of the universal age. Thus, in the sense of the last paragraph, the value m_o represents the best present estimate of the mass of a fundamental photon. If the value be different from the above, then, it must still be given by the value (h'/c'^2T') assumed at a characteristic age T′. Why such an age should be so uniquely singled out is impossible reasonably to say. Besides, introducing such a value to Eq. (289) would result in

$$(h'/c'^2T')c^2T = h,$$

being re-written as

$$(c/c')^2 (T/T') = h/h',$$

which, in view of the dependence upon the universal age of c and h, is a mere identity. So, after all, it is more than quite likely that the value of m_o given above truly represents the mass of the fundamental photon, subject only to the accuracy of the value of h and the estimate of the age of the Universe. make no mistake: Despite the uncertainty of the *exact* values of h and T, under constant M, the values of n_o and m_o *are indeed certain, the first to 121 exact numerals, the second to 66 exact numerals*! *Not one unit is in excess or missing*!

The dependence of c (proportional to $T^{-1/3}$) and h (proportional to $T^{1/3}$) and the independence of e upon the universal age result in the fine structure constant (Eq. 237) being independent of the universal age, in agreement with conclusion based on the study of spectra of distant light sources. In this regard, then, the conclusions reached here *cannot* be faulted. From the practical side, the study of kinetic phenomena both in chemistry and physics is likely to be greatly eased once the importance of the Law of Action is fully appreciated. That temperature

(increased kinetic energy) and pressure and concentration (increased proximity, required for reactants to react) favor the kinetics of all reactions is well known. Reactions must and will move to completion as soon as conditions are established that will guarantee the condition (286).

Whether this extra knowledge shall henceforth be used for good or ill (including premeditated, unquestionably purposeful evil), shall, of course, be up to us to decide. Perhaps, we will finally decide to heed the lesson the Universe is teaching us: Despite all the Fury of Creation, and all lesser furies since, the Universe has preserved its mass: In other words, it has *not lost, nor wasted, even a single* fundamental photon! Perhaps, then, we may still learn to use the extra knowledge for the purposes of the Human Universe, without waste of a single Human Unit, or exploitation of the least one among us who is just as precious and sacred as a Unit as anyone else! Beethoven's "*O Freunde, nicht diese Töne*!", we now find, has this meaning too, and he fully meant it! Otherwise he would *not* ever since have been asking of us "Ihr stürzt nieder, Millionen? Ahnest du den Schöpfer, Welt?"!

Forgive me Professors of "Science" and "Theology", but I cannot help it, and I *may not* avoid making this last comment: Your silence since 1985 *has been willful, furious, abysmal, a veritable continuation of your past habits*: You know it just as well as I, that it has *not* been truly against me, but against *den Schöpfer of all this exactitude*, Who calls first upon *both* of your opposing camps, that each for itself claims arrogantly to be the sole spiritual teachers and leaders of Mankind and only then upon each one of the rest of us all to repair our ways! *Only now* at very long last do we all begin to comprehend where you have led us and shall continue to lead us, if you are allowed to have your separate ways! The catastrophes of your kind of "peace" *are* far worse than any of the wars in which you have always had a dirty part! Whether you and we all like it or not, in this World, *its Creator alone shall have the very last, as He alone also had the very first, Word*!!! For, *He alone is its Unquestioned Master*! We, *each one of us from his own pos*t, are its mere custodians! Under your stubbornly divided "leadership", I for one tell you, that we do *not* perform our duties, but *are guided by you to kill* the Master!

3.6

THE RELATIONSHIP OF PARTICLE MASS, STABILITY AND SIZE AND THE INTERACTION OF SMALL AND LARGE

Age-old experience has taught us that large objects can be cut to pieces: That the pieces are geometrically smaller than the whole original object and they weigh less: The sum of their volumes equals the volume of the original object. Similarly, the sum of their masses equals the mass of the original object. These classical notions have been applied with great success all the way down to the atom, and we have persuaded ourselves that they are universally true. Bohr applied them to the electron, but there, the picture became quite confusing: The energy of the electron was found to become zero at infinite radius of revolution. Under the notion that we are free to set arbitrarily the zero in the scale of energies, we thought that no harm would be done, if we set it where *we thought* we found it, at an infinite radius of revolution, *while retaining* the classical notion of larger being heavier (or, in this case, more energetic). The only way in which these notions could come together was through the introduction of negative energies. So, we decided, quite uncritically, it now appears, to declare that the energy of the electron is negative on this side of an infinite radius of revolution. In the infinite universe of numbers, the mathematician is certainly quite free to set his zero of them at will, and declare some of them as being positive and some negative, relative to some arbitrarily fixed median value. But a physicist, *being honor bound to be dealing in physical quantities, may not forget* that words such as physics, physical, physicist come from Φύσις, meaning *Nature*, and thus he *may not* be quite as unconstrained as a mathematician. For he must be careful to ensure that physical scales do not violate the Logic of Nature: If, physically, zero means non-existence and infinity an infinite amount *of a physical quantity,* then most assuredly, *all existing physical quantities belong to the positive realm*. Negative quantities are non-physical and therefore undefinable in the physical world, i.e. the world of Nature. In the case of the electron, the *physical-natural* law of Coulomb under Bohr's view of things seems to be compelling us to conclude that the energy of the electron at an infinite radius of revolution *is physically* and not only mathematically zero! This *is* wrong! The energy of the electron in *any* finite radius of revolution *is indeed positive as a matter of physical necessity*!

[We *may not* confuse matters: whereas *there are no physical zero or negative* matters, because *as such they would be nonexistent*, we are *not* logically

prevented from assigning the plus or minus sign to a *geometrical* direction, or its opposite! As universal expansion *is* natural, we are *not* wrong to assign it a positive sign, and thus also a negative sign to the direction of universal contraction!

And as for the *zero* point from which the Universe began its course, it does *not* seem Logically improper to think of it as *both physical and geometrical*, since it represents the passage from nonexistence to existence of the Universe itself! If that is objected to, one *must Logically explain* the presence in the dimensionality of the *physical* Law of Gravitation of what we call "time": One *may not* reject the *physical-geometrical* existence of the zero initial point at which the Universe was created obeying the *one physical* Law of Gravitation-Expansion with the thing called "time" built in it, when "time" *cannot* Logically be other than the *finite age* of the Universe!: If "time" were not just that, but something extending indefinitely into the past, its presence in the physical-dimensional structure of the Law, placing it inescapably in the denominator of Eq. 2 *would make the Universe we know impossible,* as it would make the *physically measurable and meaningful* size of the universal gravitational constant zero, thereby dissolving to nothing at all both the Universe *and us in it* arguing about these matters! The professors *may not* object—by hiding, as they have been doing since 1985!]

This was *not* realized; and so, we continue to this day to hold on to the "classical" notion that geometrically smaller and physically less massive (or energetic) are synonymous, that the notion is universally true, and therefore that it holds inside the nucleus also. But there, we have run into serious and unexpected difficulty. We find that the nucleus is "very stable", unless attacked with very highly energetic "probes". The energy is supplied by particle accelerators. Experiment has shown that the mass of accelerated particles increases, but in light of the theory of relativity, we attribute the increase of mass to velocity: We do not regard the extra mass as real but only as "apparent". As a result, when we find, amidst the embarrassing riches of subnuclear fragments, fragments that are heavier than the nucleus or nuclide they are supposed to have come from, we are greatly surprised, because this finding evidently runs in the face of the laws of additivity and conservation of mass. Still, the findings demand an explanation. Instead of questioning our own principles and assumptions, we are quite prepared to accept the notion that inside the nucleus the additivity of mass no longer applies as commonly understood. So, we have created theories to cope with the *imagined* "facts", amongst which, the theory of quarks is unique in that it quite openly espouses the notion that a nuclide is made up of particles heavier than itself, which however do not show their masses in their totality to the outside world while in the nuclide and do not exist by themselves outside it! This is perhaps the essence of the mystery as currently understood, which the physics of very high energies tries to resolve, a mystery that only grows thicker as higher energies are employed which lead to the discovery of heavier and heavier fragments of matter supposedly residing inside the nucleus.

The ideas we have advanced here allow a *totally natural and consistent, yet, quite unexpected* (from the viewpoint of current theory and notions) resolution of the above problem: We have seen that the electron in the hydrogen atom

really becomes smaller when it s more energetic. As a result, when we apply energy to the electron, the entire hydrogen atom becomes smaller. If ionization is prevented as energy supply continues, in a process that in essence slowly reverses the spontaneous disintegration of the free neutron, there is only one way for the hydrogen atom to go: inwards. The atom becomes smaller still than the size corresponding to the state n = 1 of its electron. This does not imply that there are fractional states for the electron under these conditions (this problem has not been investigated), but only to show that when sufficient extra energy has been supplied, the neutral hydrogen atom turns *quite naturally* into being a neutron, the difference in mass thus gained truly representing the energy of "compression" as it were of the neutral hydrogen atom.There is thus no question that the heavier nuclides represent even more energetic states of aggregation of mass and therefore are geometrically still smaller. Similarly, the very highly accelerated particles are also smaller in geometrical size than the original size they started from but they also are , correspondingly, *really more massive*. Eq. 288 gives an early rough estimate of the relationship of energy (and mass) packed and size of particle (package) obtained, since obviously the "reaction distance" δx is related of the size of the particle. Thus Eq. 288 is in complete qualitative agreement with the model of the electron we have already presented as well as with the expansion of the Universe examined in detail in Section 2.3.2 (where we saw the Universe to be smaller in past ages when it was more energetic, while obviously always of constant mass).

Eq. 288 provides additional insight into the notion of stability of the nucleus. High energies are required to smash the nucleus not only because it is very stable but also because it is very small. Since an interpretable picture can only emerge when the colliding particles are roughly comparable in size, in reality, part of the energy we supply during acceleration is expended in order to decrease the size of our probes. The strong nuclear interaction that we believe holds the nucleus together and at the same time repels strangers from very close proximity may to an extent be an artifact due to the fact that under ordinary conditions there are not enough probes around of the required action nh as per Eq. 286, capable of inducing a reaction involving the nucleus, and to the fact that our probes exhaust very quickly their penetrating power simply because they are not small enough at impact, or cannot stay in the proximity for the time interval required for the reaction to be completed and take effect.

Thus what has been missed by current theory is the realization that very small probes *are really more massive*, because the only way to make them smaller and smaller is by supplying them with more and more *real mass*.The masses of the particles "created" in a nuclide disintegration are not made up exclusively of the mass of the nuclide and the "rest mass" of the probe. They also include all the very real mass we supplied in accelerating the probe under strict conservation of mass: *Without supply of mass there is no acceleration*! Thus the nuclide does *not* contain masses heavier than the whole. Nor can it contain "lumps" of masses the volumes of which are smaller than the volume of the nuclide that contains them, because then those lumps, by the very fact that they are smaller, they also are more massive, which is absurd under the law of additivity of mass.

Therefore, the "structure" that we see on smashing the nucleus is *not* a structure that exists inside the nucleus. Lighter fragments are larger than the nuclides they come from, while heavier fragments are smaller but created on impact. Thus, none of these particles has an independent existence inside the nucleus. They all form on impact. The fact that all these fragments are unstable (and this in a sense includes the neutron also) when compared with the nucleus as a whole from which they "come", should be interpreted as sufficient evidence of the truth of this statement. That they are "long-lived" by the "nuclear time scale" does not at all alter their basic instability relative to the nucleus as a whole. The "nuclear time scale" is a purely man-made criterion without a necessary significance in Nature: The product $(\delta\epsilon)(\delta t)$ for a particle of $\delta\epsilon < 1.24$ Bev and $\delta t < 10^{-13}/3 \times 10^{10}$ (the "nuclear time unit"), is less than h, and so, no mass less than 1.24 Bev *can* act in that period of time. The Universe as a whole teaches that there is an inverse relationship between the mass (or energy) and the volume of "entities" (since the Universe was in the past more energetic *and* smaller), and of "particles" (since both the Bohr, under positive energies, and the present models of the electron also show the existence of the same relationship), in the face of which we are obliged to reach the conclusion that no more "lumps" of mass exist inside the "basic" (but *not* fundamental particles such as the electron and perhaps also the proton and the neutron. (This last perhaps is used in order to convey our ignorance of the relationship of charge and mass in the proton, whether it contains a positron somehow distinguished from the rest of the protonic mass and of the corresponding configuration of masses that would otherwise form the charges, as suggested in Section 3.4 for the electron, relative to the balance of the neutronic mass). The same conclusion may in fact be necessary for the entire nucleus, if protons and neutrons are no more than the most stable fragments produced upon impact of a nucleus. That these fragments have an independent existence outside the nucleus is not proof positive of their *"independent" existence inside the nucleus*. A "basic" nuclide (and certainly also the nucleus as a whole) contains only smaller masses, the volume of which, however, if it were possible individually to be examined, would be found to be *larger than the size of the nucleus that contains them in a state of compression*. Thus the true mystery of the nuclide is not in that it contains masses, each heavier than the whole, but in the fact that it contains a *very large number* of fundamental photons (units of mass), which, because they are the lightest particles of mass, are *necessarily (each one individually) the largest (geometrically) single objects in the Universe*!!! *This is a dramatic conclusion indeed, but the only one that can be drawn*! The most massive particle, ever, was the entire Universe at age $T = 0$. At that moment, within zero volume, it contained *all* the fundamental photons. As it expands, smaller composite masses become evident that are also geometrically larger. At infinite expansion, one can expect that all the individual units of mass will also stand each one by itself and each one will be of infinite size!

In the meantime, between $0 < T < \infty$, the mystery of the electron and of the nucleus, the nuclides and their fragments is compounded, of course, by the fact that there evidently exist quasi-stationary solutions for the dynamics of the entire

ensemble corresponding to the observed stable particles and pseudo-stationary solutions corresponding to the "long-lived" (by the nuclear time scale) unstable fragments of nuclear disintegration.

If one equates the size (δx) associated with the emission of the fundamental photon discussed in Section 3.5 (p. 221) to its diameter d (considering the emission to be very much like the release of a perfectly spherical drop of water from a slowly dripping faucet), it turns out that $d = 2R/3$, which at present has the value of 1.135×10^{28} cm.

In light of the above discussion, then, the search for the fundamental constituents of matter inside the nuclides is totally misplaced. The only things that are likely to be discovered there are particles of progressively greater masses and shorter lifespans as the energies supplied are further increased. In a very real sense, looking deep inside the nucleus and the nuclides permits us to see things as they were in past ages of the Universe, when they were more compact. In this connection, values of the velocity of light greater than its present value *cannot*, of course, be recaptured in view of the forward rush of the age of the Universe, so that the picture we obtain by so looking inside the nucleus *is not and cannot be* faithful of the things as they were: more compact *and* more energetic, or *truly are* now! The search for the truly fundamental particles will be more successful in the opposite direction: The most extreme wavelength we can detect is by definition the lightest particle we can, so to speak, "lay hands" on. In retrospect, it is indeed most curious that this has not so far been the direction of search, especially in view of the Einstein-Planck equation $\epsilon = mc^2 = \nu h$, which clearly suggests that the smaller ϵ and m are without question associated with lower frequencies and longer wavelengths! This has undoubtedly been so because we have not yet become fully conscious of the fact that light *is* indeed mass!

The above discussion in effect adds to our view of the Harmony of the Spheres that we first encountered in Section 3.3, when we examined the electrons in the atom of helium. Here, we see that photons also are interpenetrating and interacting spheres of inversely related mass and radius. The larger (and lighter) spheres provide the light field within which the smaller (and heavier) coagulations of light and the entire Universe reside. What decides that mass m_1 such that $m_1c^2 = vh$ is still light while mass m_2 (and energy m_2c^2) only a ponderable body, so that the former can travel at the speed of light, while the latter necessarily at reduced speeds, can only be related to a fundamental internal structure difference between photons and ponderable bodies: Perhaps only to the fact that the latter possess structure, meaning that photons trapped inside them are forced to participate in a variety of motions the vectorial sum of which is c (see Section 2.3.2.2.4), while the former do not possess such structure and thus can only have a single, *physically unresolvable,* velocity vector.

Seen in this light, gravitation in reality is the force that holds together all the photons in the Universe, while electromagnetism is the force that determines the interactions of charges, each charge being the geometrical arrangement in space of a particular number of photons, such as that making up the electron (Section 3.4). Obviously, the two forces are not unrelated, since in the final analysis they only involve photons. Thus, the similarity between Newton's Law of Gravitation

and Coulomb's Law of Electrical Interaction is anything but accidental.

We also see how Mach's Principle, namely, that local phenomena are affected by distant ones, finds a natural home in the Newtonian scheme of things. Since photons interact and come in all sizes, from extremely hard γ-rays (if not harder still) to wavelengths of truly universal dimensions, distant phenomena do indeed affect local ones and vice versa. In this light, our first suggestion in this work, namely, the suggestion of the *logical* need *for* the *existence* in Nature of the Law of Separations, that alone determines, based on the effects of the entire Universe, the path along which the separation r is to be measured that enters Newton's Law, is nothing other than the formal incorporation of a generalized Mach principle in the basic universal interaction that we call gravity: Gravity, even between only two bodies, continues to be a global phenomenon, since all other particles in the Universe affect it.

With the Universe a Euclidean three-dimensional sphere of finite though ever increasing dimensions, there can be no question that Newton's third law applies in the fullest. With the Universe having a center remaining motionless for being the center of expansion relative to which all momenta vectorially *must* sum up to zero, the slightest move that tends to unbalance that delicate balance must be counteracted. If we express this idea for a single process involving mass m, namely, photons of an equal total mass, then this action-reaction process must be written in the form of the Law of Action (Eq. 287)

$$mc^2(\delta t)_m = (M - m)c^2(\delta t)_{(M-m)} = h.$$

The reaction time for a man of 80 kg of mass is 9.22×10^{-53} sec. For the entire Universe, it is 6.42×10^{-104} sec. A man's action will thus be counteracted by the entire Universe in

$$(\delta t) = h\left[Mc^2(1 - m/M)\right]^{-1} \cong 6.42 \times 10^{-104}\,(1 + 6.98 \times 10^{-57}) \text{ sec.}$$

It is obvious that the action of not just a man but of an entire galaxy and much more can hardly cause the Universe to delay its reaction. Nothing ever happens that passes unnoticed for long! The Universe remains in a very real sense the single atom that it was in the beginning. Its ability to know itself has hardly been reduced: It will always know itself within n_o^{-1} or about 1.7×10^{-121} parts of its age. The "velocity of reaction to change" in terms of time far exceeds the velocity of light. This is as it should be.* And it is the cause of inertia, since the slight-

* Measurements indicate that light does not spend measurable periods of time interacting with matter. Both light transmission and electrical conduction are delayed only because refraction increases the length of the "optical" path. For example, light requires 8.0×10^{-11} sec to traverse a length of 1 cm in diamond, meeting along the way about 5.76×10^{-7} atoms, each of 1.99×10^{-23} g. The interaction time for one atom thus is 3.70×10^{-25} sec. and the total time, assuming that each atom interacts in succession, is 2.13×10^{-17} sec., or only 2.64×10^{-7} parts of the total time needed. If a crystal of 1 cm^3 interacts as a unit, it only needs 2.34×10^{-48} sec. to interact. Indices of refraction are not known with sufficient accuracy to decide which of the two methods actually applies and to calculate the reaction time and obtain a true estimate of the path light follows in the crystal.

est motion tends to upset the universal balance at its center and causes the entire Universe to be set to motion in order to counteract the initial action of a body. The velocity of light is far too slow to permit a measurable reaction by the Universe in an equal, or even "reasonable", period of time. If my motion causes the entire Universe to move, it is hardly surprising that I should have difficulty starting or stopping, the more so the faster I try to do either. If action begets so fast a reaction, the gravitational mass m of a body, acted upon by universal gravity GM/R^2, and the inertial mass of the body, which experiences the essentially immediate effects of the rest of the Universe reacting to the initial action of the body, *is one and the same,* since no body smaller than the Universe can alter its own mass in any way (since its own reaction time is so much longer than that of the Universe as a whole) before the Universe reacts to the initial action of the body. It is also clear why the velocity of light is not the "velocity of reaction to change": If it took the Universe so long to react as the velocity of light indicates, this velocity could not possibly be uniform everywhere at the same time and independent of direction: It would depend upon the mass within a "reaction sphere" surrounding the travelling photon, namely, upon the local concentration of matter, which is not observed. This suggests that the search for "gravitons" mediating gravitation is totally misplaced, as is the general notion of particles "mediating" interactions. Gravity, as the "force of interaction" among all the photons in the Universe, needs no "mailman" to carry the interaction, nor a "street" upon which the "mailman" can walk. Gravity is as "pure" a law as we can hope to have. If it were not, another, even "purer" law would be required to set the ground rules for the operation of the former. But we have discovered no such law, nor indeed the need of one. The subject of Law will be taken up later.

All this taken together provides a much better idea of the complexity of the problem of "relativistic quantum gravity". It is clear that quantum effects are not limited within the atom, but are indeed universal and extremely fast. If they were not, the velocity of light would *not* be constant everywhere at constant T, nor indeed the fundamental photon a particle of truly universal size. On the other hand, it is also obvious that quantum effects cannot be probabilistic: If they were, the value of inertial mass could not be constant and equal to the mass acting. *Under a law of probability, the Universe could not know exactly where to forward its reaction*! That gravitational and inertial mass have already been found by Dicke to agree to within one part in 10^{11} *is our best proof of the absence of probability in the Universe*. From the relativity point of view, it is also clear that gravity cannot be "curvature of the space-time continuum". It is too much dependent upon the granular nature of the photons in the Universe, regardless of their size, to be regarded as curvature of a "continuous field" which in the absence of light simply cannot exist. The "field" *(nobody* has explained exactly what that is!) *cannot* be primary and specifying the mass of each photon, according to the "field's" curvature at any one point. A *point in the physical field is not inhabited by a single unit of mass* in view of the fact that photons of variable size and direction permeate the space occupied by the Universe. Rather, it is the field that is being specified by the universal distribution of mass. A. Pais has quoted a let-

ter from Einstein to Besso, written in 1954, where it was stated that "I consider it quite possible that physics cannot be based on the field concept, i.e. on continuous structures". (*"Some Strangeness in the Proportion",* H. Woolf, Ed., Addison Wesley Publ. Co. 1980, p. 242). What Einstein had in mind was that "it appears dubious whether a field theory can account for the atomistic structure of matter and radiation as well as of quantum phenomena" (loc. cit.). The problem has, it appears, been solved already in the reverse, i.e. the *natural* sequence, by the Good Lord: He, by providing the integral solutions of all motions, which alone can assure the uniform radial distribution of mass, which alone in turn guarantees the flatness of the field and the constancy of the velocity of light (at constant T), has in effect served us in the platter, as it were, the solution sought: Matter *and radiation are indeed granular, yet, the field on the whole is assured to be flat* (see Section 2.3.2.4) *and only locally perturbed*.

CONCLUDING REMARKS

This work has provided significant new insights into the Nature of the Universe and of its constituent fundamental particles. In so doing, and at the same time, it has brought us to the front of some closed doors that are unlikely ever to be opened by science: Because, the truly great scientific questions are those relating to the intrinsic nature of mass (M and m_o), of the gravitational constant G and of the universal age T. All else physical is ultimately referred to those three physical quantities. Yet, what each one of them is is exactly what human science will never answer: What can be the intrinsic nature of the fundamental photon of mass $\sim 2 \times 10^{-65}$ gm, of present radius $\sim 10^{28}$ cm, of present density $\sim 3 \times 10^{-150}$ gm/cm^3, *that is both whole and indivisible?* And what is G? What is T? *We have* deluded ourselves into believing that we have a very good grasp of mass, length and time. In reality, we do not know anything at all about the intrinsic nature of these things. The mere fact that we so far have regarded length as a fundamental dimension of the Natural Universe (a notion that is totally dispelled the very moment we realize the true significance of universal expansion) shows the true extent of our basic understanding! And what is *space* into which the *universal volume* manages to grow bigger? *That is* the true Utopia, until the expanding Universe makes a *Τόπος* out of it! As has already been argued, the Universe only speaks about its volume, exactly like every other body or object. So, to equate space to the volume of the Universe is now seen quite clearly to be a purely philosophical (and of *very* dubious value at that!), and *not* a scientific proposition. Are we, then, to believe the reality of these truly untouchable and unobservable things, upon the objective existence of which all else physical hinges? And yet, we do not doubt the objective reality of the world around us. It was that reality and the unswerving pursuit of consistency that inexorably led to these findings. As a result, we indeed are compelled by the world around us and our own cognitive logic, aspiring to become one with the Logic of *Λόγος*, to accept as the most incontrovertible physical facts the existence of things (three physical:

M = nm_o, G, T; one non-physical: space) that can never be observed in themselves. Subjectivists have dismissed the objective reality of things, as we indicated in the opening paragraph of the Preface. Physical scientists, objectivists par excellence, have played for more than three thousand years with rods and clocks that they thought they knew. Now, they find that they do not know them after all! The philosophically inclined amongst the scientists have already sensed that the great mysteries of Nature will never be opened to us. Socrates had recognized that he had to keep on learning: Γηράσκω ἀεὶ διδασκόμενος. Lately, scientists have recognized that science leads to truth gradually and by degrees, implying that the whole truth may never be reached. In light of this work, this appears to be both true and untrue: As far as details are concerned, it must be held as true. As far as the whole picture matters (in the manner of classical thermodynamics), the truth can really be told, except, that is, the truth about the *intrinsic* nature of the four *in themselves unobservable* G, M, T and Space. This should not really surprise anyone after Gödel, who showed that no axiomatic system is fully definable from within. This principle is now seen to apply not only to mathematics but to the Natural Universe as well: We are in it and from within we cannot grasp all its truth. We can only know about the mechanics, not about the Essence of Things. One is reminded of the Platonic Ideas and their images in the World. Science can only deal in the latter; the former are quite beyond its scope. Thus it is not surprising that the philosophically inclined amongst the scientists have developed, each one for himself, it appears, a kind of scientific mysticism. Those may find in these pages some additional proof of the correctness of the view that the objectivity of the World inexorably leads to the "subjectivity" in the comprehension of the physically demanded unobservables. Are all the rest, let us call them, without prejudice, unrepentant objectivists, to give up in despair? Certainly not! Because, the true Lesson the Universe teaches us all is *not* yet complete. In the end of that Lesson, it will be realized that objectivity need not be surrendered. Only lifted up to encompass a wider field than has hitherto been restricted to by the notion that objectivity is necessarily and exclusively experiential materialism. It is not!!!

NOTE
ON
THE EVOLUTION OF THE UNIVERSE

(Not only for the non-mathematically trained Readers!)

NOBODY denies that the "physical dimensions of energy" are: "mass times velocity squared: [e.g., kinetic energy is $mv^2/2$, $mc^2/2$], and yet light (demonstrably having energy, now at last collected and put even to dishonest, not just honest use!) is still regarded as massless; and, therefore, supposedly *as not it too subject to gravitation*!!!! Do I need to say more??? Here some of it goes: Energy ***cannot*** be understood in terms of a mass that is zero!!! Ergo, as light ***is*** a form of energy, ***it has*** mass!!! In addition, velocity has the dimensions of length/time (e.g. cm/sec) At the **exact zero** start of time, ***INESCAPABLY***, the velocity of ***ANY***, not just the smallest but also the largest, moving mass ***WAS NECESSARILY INFINITE***!!! As light now has a non-infinite velocity, it only **proves** that it has since been retarded, **due solely to the gravitation exerted upon it by the entire universe**!!!

In light of which, first of all the physicists ***MUST***, at very long last, face the greatest of all undeniable facts and tell us who/what was the ***CAUSE*** for the genesis of the physical universe! **Silence on this all too important matter implies blatant cowardice and dishonesty**! As the universe is at all understandable in terms of mathematics, how indeed can this be solely an *a posteriori* conclusion? How is it possible that mathematics, a *purely mental activity/process, was not an* ***A PRIORI MENTAL NECESSITY*** *(yet, IN* ***WHOSE MIND?****), for a universe yet to come into being,* ***to be understandable if at all, even by us yet to come into being, in purely mathematical terms?***

Following which, how indeed may the "scientists" still claim to be honest??? ??? ???

PART FOUR

THE SIGNIFICANCE OF LAW IN THE ORDER OF THINGS

4.1

THE EVIDENCE OF NATURAL LAW AND THE NEED OF ITS STUDY

As works on Cosmology go, this one is totally different. It has not sought to describe astronomical details and other "facts" in hopes of gleaning from them clues into the laws of operation of the Universe. Such a course, as current literature shows, begins with the supposition that all that passes as presently established physical law and accepted theory has continued validity in Nature over distance and time. Since no check is possible within present knowledge of the validity of every item in this whole and elaborate body of supposition, and of the internal consistency of the whole body, any conclusions reached by such a route are doubtless going to be inconclusive, because in such a structure, human contingency and Natural Fact *cannot be told* apart. The current agreement of experts is neither proof nor guarantee that the lesson of the Universe is well learned. In times past, *all* experts agreed that the Earth was flat. Nature did not oblige. The sophistication of presently accepted ideas has not brought us really much closer to any grand synthesis. If anything, it has made the whole panorama that much more difficult to grasp. "Facts" accumulate faster than can be analyzed and no theory exists able to make the important connections.

In juxtaposition to all this, the present work started with the idea of the absolute validity in Nature of the fewest possible, truly independent fundamental laws and built upon them a body of logically tightly bound theorems and minor laws and sought to find out whether the entire logical edifice can stand up in the cool, cruel light of irrefutable evidence in Nature. In the process, a very large, arguably the largest ever, body of notions was brought together and their relationships established, mostly quantitatively, as never before. Thus either the whole edifice collapses, if one of its parts is found to run explicitly against the irrefutable evidence of Nature, or it stands compellingly together as no other theory of the Universe ever stood. As a result, the present findings are the easiest to falsify or to accept, one might say, the sharpest so far Occum's Razor upon Popper's Delight!

If at this stage, one were to ask which, briefly, is or are the one or two items that guarantee best the "viability" of the ideas advanced heretofore in this work, the answer comes unhesitatingly: Number One: The agreement of calculated and observed density of matter and the derivation of the value of the universal mass from the present velocity of light. Although the values of D and M thus obtained really depend upon the assumed age of the Universe, still, together they demon-

strate that G is *not* a mere proportionality constant but goes to the very core of the structure of the Universe, in which nothing *has been overlooked* and everything is made up of fundamental photons held together, to the extent that they can be held together, by the force of gravity. It is only natural, then, that universal gravity and the velocity of light be related as here determined. Number Two: The absolute absence in Nature of uncertainty, as conclusively demonstrated by the extremely high degree of identity of gravitational and inertial mass. The latter, determined by the reaction of the Universe to the initial action of a body, shows beyond any doubt whatsoever that the Universe knows exactly by how much and where to apply its reaction! The Universe in this particular regard does *not* play dice, and it is safe to conclude that in no regard does it ever play dice. Planck's constant is *not* the measure of uncertainty in the Universe, but the *exacting measure of action* that permits an exactly metered change and guarantees stability of form in the face of continual flux. No other, stronger than these two together, evidence can be found, or is in fact needed, that the Universe indeed works on the basis of Law. And no refutation of this statement should be accepted, unless *it proves beyond scientific doubt freed from doubtful suppositions* that things in *Nature* (not in "physics") are not truly as here stated.

It is this overwhelming evidence of all-encompassing, strictly formulated Law that calls so irresistibly for attention to the Law itself. And it is thus that it is safe to claim that the study of the Universe cannot be completed without study and analysis of the Law, without evaluation and determination of its position in the Scheme of Things. The overwhelming evidence of Law compels us to accept the existence of an objective to the satisfaction of which the Law sees. To argue against the existence of such an objective, in reality, is to argue against everything that the human enterprise is about. If these specks of dust that we call humanity recognize the legitimacy of objectives that can only be attained through law rather than through chance and chaos, and that human law exists precisely because there are objectives worthy of attainment, it is positively silly, nay, *insane* to state that the Universe as a whole has Law but no objective! *The Lesson of the Universe, in effect the determination of* its *objective, can only be learned through study of its Law*.

It is this logical necessity that compels us to go beyond the limits of any other work on Cosmology, beyond even what could be *called the "scientific" limits of the present findings*. It is parochial, indeed it is lamentably naive and adolescent to divide knowledge into tight compartments and be satisfied with stopping "here". Knowledge is one and indivisible because so is Logic. We *must* press on: The existence of *strict Law* in the Universe argues compellingly for the existence of *strict Logic* behind the *strict Law* found in the Universe. Thus, our work will not logically be complete until we are logically brought to the very edge of Logic itself, as can be seen from this side of the *truly* Great Divide.

4.2

THE LAWS OF NATURE AND OF PHYSICS: THEIR LOGIC, DEVELOPMENT AND INTERACTIONS IN THE FIELD OF IDEAS

Understanding in Man comes slowly and painfully as he absorbs and gradually begins to comprehend his experiences. Regularity of repetition, preeminently the alternation of day and night and of the seasons, is undoubtedly amongst the earliest experiences of the Thinking Man. Very few other experiences can possibly be established and comprehended in a shorter period of time. Perhaps only one: If mountains or hills are around, our Man will *surely know before day's end* that it is far easier to climb *down rather than* up; that rocks, if disturbed, *only run downhill and never uphill*. And if he is lucky enough to be near a body of water, he will immediately be struck by the flatness of its surface, that is automatically established when the water has run down and can run no more. If the body of water is large enough, our Man will not fail to be amazed at the horizon, the smoothest, "straightest" observable line in all of Nature that is actually a circle. Thus a Man with a modicum of comprehension will not for long fail to notice some basic phenomena that, he concludes, must be governed by laws, distinct laws, one law to each phenomenon, one "god" to each attribute of Nature, Laws of Nature. Much later, after Newton, he realizes that all of the above phenomena can be explained on the basis of a single law: The Law of Gravity. But by then, other more complex phenomena attract his attention that "cannot" be explained on the basis of gravity, or at least not in an obvious way. The body of scientific knowledge has begun to grow fast now, and "Laws of Nature" are discovered in quick succession. Scientific knowledge branches out and what in earlier times was called "Natural Philosophy" now becomes semi-independent bodies of knowledge surrounding "Physics", the mother of all natural sciences.

Malpractices in the relationships of men, in the meantime, have led to revolt: political and religious; but worst of all, philosophical and intellectual: Man breaks, or so he thinks, the bonds of servitude to men who had imposed upon him their power "Dei gratia", meaning principally if not outright exclusively up until not too long ago, if not still, His special dispensation to them to rule at their own absolute and unquestioned will and discretion. So deeply was this connotation embedded in the minds of masters and servants, that when revolt came, it did not stop at the palaces of humans; it also challenged the Gates of Heaven:

if God gave them permission so to rule, then He more than they are at fault and a true revolution can only be complete if carried out against Him rather than them. No greater revolution can possibly be thought of than the one that breaks the bond of Man to God.

Things did not have to develop this way and, in fact, they did not develop this way everywhere. But they did develop where it counted the most: Catholic or ex-Catholic Europe. For it was there that faith was compulsory rather than tenderly cultivated spontaneously to bring forth its abundant fruit in its own time. It was there that, to put it mildly, the faithful were actively discouraged and still are to this day to study the Testaments on their own. In the inevitable Darkness that ensued, the most abominable, unholy alliances of Religion and Politics were formed and dissolved always for express political gain, and the most barbaric acts enacted in the Holy Name of the Living God of Love. Centuries later, to this very moment, the surviving arrogant organized bodies of "Faith" have yet to admit and publicly repent for the unpardonable sins knowingly committed against the Holy Spirit. It was inevitable that, when revolution came, it should try to redress all past grievances. The Catholic and ex-Catholic Churches had not cultivated spontaneous faith in a Loving and Caring God; they had only instilled the fear of superstition, the fear of everlasting Hell in the hearts of the illiterate, whose greatest approach to the Divinity was to kiss the ring (a permission doubtless grudgingly bestowed upon the lips of the sickly, disease-carrying populace) on the finger of the living representative of Christ, who had self-ordained his own right to be carried shamelessly and mightily upon the shoulders of Men, when the Master, in Whose Holy Name he claims for himself such imperial honors, would just barely bring Himself to seat sideways on a little donkey, only to remind us all of the prophesy, now finally fulfilled, so that we may henceforth know Whom we had happened across, Whom we have yet to recognize, just days before He willingly ascended on the Cross, so that we may live the rest of our lives on Earth as brothers rather than as masters and slaves! So, the time of revolution was the time of harvesting the produce of the seeds that had thus been sown. That superstition was not only yesterday's nightmare but continues still can easily be attested: One only has to listen to the blandness of the religious message (that does all but prick the consciences of the audience at their most sensitive, lest they see the churches completely emptied), to feel its spiritual emptiness, its scope and its tenor, to comprehend the total absence of faith committed to a Living, Loving, Personal God that it exhumes despite all lukewarm empty words to the contrary, to *know* that speaker and congregation most definitely do *not* feel they are in the presence of God!

This was and still is the spiritual climate in which scientists and science grew and grow. Schools teach "science". *Nobody* teaches the rudiments of committed Christian Faith. Oh, yes, obedience to this or that fractionated religious dogma in hopes of heavenly recompense is still taught, avidly! As for superstition, it is taught freely almost everywhere! Only, it is given other, fancier, modern names! It is and will continue to be a grave mistake to overlook the positively deleterious effects of this environment upon science as an activity of complex

human beings, effects that are bound to shape the form of the scientific "findings" and "conclusions", and thus dressed as universal "facts" to flow back into the blood-stream of society, ready for another vicious cycle!

When religion could and can hardly be separated from superstition, the first steps of revolt were and are tentative and apprehensive! Man was and is testing the "Wrath of God". When no calamities befell, Man, judging God in his own measly measure in which alone can the perceived "Wrath of God" make any sense at all, began to think less of Him: If I insult Him and He takes it, perhaps He is not at all what He is supposed to be. Let us insult some more! No response? Well then, He does not exist! Man has relegated the Personal God out of existence! Atheism has entered the vocabulary of Man! There were and are psychological reasons, too. Which one of us sinners really likes finally to be called to account? And the shame of it! Oh! That that shame is all we carry through life, along with our faith in His Hand ever-ready to render assistance, so that we may as we progress through life reduce the frequency and magnitude of our transgressions, so that we may be better prepared to board Charon's Boat, is a realization that has yet to enter our consciousness! Modern man has been told, has persuaded himself that is, that minding his sins is "unhealthful". Gone are the sins? Gone is God the Judge; but only man is left much the lesser for it! He progresses through life but really regresses in moral stature! One only has to look around, to compare the idealism of the young to the "pragmatism" of the old, exceptions notwithstanding!

Even science, with telescope and microscope in hand, the entire Universe open to its examination, is unable to provide anything but the most fleeting aesthetic satisfaction to Man, thus agonizingly and desperately alone going through life. It is positively depressing to read the closing pages of books on Cosmology: One would expect to find there the very best the author has to offer, his personal testimony of wisdom gained through science. But the reader only finds blandness and the cold emptiness of a "meaningless" expanding Universe; or the total purposelessness of an oscillating one, the only saving feature of which is that it perpetually oscillates and thus theoretically(?) is able to bring forth another cycle of totally purposeless life where acts of love or of hatred are just as good or bad or indifferent, that no impersonal "god", Spinoza's or Einstein's pantheism, the ever expanding or ever oscillating but always ever arrogant and ever oblivious Universe itself, can possibly fill to Man's heart's content, however desperate an unbelieving author's intellectual salti, full of important sounding yet in reality totally meaningless non-sequiturs, that are only there because it is the custom thus to close such works! Again, no personal offense is meant! Only our "culture" is analyzed.

If Cosmology, the science of the Cosmos, la crème de la crème of all branches of knowledge combined, is judged by the closing statements in books on Cosmology, then indeed one is compelled to conclude that modern man is totally to be pitied. Look at his spectacle: Shoulders bent, head low, eyes blank, full of emptiness inside and out. Is this the state of "bliss" his modern culture had promised him? Continue feeding his mind with the trash that today passes for food and you will positively be surprised at what he can still do! The horrors of

the past will be as nothing in comparison! Dostoyevsky said it best: "If there is no God, nothing is forbidden". Here I am not just talking of the phychologically sick man, but of the supposedly healthy one who is fed all the fruits of modern science! It is *themselves* that scientists try so hard to persuade that God does not exist! Just tell me: what major modern scientific advance from the A- and H-bombs to scavenging for *living* organs (now *really*, in order to *save* lives or just in order to make even more money while "selling" themselves as saviors?) is not having its hands bloodstained? What weapon of mass destruction was not constructed by scientists before it was delivered to the hands of generals and politicians? The modern scientists' talk about a non-existent God is their desperate effort to soothe their own screaming guilty consciences! Is it any wonder that such a Man would rather die tomorrow in the mushroom of an H-bomb and destroy *everything* in the process than wait for the interminable end of an ever-lonelier existence in the perfect isolation chamber, where even the comfort of the narrow walls will be denied him, as we all now tell him? Early on, in his beginning, the serpent seduced him: "Eat of this fruit and you shall know and shall become greater than God". And Man ate and henceforth knew!: By disobeying the Law, he learned of the loneliness and nakedness of untrusting in God. And never before was he as lonely and as naked, as empty of faith in all good and as irrevocably hopeless as when he relegated God to nonexistence. He came to know many things, but never how to fill the emptiness of his soul. Gone is the Law, that compels consideration of the presence of the Lawgiver? Gone is God the Lawgiver, too, who *by His Law* fills all! So, is your conscience nagging you? Abolish God who hides in there! You cannot forget God? Perhaps the talk of non-existent Law, of total lawlessness in the absolute chaos of meaninglessness will confuse your brain so much that, exhausted you shall at last fall asleep, closing yet another day of guilt! Just a glimpse in a scientist's day and *nightmarish yet sleepless* tossing in bed! Even that takes some conscience! But just think of it this way also: The Americans are justly proud for being the first nation with a tightly written Constitution, that through Law freed the nation from the awesome effect of unscrupulous demagogues of the Athenian type. And yet, there are highly respected American scientists, Nobel laureates no less, who of think their own talk about a Lawless Universe as inconsequential! That *is* irresponsible in the extreme!

The tears Man shed on being expelled from Eden were *not* for the loss of comforts. They were for the loneliness he felt outside the Realm of God's Law. In this empty outside, we must provide our own law. It was not for nothing that God taught Nature to follow the path of least action. It was meant to teach us a lesson and to preserve our own strength for the really difficult struggle. In the material expanding Universe the "fact" that stones roll downhill is a mere illusion, for in reality they too are being lifted up against all gravity at the Lord's first command: "Let there be light". Are we no more than stones? If so, we can wait for our turn with the rest of them! But if we indeed are more, how can we wait for so long? The Spirit in us can only be too anxious to rejoin the Higher Order that it once knew! The path of least resistance is the path of the stone. The path of the most resistance is the path of the Moral Self struggling to free itself the soonest! We need the material relief of the first, so that we may best follow

the second, the path of the Spirit. In instituting the Prohibition, the Lord showed us that we indeed carried a living icon of His own Spirit and were no mere stones. The struggle of Matter against Spirit was already on from the moment of the first Prohibition. For it is this juxtaposition, the opposite paths of least and most action, that separate and distinguish Matter from Spirit. With the institution of Law, the two had been shown where each belongs: Had we chosen to stay in Eden, we would still have to choose day by day, moment by moment. Only, the choice and the struggle would have been that much easier under the Father's Loving Care. Instead, we chose to disobey, which means that *we* banished *ourselves* from Eden. The spirit in us chose the way of the matter. Light became darkness. We no longer belonged to the Land of the Light. But outside of Eden, we now find we have to produce our own "Law", our own "Light" to guide our steps. Still, denying God's existence, we cannot and shall never produce any Light, for only God *is* Light. The more we deny Him, the blacker the abyss into which we choose to plunge ever deeper. Now, our cheeks are dry: not because we ever got used to our loneliness in the darkness of the abyss, for nothing is so devastatingly oppressive as God's absence, but because we have no more tears! We are thoroughly dried up and we know it. Otherwise, we would not run after every false image of Moisture to moisten our parched lips, to give color to our cheeks and life to our eyes. Only one thing do we not consider: How to bring the Waters back to our internal Fountain of Youth. Now, it looks as though we are indeed far gone! Still, there remains the *one last hope:* The wounds *will* heal, the fountains of our eyes *will* be replenished and our sight restored, when we heed the Last Lesson: the Way of the Law that the Universe itself teaches, teacher of absolutely last resort, now that the Lord God no longer exists for us! If we miss this *last* lesson, we *shall* be lost and shall only have ourselves to blame for heeding the false messages of optimism emanating from the mouths of the Sirens, professional deceivers of all persuasions. Theirs is the optimistic assurance that the path of the stone is the easiest—for stones. The Lord's τεθλιμένη ὁδός, the Hard Way, is the Way of the Spirit. The choice is ours. And it identifies us!

What, before Man's "emancipation" from God, had been seen as a single Universal Order in Nature and Society is now broken. Without God, and to avoid the irrefutable religious connotation, the term "Laws of Nature" is deliberately avoided and replaced by the term "laws of physics", only later to be re-introduced tentatively and timidly, by those who, having found nothing away from God but still most anxious to keep Him away, recognize that still "things *must* make sense, somehow". To them, only one option remains open: Nature, the Universe itself in itself, not Creation, but "god" of sorts! But Science and Logic will show that *the Universe is not God*! Copernicus "demolished" the notion that the Earth is the center of the Universe and with it the notion that Man is unique in the Universe as the inhabitant of its center. But the irony must not escape us: Godless Man, in the guise of his "laws of physics", has reclaimed not only the position he occupied prior to the discovery of Copernicus, but a great deal more: "Physics" is *his "*invention"; "the laws of the phenomena do not exist separate from his ability to categorize the phenomena", to paraphrase Bronowski! The "anthropic principle" is introduced to make some sense out of the obvious god-

less nonsense the professors thought up as "explanation"! Because, even a godless world feels the irresistible urge to fill the vacancy at the center: With God relegated out of existence, the position belongs to Man, recognized as the only being capable of the most advanced if still crooked thinking, and he can exclaim "Copernicus, I have beaten you"! The "laws of physics are mine and mine alone! I will use them, and if I will, abuse them!". The great man-made calamities Man has brought upon himself and his world in this most scientific of all centuries cannot and will never be understood, and the greatest calamity of all for which he now prepares so openly and shamelessly will, alas, not be avoided* without correct comprehension of the intimate relationship of Science-Nature-Law-God-Man.

On nothing else does Man, whether he be the greatest intellect that ever lived or a mere illiterate peasant, rely more than on his own mind. Atheist scientists, in order to soothe their consciences by dissociating Man from the Spirit, have mightily tried to identify his mind with his brain. If that indeed be so, however, they have *yet* to present us with a *Logical* explanation of how it is that, *in a Nature that according to them depends on the principle of indeterminacy, and on everything being in total, unpredictable, chaotic flux down even on the level of the so-called Planck distance, their own brains do so very much remain intac*t, at least enough so that they carry on so determinately the war against the Spirit, since nothing else can demonstrate their life-long *mindful* efforts, even from the wheelchair of a famous invalid, to discover equations that will prove the Spirit unneeded! How is it that the innermost chaos and the principle of indeterminacy do indeed fail to produce equally chaotic brains? Or must we conclude that their brains indeed are chaotic, or else such great "brains" would certainly *not* so totally fail to comprehend this terrible predicament they, so, have created for themselves?

When the revolt of Man against God was still young, Man could not fail to enjoy the exhilaration of his assumed emancipation: after all, he did not have to listen weekly to fiery speeches on the properties of Hell! The notion that "Man does not need God, Science suffices" was not introduced by rulers, novelists, generals, or popularizers of science, but by the scientists themselves, preeminently by Laplace. Such. already was the confidence of arrogant Man in himself and his "physics". The notion caught. After all, it was the authoritative word of the "New Magicians", performers of *tangible* "miracles"! Humanism, the belief that Man suffices and God is superfluous, supplanted the *healthier* earlier moral and intellectual system based on the belief in God. Evolution of the living species (see next Section) based on pure chance and the animalistic instinct of survival, entered the arena of human thought. Relativity, the abolition of absolute relationships in space and time, the notion that the Universe is *as seen by this minuscule observer* and not to bother about illusions, followed. The bitter cup was then filled to overflowing by the introduction of chance to the whole of Cosmos. and the comprehensive abolition of Causality. The greatest calamities had not yet come.

* Remember: this was written in the days of President Reagan and all the nonsense of so-called "Star Wars" of Hollywoodian inspiration having taken hold of professorial brains of high caliber!]

When they did come, it was realized that they *could not have been as severe,* if science had not played so crucial a part in the development of the means of destruction. And then, slowly, it began to become obvious: Science is still too far from answering its own logical inconsistencies, that become truly glaring once faced directly rather than through and from within the strict scientific formalism of the theories of evolution, relativity, and probabilistic quantum mechanics.

The more thoughtful scientists thus finally developed a certain amount of humility and began questioning the logical and philosophical foundations of modern science which they serve. However, the splintering of thought engendered by the unavoidable increase in specialization; the abolition of the all-rounded and time-consuming classical training in favor of a training better suited to "quick results" required by technologically-based commercial competition, in which the systematic study of Logic, Law, Ethics and Religion were seen as totally superfluous if not a manifestly undesirable baggage that could only impede the headlong rush after the greatest possible profit for the moment, regardless of the means used as long as one is not caught and is not punished [the results of which we now see all over the globe as this revision is being made]; the almost complete straining by day's end of the so very much needed intellectual and moral energy to contemplate and put into perspective the day's events, on the basis of which alone can Man realize the Pythagorean "know thyself"; all these things together have created a very curious intellectual product: An average man-in-the-street, an average "specialist", even an average "scientist" *who is* ill-equipped to handle the larger questions. Even thoughtful scientists today have great difficulty discussing anything that is outside their narrow field of professional expertise (sometimes even seeing their own field in perspective), and even greater difficulty still presenting a well-organized body of fully formed, informed and confirmed personal opinion to guide the holder through intellectual, scientific, philosophical, moral, yet thoroughly united and meaningful in itself life. Technology rushes along and we all are left breathless behind our own creature, unable to control it, to balance ourselves, to bring meaning back to science and to the entire human enterprise. Thus, the humility of scientists, so painfully re-acquired, has not yet been brought up fully into the active conscious, nor has the news of it spread yet through the ranks of scientists and very much less so through the rest of culture. There are people around, scientists too, who still believe that current science and technology will solve our problems, though themselves have no idea how this feat will be accomplished.

This long discourse as well as all "non-scientific" excursions heretofore interspersed throughout this work, the casual reader, product of modern culture, will doubtless say, have no place in a scientific treatise. But here, we have undertaken, no less, to lay down the Principles of the Universe, the ultimate reality in Nature. All that transpires in Nature transpires in the Universe. The theist holds that there is more to Reality than the Natural Universe. The atheist denies the reality of anything outside the Natural Universe, as seen through the instruments of science; for him there is no Higher Order. Whether the latter cares to call himself simply atheist, or dialectic materialist, or natural pantheist, or whatever, to the extent that he refers everything to mass, length and time, or, now, to $M(=nm_o)$, G

and T and to nothing else beyond these *including the source of the Laws that control these*, *he is in effect a real unalloyed atheist, no longer a true scientist*! But, neither theist nor atheist can deny that our human activities, to the extent that they partake of and use as support the Natural World are indeed activities shaped by, and in return themselves shaping our perception of the Natural World and of the World of Ideas. Thus, each of the two has a vital interest in finding out once and for all whether the Universe as a whole proves *his* philosophical position. Its Laws and its Logic are therefore crucial, and the search for them must be all-embracing and exhaustive. It is the humble yet fully considered opinion of this author that without proper analysis of the position of Law in the Universe, ultimate understanding of the Universe will remain incomplete, for ever elusive. In a very real sense, all that has been presented so far in this work, important in itself though it may be, is as nothing when compared to the problem of the Laws and Logic of the Universe. Only when the first three parts of this work are seen as an introduction to this Fourth Part, will they have served their purpose. Is the Universe all there is, as the atheist believes, there to be exploited for however inhuman political gain or monetary profit? If so, the Laws and Logic of the Universe are indeed the apogee of atheistic faith and must lead irrefutably to the atheistic tenet that it is the absolute right of one to exploit the other, in the incessant pursuit of which, "compromise" is but an expedient to catch our breath, to regroup, stealthily to gain advantage in the eternal struggle for domination on this preposterously little stage on which the human drama unfolds in the midst of an indifferent Universe! Or is it but a tool, the ladder that leads to the Ἱοθεινὴν Πατρίδα, the longingly and continually contemplated Fatherland, the Jerusalem in the Heaven, God's own embrace, of the Orthodox Mystic, the Ancient Greeks' and Schiller's and Beethoven's Elysium? If so, its Laws and Logic must be the ultimate means in the hands of Man to bridge the Great Chasm of Faith that separates the Here from the There. No one has truly believed, who has not experienced the terror of unbelief, who could not use all the help he could find to make the Great Leap of Faith as short and as safe and assured as he could make it, who has not felt the hot tears streaming down on the cheeks on hearing inside of himself the heartrending cry of "I believe, O Lord, help me in my unbelief!". Nor can there be a greater despair than the intellectual's who has gone to the Ends of the Universe and nowhere has found a place worthy enough to deposit upon his precious, nay, sacred burden of human hope, while every fiber of body and heart, every instinct of intellect and soul has never stopped crying out for a Reason for Being! If the Lord is There, waiting, would He not have made that Chasm a really bridgeable one? What Father deserves the holy name who does not extend a strong, loving hand in the time of his child's most desperate need, even if it be the least of his children lost in the very fringes of the Universe? Where else but there, then, *must* He place the net of Law and Logic to save that wayward child before it falls off the precipice? And so, indeed, what Cosmology is complete when all the materials to make the Cosmos whole is at hand but the cosmologist leaves them here and there disjointed and lifeless and does not make the final great attempt to make sense out of all the *apparent* nonsense?

Now, this great synthesis cannot really be accomplished, if in our search we begin from the here and now standpoint, if the so-called "laws of physics" are not stripped of the thick varnish of human supposition, layer upon ever more opaque layer. When we make models of the Universe based on first principles and we are forced to make additional assumptions to help us along the way, for the obvious reason that the first principles adopted were not sufficient in themselves, we may indeed arrive at a certain conception, but then the findings have to be weighed against the objective value of the first principles posited and all later assumptions. To the disinterested reader, most of the discussion and non-discussion (!) on relativity and quantum mechanics *is not about the World out there but about the theories themselves*! As a first example, take a subject of non-discussion: The velocity of light being constant. The entire edifice of modern science and cosmology is built largely upon this one leg. *But this is a mere human supposition*, the questioning of which must be veritable sacrilege in the temples of modern science! As a second example, take Mach's principle, "the idea. that the inertia of a body is due to its interaction with the distant parts of the Universe", that is here amended as "… with *all* parts of the Universe"! Whether or not this principle is included in Einstein's differential equations of general relativity has been an *important* point of debate. Einstein himself thought that his equations automatically included the principle. Most experts today disagree! "Argument has raged." (Clive Kilmister: "The Nature of the Universe"; E.P. Dutton, New York, 1971, p. 92; see also R. Besançon's *"Encyclopedia of Physics"*, Van Nostrand-Reinhold, 2nd Edition, p. 179)! Now, general relativity is viewed as the theory by means of which we shall some day know the World. Yet, its own creator and most gifted students cannot agree on the contents of the theory itself! The objective observer feels compelled to paraphrase Shakespeare: "There is something suspicious in the state of general relativity"! The Universe bespeaks of Law and here we have a theory that cannot set its own house in order! Is it really presumptuous to call *it* presumptuous? As a third example, take the much sought after unification of relativity and quantum mechanics: This unification is seen as having played a most important part, in a manner *totally unknown*, in shaping the World during the so-called "Planck time", the first 1.35×10^{-43} sec of the existence of the Universe. How do we "know" this? Because there is only one way in which G, c and h can be combined to yield time and this combination is $(hGc^{-5})^{1/2} \cong 1.35 \times 10^{-43}$ sec, or $(hGc^{-5}/2\pi)^{1/2} \cong 5.39 \times 10^{-44}$ sec. Why is this quantity of time thought so important? Because it combines an element from Newton's Gravity, an element from Planck's Quantum and an element from Einstein's Relativity! And so, the Planck time "must" be important in Nature! So, *tacitly*, the argument goes. But only if this quantity can really be proven to be constant, can it possibly have had some significance in Nature! Yet, of this there is absolutely no intimation in *an*y currently accepted theory. The present work shows that the Planck time is no other than

$$(hGc^{-5})^{1/2} \equiv T/(4n_o/3)^{1/2} \quad \text{or} \quad (hGc^{-5}/2\pi)^{1/2} = T/(2n_o/3\pi)^{1/2},$$

and therefore *not* a fixed quantity at all! When then did relativity and quantum

mechanics united before then get separated, or the reverse? There has been nor will there ever be such a signpost along the avenue of time!!! The constancy of G and the specific variability of c and h given in this work make the so-called Planck time to be a *constant fraction* on the universal age, that could not but itself shrink to zero back when T = 0; As the universal age is a *single smooth* time continuum, there was absolutely no moment at which the basic matters changed and Nature fell under, or liberated itself from, the control of this or that man-made theory! Our theories are only our poor attempts to "understand" matters as if they ever fell or shall ever fall under the spell of our misconceptions! The general idea that the Cosmos can be understood on the basis of man-made so-called "laws of physics" is here shown to be totally foreign to the Laws of Nature! Only now, guided by the dimensional analysis of *her* laws may we get to appreciate the degree of how far off from *her* Laws the so-called "laws of physics" fell! Man, in his headstrong belief in the infallibility of his own subjectivity that he refuses to recognize as such, has refused to seek out *in Nature* the help he needed to get to *her* Laws and through them to *their* Lawgiver! So, he indeed has built "castles in the air" [Einstein's own expression and terrified realization late in life that human science may indeed be such], by adding layer upon layer of earlier unverified supposition. That the Universe is infinite, that it has no center *are* such suppositions. The arguments, presented earlier, on the ponderability of the photon *go to* the very *heart of the conditionality of modern science*. The fundamental tenet of current quantum mechanics that uncertainty is intrinsic in Nature and not only a (limitation due to) human misunderstanding, as if Nature needed man-made rods and clocks to go about her business just as does Man, *is in effect nothing more than another attempt to hide our unexamined presuppositions*! So, indeed, even if current science and cosmology ever succeed to present a seemingly "coherent" (?) picture of the World, that picture will never be anything more than a *human* construct.

Thoughtful observers have recognized and have protested that since Man is the latest product of Nature, her Laws must have preexisted him, that it is pure nonsense to argue that order came to the World with Man: How little we truly understand is now becoming apparent. The degrees of understanding are also there for all to see: Is then the World one of order or disorder? To the man possessing the "laws of physics" it must seem to be one of order—of sorts! To the ignorant layman one of total bafflement! And, yet, it is the latter that *comprehends better,* in his innocence and humility (for he falls more promptly to the ground to look at and smell in amazement the "humble Lilies of the Field"), that the World is ordered based on Laws, indeed a *Cosmos* and *not* acosmos! The former surrounded by his own creatures, "laws of physics", has not hesitated to turn Logic on its head, to turn even against the language*, that is, against our still uncorrupted mode of thinking. Nor has he hesitated to speculate on "Law without

* To give here and for the immediately following three asterisks the references could be taken as a left-handed credit and a personal attack. *This is not the intent*! The intent is to show that the "laws of physics" are not necessarily the Laws of Nature nor the Laws of Logic. *That* only *the latter two categories count*!

Law"*, that is, Law without purpose; on "the contingent and provisory character of physical law"* (understood by the original author to refer *not* to the human construct but to the underlying Law of Nature, that Man thinks he possesses!; on the "anthropic principle"*, in essence the logically incomprehensible notion that unconscious, thoughtless, totally lawless and perfectly purposeless Nature, so arranged herself as to produce "law" (the law of physics) and after a very long while Man, in order finally to comprehend herself!!! Nineteen hundred years ago, Nero decided that Rome was too ugly! So, he burned it without warning in order to rebuild it according to his own measure of beauty! A modern cosmologist* has advanced the idea that the Earth can be saved from the fires of an expanding Sun, at its red-giant stage, if a 15000-pound H-bomb be exploded every second for one hundred million years, "on the side of the Earth opposite to the direction in which it is moving", in order that it be moved out to a safe radius of revolution! (Oh yes, some bombs would be saved if advantage could be taken of the gravitational pull of the outer planets, but this cannot be guaranteed! Better safe than sorry!). Now, this is equivalent to 2.37×10^{10} megatons of hydrogen bombs, in the face of which our present nuclear stockpiles pale! Certainly, it cannot be too long before some imaginative politician claims that an even more accelerated arms race is "good or us"! This author begs the Reader to forgive his pitiful lack of sophistication and failure to understand the finer points of this entire stream of two-thousand-year-old "logic". If a student makes no sense because he has not thought through the subject, his teacher does not hesitate to reject his paper. But how are we to make sense, if sense can still be made, out of the convolutions of "logic" that is not for students to question? The way, it now turns out, has always been there, if we could only see beyond the "laws of physics" to the Laws of Nature. In an ordered Universe *nothing is* there by chance. (But *we had* to introduce chance to compensate for the elimination of God as the Prime Mover of the World). That the earliest experiences of the thinking Man can all be explained on the basis of gravity is most certainly not a fortuitous outcome! Before Newton, one was certainly excused if one attributed the various phenomena to different "laws". But after Newton gave us the extraordinarily simple relationship according to which everything is held together, there can be no excuse. When Newton's Law of Gravitation was found "wanting" there was no re-examination of the definitions surrounding that Law. Scientific Man sought the explanation of the perceived failure elsewhere. That was his first mistake. The second and far greater mistake, which historically preceded and made possible the first, was to ignore *the physical significance of G*! In an ordered Universe, *nothing* exists by chance: The G is not there by chance! That the physical significance of G has so far been ignored *must* be seen for what it is: the demonstration of scientific Man's arrogance vis-à-vis Nature. Had G not been ignored, this work would not have waited for so long to be written by the present clumsy writer!

It is fundamentally in this that this work is distinguished from all other Cosmologies: It is solely and exclusively based on Newton's Law of Gravity.** One

** And it is for this reason that this work was deliberately so titled: To draw attention to the fact

may say that this law is just another law of physics! If so, one could not possibly extract so much information out of it, especially if the Law is in any way deficient! It has never happened before! In view of the riches extracted, the perceived deficiency of the Law of Gravitation can only be due to our own failure to realize that the definitions were inadequate: Nature defines the separation in her way; Man defined it in his! The stepwise development of the ideas studied here (namely, in order of logical construction: the Law of Separation, logically needed to define first the path along which the separation is to be measured and then the value it must have, *both as functions of the entire Universe*; then, the Law of Gravitation itself; then, the analysis of the physical significance of G; then, the realization that G is tied inextricably to the average density and the age of the Universe; then, the realization that through density, the mass and volume of the Universe are necessarily and inextricably involved; then, the realization that there are logical constraints on how all these quantities are tied together; then, the realization that Logic and Order in Nature require that there be *only one way* that these quantities are tied together; then, the patient examination of each logically possible candidate combination; then, the realization that the "winning combination" logically involves the radius of First Light as *fully identical* to the radius of the Universe; then, the conclusion that the velocity of First Light is a variable quantity dependent upon the age of the Universe; then, the realization that the velocity of light can be constant everywhere at constant T, only if the radial distribution of mass is uniquely determined; and so on) *has protected the findings of this work from the intrusion of arbitrary human supposition and preconceived pseudo-philosophical bias*! That the Law of Gravitation held through this entire logical sequence demonstrates forcefully that there is a great deal more to it than to any other "law of physics": Here, we have nothing less than one of the very few fundamental Laws of Nature!

Freed from the intrusion of supposition and bias, it is now seen clearly that the Laws and Logic of Nature hold perfectly together, *independently and distinctly* from the ability of Man to organize the phenomena in his own mind. The Logic of Nature that the above sequence of ideas demonstrates *is not there because* the present author thought of it! It was always there, before this or any other human existed; always, that is, since T = 0. There is Logic in Nature and there is Logic in Man. The two Logics are identical not because the human logic begat the logic of Nature (it only at very long last recognized it!), *nor indeed because of the reverse,* for it has never been demonstrated that it is an intrinsic characteristic of inanimate objects, be they stones or stars, protons or photons, or whatever, to be logical **. The Logic of Nature is demonstrated by the fact that

that it is the Logical continuation of Newton's Law of Gravitation; that *"Principia Mathematica"* are not quite enough to build the Universe; that *"Principia Physica"* are absolutely necessary; that the *Universe is* not *a mere theoretical, but fundamentally an engineering feat of the very highest magnitude,* based on the absolute minimum of the simplest laws conceivable! Long and hard thought was given to the composition of an appropriate title. It was not pride, but the need for Logical continuity and consistency that precipitated the choice!

* The seemingly missing "but because" will be found at the end of the Section.

she and everything in her obey in the strictest sense imaginable what we call her Laws, *while there is no way for the fundamental particles, which together make up the entire Universe, to know anything at all about what transpires in the World "around" them, or indeed "inside" them*! Of this there can be *no* question: A fundamental particle, the most basic, whole and indivisible, constant and immutable (as regards its mass) entity, the true Democritean atom, cannot send to the rest of the World any "information". If it did, it would be relieving itself of something of itself, which is impossible under the notion of indivisibility and constancy of its mass. Nor can it absorb any "information" within itself, and thus enlarge itself while remaining whole and indivisible and of constant mass both before and after absorption of such "information"! Because, the minimum amount of "information" must come and go in the form of just another true Democritean atom! As a result, we are compelled to conclude that the Logic of Nature is not intrinsic: The fundamental particles (photons) are not logical in the ordinary sense of sending and receiving and analyzing information, of keeping time and of remembering, of adjusting velocities and of communicating with each other and exchanging information so as to adjust their "engines" to maintain a universally agreed upon single value of velocity at constant T. These activities are *not* possible for the fundamental particle, whole and indivisible as it is and capable of acting on its own only in a time equal to the age of the Universe. *The fundamental particles* only *participate* in *interactions according to fixed laws, laws which are imposed upon them and which they obey unerringly despite their total physical incommunicability*. The Logic of Nature is demonstrated by and because of this unerring obedience to the underlying Natural Law, *which enters as a second ingredient of Reality, totally distinct and fundamentally different and separate from the fundamental particle*.

The Logic of Man is totally of another character: it is built upon laws of mental construction of ideas, laws that have absolutely no power outside of the human mind. Mental constructs can take separate forms depending upon the rules of construction. One only hopes that these rules do not hide internal inconsistencies. The state of human affairs is the demonstration, if one is needed, that inconsistencies abound in the Logic of Man. Thus, the state of human affairs is the scientific proof that the Logic of Man is not preordained, and that it is neither automatic, as is the Law of Nature, nor emanating from the latter: For if it were, it would contain no internal inconsistency and it would lead automatically to Cosmos and Harmony in the affairs of Man, just as it does in the affairs of Nature. The fact that the Logic and affairs of Man are, antithetically, so chaotic, proves only one thing: *that Man has to work out for himself his mental material to make a Cosmos out of it, and therein lies the essence of his Freedom*! What in Nature is done automatically, in Man it is done with the expenditure of a very large amount of mental energy and moral courage: The words do not flow effortlessly onto the paper. They get there with the most strenuous effort this head and hand have ever applied themselves to! Nor do they (hand and head and words) do so out of a sense of "cosmic compulsion" to which they automatically subject themselves. Rather, they get there out of a sense of freely made choice. Just as when

these words are read, the reader will freely agree or disagree with the content and will vehemently deny that he does so out of *any* kind of compulsion; and some readers will agree and others disagree freely, thus together demonstrating that *there is indeed Free Choice in the Logic of Man*. But even if *all* readers disagree totally with the findings of this work, they *all will* disagree that they do so out of cosmic compulsion: On the contrary, they, each, will say that independently and freely, *out of inner conviction,* reached the conclusion to reject this work! So that *they*, rather than I, will have proven the existence of Free Choice in the Logic of Man!!! Under the circumstances, they *cannot* then turn around (nor can any one else on their behalf do so, although there are very many people in the sciences—one can even see it in the concluding pages of books on Cosmology—who seriously claim that Human Freedom, the Freedom of the Human Spirit preeminently included, is an illusion in a Universe programmed strictly to follow orders according to preordained Law) and say that "their free inner conviction" is no more than Nature's subtle way of imposing order, namely, that they are not in their most fundamental level *really* free! Even if, by some unforeseen calamity, they do so (the double entendre being fully intended!), they will *not* have proven the point that there is no Free Choice in Man's Logic: To the extent that these ideas, now being put down, preexist *their* decision to reject them, this one example will have already shown that this unit of humanity (at worst, no less than about one in 6×10^9) has chosen to do something against the "perceived" order of things, that is, against the absence of Free Choice, in a Universe where not even one in almost 6×10^{120} photons chooses, or is free, to disobey orders! What I am trying to say is that even if a single man feels internally convinced to hold out against the rest of humanity, this one man exposes most massively and forever the myth of the contention that there is no Free Choice in the Logic of Man. If one Man is free, *they all* are! [It is *totally another matter* that they, *always freely*, choose to surrender it, for whatever, supposedly "good" reason! Socrates did *not*! Christ did *not*!]. It follows that our present suppositions and biases, on the basis of which we try to resolve the mystery of the Universe, are there not out of "cosmic compulsion", *for then our failure to resolve the mystery on the basis of those suppositions and biases is totally inexplicable* (because in the absence of Free Choice, *the Universe has no choice but to impose upon our minds those suppositions that automatically lead to the explication of its mystery*!), but out of freely made choice, because we all agree on their plausibility, or simply because we want to be "nice" to each other!

Thus, our failure to comprehend the Logic of Nature is only due to the fact that we have not yet been able to rid our mental constructs of their hidden inconsistencies! When we do so, we find that Logic is indeed one! The Logic in the Laws of Nature and the Logic of the conclusions of this work (arranged so that they be protected from internal inconsistency) blend together! There is no inconsistency between the two Logics, because there is out there a Natural Order and there is in here a Mental Order which are totally and forever distinct from each other and, yet, totally and forever identical! We shall not understand the World unless we also understand *this distinction and simultaneous identity*!!! Rid

human logic of all internal inconsistency and it will guide unerringly to only one, totally unconfused conclusion: Just as Nature remains unerringly unconfused! (An objective observer of humanity is continually presented with the strongest reasons to suspect that it is precisely this one unerringly reached conclusion that we dislike so much that we prefer to inhabit the extremes rather than blend harmoniously where Reason commands!). Thus, Nature is not obligated to abide by the "laws of physics". Rather, it is our duty to rein in our minds and delimit the bounds of the "laws of physics" to include only the Laws of Nature and nothing extraneous. In this sense, mathematical physics has gone far too far: It is a grave mistake to begin the study of Nature with the study of mathematics and seek natural equivalents to mathematical constructs. This is the philosophy of a solution seeking an application and a problem, and it may or may not lead to results. Obtained in this fashion, the results cannot be unambiguous: The more general the formulation of the mathematical problem, the more the mathematically acceptable solutions that it admits. Which one of them is the solution, that the Logic of Nature for its own inscrutable reasons has chosen? This is essentially the predicament of relativity theories. An objective observer *has* to conclude that our understanding of the problem of the Universe now, as compared to that prior to the introduction of relativity, is that we now "know" the broadest category of mathematics within which the solution of the problem of the Universe *is likely* to lie, but even *this is* not a proven statement! *How really concrete,* then, are the results of the effort from mathematics to physics?

As regards quantum mechanics, the earlier criticisms will not be repeated here. An important lesson that was learned in the present effort was that when a particular avenue of pursuit led to great difficulties, conceptual or mathematical-computational, another way always existed that did not require so much effort! In view of the principle of least action, this appears to be precisely Nature's Way, too! In this light, one will do well to reconsider the proposition that relativity and probabilistic quantum mechanics still hold promise of explaining the Universe, when they have until now failed to do so, after so long a time and untold effort! Is it at all likely that Nature's Path of Least Action leads through so much theoretical toil? The answer must be: No! That the difficulties we face *are* of our own making! Consider the particular problem of particle physics: Ever since antiparticles were discovered, the nagging problem of why Nature has chosen to be "this" rather than "that" way, or why not equally of both, has been debated at very great length but has not been resolved. All conjectures have been of a purely ad hoc basis. That "symmetry" should exist in Nature is purely of human origin having to do with the perceived "laws of physics", our conception of conservation principles and most peculiarly of all our own notion that energy is totally distinct and different from matter, except that is, from the totally mysterious relativistic $\epsilon = mc^2$, and the other notion that in the beginning the Universe was composed exclusively of the mysterious energy which only later condensed into matter! Now, why this last one should have been so at $T = 0$, when the density of the Universe was infinite (current theory is not quite definitive on this matter, but at least it admits that the density must have been higher then than at any other time and place

since), when we no longer consider any current particle (say, an electron or a proton, the density of which is no longer as high as the density of the Universe was then), to be composed of "pure" energy (by decomposition of matter back to energy), has never been explained. The reasonable method of approach is to conclude that condensation into "matter form" is proportional to density and therefore that at T = 0, the Universe was not composed of anything other than the most condensed "matter form" even theoretically conceivable. The problems of symmetry and symmetry-breaking, then, vanish into thin air: At T = 0, "energy" had "form" and "structure". This was broken at the start of time, and "amorphous energy" (namely, "structureless" photons) is being released ever since as the Universe expands. Antimatter appears only when we try to recondense "amorphous" energy into ponderable form, forcibly and against Nature's Way. We must conclude that when photons are so forced, their motions within a *one only* particular kind of condensate would destroy the instantaneous conservation of momentum in the Universe. The mirror image of *that* particular kind of condensate is needed to conserve the momentum of the photons brought together, and to maintain the momentum of the entire Universe at zero, as it must always be at all times since expansion began. The fact that matter and antimatter annihilate shows that it is *less effortful* to have form of one kind, or failing that, no form at all than to have form of both kinds! If this is so now, it must always have been so, or else, the Universe is intrinsically less simple as regards the structure of its Laws. Form of both kinds logically means that there can be no form at all. Now, if this is the way of Logic and of Nature, are we justified in rejecting it because it introduces the need of a Prime Mover to set the Universe off at T = 0 from its most absolute black-hole-type state imaginable? It appears that we are not. The Prime Mover did His work perfectly: By incorporating from the start both gravitation and expansion as *a single* and indivisible concept into the nature of the Universe, as this work has already shown. One *must* wonder why if relativity and current quantum theory are individually or together correct, they have not already led to this simplified and fully logical conception, or to a better one yet, if this conception is in any way defective! We indeed have no option under Occum's Razor: Theories that have led nowhere must be rejected. Theories that do lead somewhere are the ones to be refined further. To reject Logic because it compels us to introduce the Prime Designer and Mover is to guarantee failure. Nature is perfectly logical and without perfect logic on our part, we shall never understand her. If we insist on pseudo-"philosophical grounds" to reject the *logical* need of His Presence, one is perfectly entitled to question the sincerity of our "philosophy", that is, our Love of Wisdom, in case we have forgotten that our Greek terms do have an awfully concrete and uncompromisable content! The mere fact that we *do have* form* on the strength of which we can at all engage in this debate, and we are not completely amorphous as would be the case under perfect symmetry, demonstrates

* In Section 3.5 we argued that it is the fact that $h \neq 0$ that gives us form. At T = 0, h was zero. Thus, at T = 0 there was no form! Here we argue that symmetry never existed, not even at T = 0 and therefore that even at T= 0 there *was* form! There is obviously a conflict, which we must try to resolve. The real question is whether this conflict is real or only perceived. The absence of symmetry

conclusively the need of His Presence: Without Him being present we would *not* be debating. *Our Logic* and *Nature's Logic are one and the same because they both emanate from His One and indivisible Logos,* as was analyzed in the Preface and suggested in Section 2.1 (p. 43-4). There can be no question that there is a very great deal more to Intelligence and Logos than what our "ears" (read, experimental science) can possibly distinguish as Plato has implicitly argued in his *Republic* VII, 531.

[especially of the kind the "experts" have in mind that would produce the disappearance of all known forms of matter save hard γ-rays!] at T = 0, that is, the decision to *make* the *World in one particular way* must be considered to be at *the most basic* level. Then, the absence of form under h = 0, given the earlier decision to make a one-kind World, *must be at a less basic level of decision-making* [indeed, *what self-respecting serious thinker* says that even the most basic Laws of World-making do not have to be prioritized, *set in their own absolute order of importance, exactly in order that the World-to-be-made-based-on-them stand as a perfect Cosmos*?] and may only indicate the fact that at T = 0 the Universe, *all* the photons in it, within zero volume, comprised an entity of *one kind only* that had not yet acted, had not yet begun to take *the one-kind only differentiated* form. This *would* resolve the seeming conflict *without* violating Logic!

4.3

THE CASE OF BIOLOGICAL EVOLUTION

The theory of evolution presents a special problem for a work such as this. It is an inexact theory attempting to resolve the questions surrounding the origin of life and the differences and similarities of the living species. To the extent that life relies on the laws of chemistry, it is certainly subject to the implications of this work. To the extent that life presents *a deep additional "mystery"* which transcends those laws, one *must* conclude that there is more to life than simple chemistry. The debate has been on whether or not chemistry suffices.

An unbiased observer is obliged to conclude that unless life does indeed constitute an additional "mystery", it is altogether impossible to explain *why it has not already been reduced* to the laws of chemistry! If life is no more than chemistry, it must be concluded that no "material object", other than Man himself has been subjected to a more serious, determined and prolonged observation, investigation and experimentation, from without, like any other object and from within, by himself. Why then the failure to resolve the mystery of Man *before* resolving the mystery of *any other object* in the Universe? When one thinks of it, the question "what is life" *is of* the *same quality* as the questions "what is mass", "what is time", "what is G", "what is space", which, we have already determined, cannot objectively be answered from within the Universe. Answers to all five questions attempted so far are no more than roundabout and in the final analysis circular statements about relationships between objects and definitions relating to those relationships. What the subjects of the above questions *really, ontologically* are, no human knows. *Some* people will be quick to take exception to "no human knows" and would prefer the statement "nobody knows", implying that nobody exists who can know, in other words that God does not exist. However, this is not a question that can be settled before Life and the Universe as a whole *are* finally understood. In the interim, humility requires that we regard questions pertaining to philosophical, moral, religious matters as questions deserving our most careful scrutiny, *especially* in case the atheists are right, for then, *these questions are raised solely by matter attempting to transcend itself, and as such they are automatically questions of the very highest scientific importance, especially from the evolutionary viewpoint, because they must indicate the direction of the "evolutionary arrow"*! *An atheistic world owes it to itself to explain where our questions about God come from*! We *cannot* dismiss these questions as silly until we can explain where our *very ability* to judge something as reasonable or silly comes from. Until we do so, we only demonstrate our own failure to be serious. When scientists thus dismiss such questions, they denigrate science and only display their own absence of commitment to science as a discipline of thought

that has undertaken to explain the World, not only the Universe "out there", but also the Universe "in here", inside our own minds, as it objectively, *ontologically* is and ***not*** as we would like it to be.

In this light, it is most pitiful that the recently rejoined debate of "Evolution versus Creationism" once again failed to avoid old clichés and did not manage to bring us any closer to a real understanding of the issues involved. For this, *both* sides are equally responsible. By not listening to each other, they both demonstrated their unwillingness to consider *all* the facts objectively present around us. Here, we shall analyze the situation of the problem of life as best we can and shall point out the areas of ignorance surrounding it.

Darwin's "*On the Origin of Species*" of 1859 suggested an open-ended, blind, haphazard, totally purposeless and random method by which Life "advances". Without teleology to guide it, this "advancement" proceeds according to Darwin in *all* directions and survival obtains only in direct competition with the environment, other individuals of *all* species sharing the same habitat for food, and individuals of the same species for reproduction (and, implicitly, *naked* dominance!). He saw change from generation to generation as slow, gradual, quasi-continuous, though in later years he seems to have realized that the evidence did not support this view of continuity. The direction of evolution along which Life "advances" is seen as the result of the ability of the winners in the above "race" to pass their own inheritable characteristics to their offspring. At certain points, and for reasons unknown, this passage ceases to be within a well defined species: a new species emerges. In Darwin's time, the Earth was believed to be *much younger* than it is regarded today, so that in conjunction with the gradual change from one generation to the next, the notion of a fast rate of change (in terms of "forms" per unit of time) *is* quite implicit. Thus the original theory made three predictions, none of which is in fact observed: Firstly, that in the struggle for survival, nothing else matters as much if at all* other than survival of the individual and its reproduction. Protectiveness of offspring and common defense of the population against predators, at the individual defender's risk *and* loss of life, and all altruistic phenomena are totally alien to Darwin's scheme and are not predicted by his theory, but are in fact widely observed. Secondly, teratogenic developments of all kinds

* Darwin made his original observations on animals, and ever since the evolutionary principles he enunciated have been viewed in the main from the narrower perspective of the animal kingdom. The very moment the perspective is broadened to include the plant kingdom also, additional questions are being raised. For example, if survival of the individual and the passing on of its inheritable characteristics is the only driving force, it is altogether impossible to explain why *all* plants are *not* poisonous! Nothing could better assure survivability of the plant forms than the total absence of animal forms feeding on them! Nor is it at all explained why plants expend such large amounts of energy in order to produce edible, sweet fruit that bestows no *detectable* advantage to the individual: Consider, for example, a several-pound melon, in which the seeds are only a very small part of the whole fruit. How does the melon profit from the totally "wasteful" practice of producing so large a fruit? Also, consider the case of seedless grapes. What conceivable evolutionary advantage do they confer to the vine? The theory of evolution denies teleology. The plant kingdom, or at least the kingdom of the vegetable garden in the broadest sense, which has yet to turn poisonous to protect itself, *is nothing if not the most conclusive refutation of the non-teleological principle of the theory of evolution*. That Nature goes to the trouble of producing concentrated energy in the form of sweet fruit, totally useless to the producing plant, is totally beyond the explicatory power of the theory.

are required as common, indeed as in the order of things by the randomness of the process. *Only* by picking its way *through them*, does life "advance". Teratogenic forms in living populations and the fossil record *are exceedingly rare*. Thirdly, the fossil record failed to reveal the expected fast pace of gradual change from one generation to the next, and so do still living populations.

Of the three, the second is perhaps by far the most severe failure of the theory, and totally exposes as untrue the claim made by and on behalf of the theory that chance plays a crucial role in life. The near-total absence of "monstrosities" supports fully the common skepticism about the claim that the order evident in the living world is nothing more than the result of a long chain of random events. Yet, it is being said that "…few scientists share this skepticism. The majority of scientists feel that Darwin's law of natural selection removes the need for a guiding hand in the Universe; in their view, the theory of evolution is complete and requires the action of no mysterious forces beyond the reach of scientific understanding" (R. Jastrow, Ed.: *"The Essential Darwin*"; Little, Brown and Co., Boston, 1984, p. XVII). This is an altogether amazing statement to make on behalf of, presumably all, scientists! Given the amazing development of the theory (and the confession that "its adaptability is proclaimed by its supporters and contested by its detractors", loc. cit. p. 308), which is still in great flux and its final form totally unknown, one may well ask: which is the "complete theory" which Jastrow claims the majority of scientists view as such, which "removes the need for a guiding hand in the Universe"!

The "flexibility" of the theory of evolution is due to its essentially descriptive, non-mathematical nature. Words can always be stretched. But this has nothing to do with the theory's students' spontaneous drive to improve it. All modifications to the theory have taken place under attack and after fierce resistance. Modification is not necessarily bad for a theory of this type, if it can shape the theory into a more or less correct from, *but it is definitely outmoded* to claim that the theory of evolution in its latest form, with its *total dependence on biochemistry and the double helix of DNA, still depends on chance*! There is *nothing* "*chancy*" about the laws of stereochemistry (cf. S.W. Fox's: "The naturalist… must rely on the principle of *stereochemical selection*" A. Montagu, Ed.: *"Science and Creationism*" Oxford Univ. Press, 1984, p. 230; emphasis in the original). If stereochemistry finally wins the battle against *special creation,* the basic Laws of Nature, upon which the laws of stereochemistry ultimately depend, will score a far greater victory at the end of the war on behalf of the Creator of those Laws (see below), in which war, the victory of stereochemistry against special creation will correctly be seen as part of a far more magnificent, all-comprehensive, *preconceived* Design, in which special creation *is logically redundant*! Whatever "randomness" (which in itself *is very doubtful*!) still exists within the strict laws of stereochemistry is obviously inconsequential in view of the very-near-complete absence of "monstrosities"; and in reality, in view of the earlier findings of this work, it is only a reflection of our ignorance of the laws that determine the exact positioning of sub-entities within the stereochemical structure, which in effect determine what each one of us will *look like,* without *any* harm to the architecture that is called "biological man". God's Wisdom does not stop "out there". Its magnificence is shown even more "in here"! This is as it should be: If we are indeed the consciousness of the Universe, according to the "an-

thropic principle"; if more importantly, we are the means through which the entire material world will be saved, for it is with us that it fell from Grace, according to Orthodox Mysticism; then indeed we deserve maximum attention! The beauty of the "outer" world must perforce pail in comparison with the beauty of the "inner" world!

As regards the effects of the early theory of evolution upon the development of other branches of science, it is totally safe to say that, in the very least, the introduction of purposeless chance in the operation of Nature, as first engendered by the theory of evolution, undoubtedly prepared the "philosophical" and "intellectual" ground for the easier acceptance later of the abolition of absolute relationships in Nature (relativity) and of the notion of indeterminacy under chance as a basic and intrinsic seemingly lawful feature hidden in the deep levels of the "laws" of Nature (probabilistic quantum mechanics). All three theories have indeed lent each other a hand to subverting the earlier understanding of Nature as a Grand Organ designed to attain a clear-cut Purpose.

[But this has *not* been based on a *solid* previous deep scientific understanding of all the objective natural facts, but to a *well hidden and still never confessed psychological need* to find first some "philosophical" and then some seemingly "scientific" support contorted to justify our social and political world-wide activities! Darwin was very much an Englishman of the Victorian age of British imperialism. That went hand-in-hand with the notion of the "survival of the fittest", that remains the social subtitle of the theory of evolution. On p.1 of her book "The Fire in the Equations" (Bantam Books, 1994) K. Ferguson gave a short recount of the truly great public honors bestowed on the coffin of Charles Darwin. No other scientist before or since has received such honors upon his death. The British public needed reassurance that Great Britain could continue to be *both* a world-wide empire (with all the unspeakable that that entails!) *and* remain a true Christian nation. That television bombards us nightly with "educational" National Geographic films of beast tearing beast flesh on land and fish sharply swallowing fish in the deep is nothing other than the subtle passage of the very same message of how best the "fittest" survive in seeming symphony with the laws of the Universe made up exactly in order to serve best even the social "fittest"! When the Lord God is believed non-existent, the social carnivores rule! And the three theories act as chamber maids!]

For it is in the nature of all three theories mutually to reinforce each other's basic philosophy, *despite such as* the Einstein-Bohr debate, that referred to a less deep level of the philosophy of Nature. In their deepest level, all three theories assert that Nature is not absolutely hard in its definitions of relationships of cause-effect, here-there, now-then, before-after, *all this for a foreseen purpose*, as it once was thought. It is only natural to expect that the return to absolute order and determinism demanded by the expanding Universe, as we have already pointed out, will undoubtedly shake the philosophical foundations and initiate a restructuring of all three theories.

Briefly, as it now stands, the theory of evolution holds that life resulted spontaneously out of inorganic material, which "somehow" [again that "somehow", as if it can stand as a *scientific* explanation, except before and for the consumption of registered idiots!] organized itself into organic substances of higher and higher complexity (remember here the double helix of DNA) until those sub-

stances became *self-supporting in the form of the first living cell*. In this sense, life is seen as the ability of a highly organized group of substances to interact within the group and with the environment in such a way as to preserve alive the group (by absorbing from the environment energy and materials and rejecting into it heat and material wastes), even under conditions which, in light of basic laws, do not appear to be conducive to the sustenance of life. More explicitly, life is able to withstand decomposition of the "living tissue", by itself repairing the normal wear and tear of its member substances. According to the current theory, nothing other than the laws of stereochemistry is needed for the appearance and preservation of life. In other words, no act of special creation, nor life-supporting Providence, is needed. Antagonists of the theory hold that the laws of stereochemistry alone (themselves viewed as products of purposeless blind chance!) are *not* sufficient, that the probability of collecting, from the heap as it were of totally disorganized trash, the materials needed to form the first living cell, of preserving those materials in place while still unable of self-sustenance, and of mixing them in the required proportions to form the first self-supporting cell, is much too low ever to have come to pass, that in view of those probabilities, a special creative act *was* needed; yet *not necessarily* on the very spot on which the first living cell appeared but even more grandly, in the *design of the Laws of Nature*, so that *they* in the exactly preordained time bring together the substances that resulted in the living cell and its supporting environment! The problem of life, however, is still more complex. Because, we observe that the moment "life departs", the self-repairing ability, la force vitale, vanishes and decomposition sets in. Neither the theory nor its opponents have shown what is the stereochemical or other difference between a living cell and a cell that has *just* died, or a living cell and an identical(?) cell that is just ready to come to life *but is not yet alive*. Proponents of the theory assert that the demarcation between life and non-life is not clear-cut. This is at best an outright evasion. Life is nothing unless it is the ability of the organism actively to support itself and exhibit in so doing all the characteristics that are common to the living cell and all higher organisms. In this sense, the demarcation is *absolutely clear*. *Without* understanding this difference, the question of need or redundancy of a special creative act and of possible as hoc providential support for life cannot be settled. We are nowhere nearer resolution of this question than we were at any time in the past. It must further be realized that even if special creative or providential acts are not needed, *this does not constitute sufficient proof* of God's redundancy or neglect. To the extent that the laws of stereochemistry have been instituted such as to include automatic creation given objective environmental conditions, and to the extent that the latter are predicated and can be trusted to come to pass on the basis of the fundamental Laws of Nature, the wisdom of Creation is already present in the Original Complete Set of Laws of Nature. *Only by showing that these Laws are the product of chance rather than the product of Design and of Power to bring them into being, can it be shown that God is unnecessary*! *This has never been shown*. In effect, this whole work, especially Part Four, is precisely an attempt to settle this entire issue. As for neglect, no neglect can be charged unless the Plan *is* known. In light of our present ignorance of all logically preceding matters, the presence or absence itself of a Plan *cannot* yet be decided.

The theory of evolution further asserts that the first living organism automat-

ically possessed within itself the ability to grow and replicate so as to produce a population; that with the increase in the number of population members, living cells automatically found the ability to create colonies of still higher organizational order resulting in more complex organisms; that differentiation in form or structure or activity of cell are solely due to variations in the stereochemistry of the highly complex structures of the entities forming each cell. Even when complexity became so great that it itself now appeared to fall into species, phyla etc., according to the theory, such divisions developed automatically as a result of differentiation in stereochemistry, still without any special creative act. Opponents of the theory deny all this automaticity. Again, before the true nature, scope and extent of the laws of stereochemistry are fully known, each side merely expresses an opinion. It is a fact, however, that never has life been observed automatically to be created out of inorganic material or out of however complex organic substances mixed together, nor has it ever been observed to cross the borders between species. On this issue, the opponents of the theory have this negative observation on *their* side. Still, what happens or does not happen now cannot be taken as a measure of how things were in the past or will be in the future, but it may well indicate that the time of creation is indeed over: the "sixth day" of Creation long gone!

Given the presence of a finite number of fundamental particles within each atom, the number of atoms within each molecule, the number of different stereochemical configurations possible under the laws of chemical bonding, the number of ways molecules can arrange themselves into living cells and the number of ways living cells can form different colonies, namely, organisms of various degrees of complexity, the number of variations which are possible under the Laws of the Universe is indeed huge but is not infinite. How far along evolution is to exhausting that number is not known. A special creative act, if needed, only shows that the Creator *for reasons of His own* did not preprogram the Universe in such a way as automatically to bring about the special variation when "needed". Special creation refers solely to this automaticity or absence of it. It does *not* alter the number of variations objectively fixed with the number of fundamental particles and the laws of their organization. Thus the debate of evolution vs. creationism as is currently carried out is merely a debate on whether or not automatic creation suffices or special creation is needed to bring about a particular individual or species, in view of the variations open, given the number of fundamental particles involved and the laws governing their relationships. Because the numbers are finite, the debate can be settled in principle, but given our ignorance we cannot decide it. Nor is it really important. The appearance in time of a species is tied to its environment, which alone can guarantee its further sustenance. Not before the environment is ready can the cell or organism come into being (one cannot occupy a hotel room before it is ready!). Delay in appearance on the other hand does indeed indicate an unnecessary waste of resources. The law of least action guarantees that a reaction will take place, or perhaps an organism will appear, the very moment the overall action equals the threshold value. The Genesis account is fully consistent with this picture. When the particular moment arrives, the appearance of the species, whether by an act of the program, or by an additional ad hoc input, is *physically indistinguishable*. Even if we were present and observed it with our own eyes and instruments, we would only be able to observe

the event itself of appearance. We *would still* be unable to decide whether it resulted automatically or ad hoc, unless the appearance was truly miraculous, namely, happened in a place where the necessary materials were not previously present.

Just as particles, stars and galaxies, so too cells and living beings demonstrate the existence or non-existence of God through the intelligence and overall behavior of the Laws they obey. Relative to the importance of those Laws, and because it has ignored them, the debate of evolution vs. creationism is perhaps very little more than a kids' disputation. Not without excellent reason, many thoughtful people regard the evidence of the vegetable and flower garden as *sufficient* evidence of the existence of Law and Concern and as a Lesson that the Lawgiver patiently tries to teach us all: When the gardener plans a garden and plants various kinds of seeds and eventually gets *precisely* what he has planned and planted and not an undescribable mess, then indeed we all are compelled to conclude that that order obtains because there is beneath it all a Law that respects the gardener's wishes and effort. The order and beauty of the flower garden, which chance can never provide, far exceeds (cf. Matthew 6, 28-30) the order of the stars and of the galaxies. Not until we recognize this, have we avoided folly. That *we alone** in all of Nature are capable of *reasoning is* precisely what sets us apart from the rest of Nature. It matters *not much* what the precise mechanism was by means of which we acquired this unique capability. What *truly* matters is our ability itself to reason, which in itself *is all* the *evidence we need* of the existence of underlying Law, both inside our own minds and out there in the physical world, where our ability to reason is eventually objectively validated. So, what the Lawgiver patiently waits for is that we eventually comprehend what is going on inside us and around us. This can only be done when we finally stop merely seeing and smelling and begin the real business of thinking (as Plato has already begged us to do) and of believing in our own ability to reach Reason through the diligent, continuous, conscientious effort to avoid folly, which we can still do once we persuade ourselves that *we indeed* matter *and are not only simply matter,* clay and water, but far more importantly Spirit out of His Spirit that somehow, in His own Wisdom, He blew into us. The Life, and not merely life, that we got in this manner is certainly more than the blindness of the fundamental particles which make us up as parts of this Universe. By the particles, we are of this Universe; but by the Spirit in us, we belong to another, far superior World. There can be no question: Reason, *not* belief, compels us categorically to state that when Nature, even more so through evolution, points at an even more all-encompassing system of Law and Order and Wisdom, if the "evolutionists" reduce themselves to being no more than the standard bearers of atheism, (by denying the evidence upon which they build their own case against the "creationists", by dismissing the Law and Order upon which they themselves logically stand, and by substituting chance and chaos), then indeed they are wrong: not as a matter of faith, but as a matter of *deductive* Reason.

* *This is the evidence*! Notions of intelligent life elsewhere in the Universe *is mere speculation*! A scientific argument *can only* be *based on solid evidence*! Even if intelligent life exists elsewhere also, in no way is the thrust of the argument diminished! *The same logical arguments apply universally*! *If the objective of the World can be met by the one life that we know, then it alone suffices*! *As the Law implies objective, so, too, this life does have an objective*!

4.4

THE INDUBITABILITY OF THE LAWS OF NATURE AND THE RESOLUTION OF THE PROBLEM OF GRAVITY

It is not an overstatement to say that the search for understanding the essence and origin of the "physical laws" and their position in and relationship to the Universe *has greatly been neglected* by science. This can easily be shown by the following conversation: "Father, you say that the Earth goes around the Sun. Why does it do it?" "Child, it does so because there is a law of gravity, and the law makes the Earth go around the Sun". "Who made the law?" "Oh, this is a deep question. It appears that matter, which is what makes the Earth, is such that the law of gravity results" "But, Father! You said the Earth goes around the Sun because there is a law. Now, you say that there is a law because the Earth is what it is! I *don't* like it! What I *really* want to know is how it all started!" The father had not until then realized that his child had really grown up, that it could not be made to go around a circular argument. The child in its innocence, is in fact asking for the Prime Cause of Things and finds it incomprehensible that its father's science can give no answer! In effect, we are here to decide who is right: the child or science? Shall we bless or pity the father for his child's unhappiness?

In the "grown up"(?) world, it might appear at first glance that from a purely utilitarian standpoint, understanding the physical laws is unnecessary, *provided* that we can rely upon them that they will *always* work. Yet, the fact that the physical laws work is of a purely "observational" basis, namely, that the laws (based on what we observe *now) appear* to have worked in the past. We definitely have *not* shown that they *have* to work, or that they shall keep on working. We only simply observe that they work now. Thus, our reliance on the laws is really based on the (now seen for what it is: *simplistic*) assumption that in the simplest case, they have always worked and will continue to work precisely as we "understand"(?) them to be doing now! To say, for example, that two bodies and two time intervals are equal is to assume that the rigid rod and time units that we use in our measurements remain unchanged as we carry them between places and (unwillingly!) times. Since we have not shown that they indeed do so remain, all our scientific as well as technological statements should include the qualifier *"assuming* that the physical laws at work in this case continue to work *as here assumed"*. But with such a qualifier included in every statement of some substance, how much substance does remain? Science becomes *totally suppositional, a* house made of thinly veiled contingencies! Are we justified in dropping the

qualifier? Moreover, having dropped it, are we conscious of the tacit assumption that we make in so doing, to the effect that there are higher absolute laws of invariability of the physical laws themselves, in the absolute invariability of which (higher laws) we immovably depend and blindly trust? For without such higher laws, how are we to accept the continuous applicability of the "physical laws"? The present study has shown that, in an expanding Universe, some of our most cherished "laws of physics" are *not* invariable, while others are mere illusions. The constancy of the velocity of light belongs to the former, the first law of thermodynamics, derivative as it is, probably to the latter, the notion that "standard" lengths are constant belongs definitely to the latter.

On closer examination, it becomes obvious that the existence of higher laws regulating the Laws of Nature is an additional level of logical complexity, the existence of which should only be invoked if the "ordinary" Laws of Nature are shown to be inadequate, incomplete or indecisive in themselves. Of this we have no indication whatever. Logical consistency compels us to conclude that the "ordinary" Laws of Nature and any "higher" laws regulating the former *must together comprise a complete, self-consistent, logical set of Laws. Logic requires further that the set be the simplest possible,* for only thus can self-consistency and the *simultaneous* absence of logical redundancy be assured. The required laws of conservation and laws of change must together form *such* a minimal set.

So, when we drop the qualifier mentioned above, we in effect rely upon the continued dependability of such a minimal set of Laws of Nature. Unless this set is fully consistent, it *cannot* lead Nature *to only one outcome,* and Nature *cannot* remain unconfused. The observed consistency of Nature, conversely, ultimately reflects and refers us back to the consistency of the Laws that govern it. It is also obvious that once we take possession of the complete set of Laws, all doors of understanding still locked *will* be unlocked. To the extent that we have not yet succeeded in unlocking all doors with the "laws of physics" already in our possession, we are obliged to conclude that these laws *are not the true set*. Thus, our faith in the continued dependability of the Laws is not at all, objectively examined, faith in the "laws of physics" and we are manifestly wrong to place faith, this particular faith specifically, in the "laws of physics". The latter have *already* let us down, since they have not yet, *and obviously cannot,* unlock all doors, or *they should have already* done *so with* no *difficulty whatever*! A key either *fits* or it does not fit.

To the extent that we are permitted to carry out today the plans we had already set down for today, very much as we had set them down, shows that the minimal set of Laws of Nature *holds* no *surprises*. *Chance and confusion are thus totally excluded from the Laws of Nature*. *This* conclusion is identical *to that* reached earlier (p. 230) on the basis of the identity of gravitational and inertial mass. Without confusion and no randomness of any kind included in the Laws, we must conclude that the set contains detailed instructions about the *exact* logical and physical order of things. Our inability to decide whether the Earth obeys the law of gravity or whether gravity results from the matter of the Earth thus *is* entirely of our own making. As we grew, we obviously lost sight of the logical

simplicity that is an *indispensable requirement* in the child's mind. We are compelled to conclude that this requirement *is innate* in Man, the "laws of physics" are *not*! Through schooling, it seems that we have managed to accumulate knowledge *at random,* and to have constructed a semblance of a set of "laws" but we have failed to examine its internal consistency. Worse, our failure is due to the method of study we have chosen, the sophistic rather than the truly philosophical, we can almost hear Socrates say, from the local, special and temporal, details to reconstruct the whole. As long as we insist on this method of study, we shall remain confused. Yet, the present discussion has *already* demonstrated that confusion does not exist in Nature! The child's intuition is shown by Nature to be superior to our "adult" science!

Thus, it is obvious now that the study of the foundations of the physical laws cannot be left to "philosophy" alone. We have a real and pressing need within the science proper at least to distinguish between true laws and appearances, to make a real effort to answer the child's great question.

In general usage, the word "law" applies to a relationship among or between either people or objects. As regards people, the law is made in parliaments and adjudicated in courts, or so we think! But in fact, the "law of the people" is a *moral* activity and as such is *always* inside our own conscience and nowhere else and *always* reflects the quality of the *inner* Man. Science concerns itself with the "laws of the objects". Where are these laws made, where adjudicated, what do they reflect? The objects of science can be physical or mathematical. The law of gravitation applies to physical objects; the law of diminishing returns to mathematical entities. As a result of this classification, a law is either *an intellectual construct that is found only and always in the mind*, or is a relationship, namely, an expression of interaction amongst or between real objects, objects "out there", and as such it has an objective reality outside the mind as is immediately obvious when the interaction is constant or "precisely" repeatable. It is in this that the "physical law" differs from the moral or purely mathematical laws: Whereas the latter two are and are comprehended always in the mind, the former is *(acts)* in Nature *but is comprehended in the mind*!

There is, however, a third class of relationship which is all-important in its implications: Namely, the *direct* relationship between the mind and material objects: When I drive my car, I command *it,* or else *it drives me*! This means that my desires of heart and mind, pure "laws" that I freely set in my mind and to the application of which I set out, are translated into *physical action by objects in the world out there*! But the very best example yet of such relationship is a set of commands issued by the mind and executed by a computer in the performance of a certain task. In executing that task, *the set of commands issued by the mind becomes the law of operation of the computer*. The law of operation can be ascertained by studying the modes of operation of the machine, *but we know that it did not originate in the machine but in our minds*! No *matter* how advanced a computer we build, even a (hoped and feared) thinking one, if it is to make sense at all, it will always have to fall back to a set of instructions, its most basic principles, which as Gödel has shown cannot originate in the computer itself! In

other words, *even the best* thinking computer, in order to make sense, even to itself, has ultimately to fall back on a set of instructions that were put into it from the outside! On this issue, even the best thinking computer *will have no option* but to obey and "believe" blindly in those instructions, or else it will be totally meaningless! They will be its own "constitution", its 'bible".

It is now obvious that the Laws of the Universe may only belong to the second and third classes. It is also obvious that should any Laws of Nature be found that belong to the third class, a *Mind and a Will other than the human mind and will* and far superior to the latter *must necessarily have been involved*, since they are obviously obeyed by *all* of Nature! Now, it may indeed be difficult directly to prove the existence in Nature of laws of the third class (being *first* in the Mind and *then* in Nature) affecting the entire Nature. But indirectly, Gödel has provided the way out in what may be called his reductio ad absurdum: If a law or laws is or are found to operate unbrokenly and universally throughout the Universe, that cannot make sense given the limitations of the Universe if adduced to it as its or their sole source, then logically-necessarily-sufficiently, this law or laws is or are instructions given to the Universe from the outside, no "buts" or "ifs"!

If we were asked today to decide whether gravity is additional, that is, in addition to the concept of matter, or derivative, deriving from the inner properties of matter, we would not hesitate at all in choosing the second. This is because we have developed an aversion for action at a distance and a liking for fields and particles. However, Newton's confessed ignorance of the source of gravity *has not been lessened* since. In the game of ideas we still seem merely to be changing concepts. Some of these concepts are better suited to mathematical treatment, but the need of mathematical concepts to have necessary counterparts in the *physical world* has never been demonstrated. Thus, it is wise to regard both the field notion and the particle notion as currently understood respectively by relativity and probabilistic quantum theory as mere mental contrivances and to seek differently to make the important connections that objectively exist out there. Those connections cannot be made until we move beyond the study of Nature to the study of its Laws. As were the acousticians, whom Plato described in Rep. VII, 531a, concerned with what they strained their ears to catch in between adjacent notes, so still are we so very much occupied with the minute details of natural forms that can fall under our senses to pay the *needed proper attention to the general Laws that govern all of Nature*: Even as we call ourselves scientists, our *senses* still govern our minds, *not* as it should have been the other way around!

To be more specific, Einstein's substitution of the field concept for Newton's action at a distance concept has not helped resolve our predicament brought to the fore by the child's question. We can hear that bright child make the following comment: "Einstein's attempt to solve the problem of action at a distance through the introduction of the field as the supreme physical entity in the Universe cannot be considered to have been logically successful. It is not a matter of spacetime that there is a spherical field of gravity around the Sun, giving the Sun the ability to attract other bodies to itself. If this were so, the property imparted by the field to its center should be independent of whether or not that center is occupied by

this or that mass or any mass at all. It is an evasion of the problem to state that we cannot remove the Sun and thus demonstrate whether or not its field remains just as it was before. Because the properties of the field must be universally applicable, the same principles must apply to the field of the Earth. The Earth as it moves around the Sun vacates the space it occupied a moment earlier, but it does not leave its field behind, it drags it along! To say that the Earth and the Sun are mere illusions created by their respective fields, the real masters, is equivalent to denying belief in the 'material' and pinning all hope in the 'immaterial' and unobservable, which flies in the face of the 'scientific method' which so far has been calling for 'experimentation in and reliance on concreteness'! Surely, the reality of the field *cannot be tested concretely* by the use of what we call a 'test particle', which in itself *must also be a mere illusion* brought about by the corresponding 'test fieldesimal'(?)! How then dare we consecrate our 'experimentation in and reliance on concreteness'?

[It is exactly on this point, after all, that the 'scientists' dismiss the sayings of traditional 'theologians'? How then do the former, tacitly, through the introduction of the 'field', dare do exactly what they accuse the latter for? The previously 'immaterial field' "somehow" condensed to form 'matter'! The always immaterial God once appeared just as a man! Where is the *substantial,* the *ontological* difference setting diametrically apart the two sentences? Certainly not in the 'permanence' present in the former and the 'transitoriness' present in the latter! We have *no* assurance of the *permanence* of the former when we think of it in the context of the infinite expanse of time; nor may we admit the pangs of conscience that we *all* feel having *curiously* an *identical* direction as *our* creation and dismiss the idea that they were identically placed in us from *out There* for an *identical* specific aim!]

When I pocket an apple, *what exactly* do I pocket? I must be pocketing a weighty illusion! When I feel hungry and eat the apple, is it true that one illusion satisfies its 'hunger' by eating another illusion? For obviously, the fields are still out there totally intact! Of course, a well-fed stomach may well define somebody else's hunger as a mere illusion, but this does not at all explain the revolution which finally becomes *very real, for we feel it in our knees*, when it brings down our own door! The concept of the field does not strike me as serious business, Father! And from a purely logical point of view, to replace two bodies acting at a distance by their fields, completely inter-meshed, running in each other, tasteless, odorless, totally unobservable *except through their ability to cause illusions at their centers* does not exactly strike me as a great feat of Logic!" Now, we must ask ourselves whether this is a child's spurious tittle-tattle or a voice of our own common sense. Except in a world governed by a very cruel god indeed who sends us this "common sense" merely to annoy us, we must ask ourselves what is this "common sense" that dares speak up against modern science—unless of course it is with a very wise God indeed, in which case we had better re-examine our modern science.

There is another difference of fundamental importance between Newton's and Einstein's conception of gravitation. Newton believed that the action at a

distance, that we now attribute to the 'field', shall vanish instantaneously together with the 'field' that we now think as the generator of mass. Einstein and modern science object. They posit the principle of the velocity of light as being the limiting velocity of communication in the Universe. After some reflection, we are compelled to side with Newton!: Consider a very hard γ-ray, its geometrical size as very small, its wavelength being about 10^{-9} cm and its mass about that of the electron, say. Consider a large number of such γ-rays scattered all over the Universe at the same time. We are asked to suggest the mechanism by means of which *all* these *rays* manage to maintain their velocities constant. If they at any one time and always are to have a *common* constant velocity, we are compelled to conclude that *they are, in the very least, in essentially instant communication with a "central authority" that instructs them and maintains them*! *These are real particles* out there and their velocities *equally real and commonly constant*! They are *not* figments of a mathematician's imagination, upon which he can play mathematical "tricks": Their *reality,* their *objectivity,* compel us to conclude that although we at present are unable to suggest the mechanism, the velocity of light *must perforce pail* in comparison to *the velocity of propagation of effect*! In other words, this is another demonstration, and a crucial one at that, of the fact that Nature remains unconfused despite our "laws of physics". Common sense compels us to side with the reality of the mass rather than that of the field, and with Newton rather than Einstein as regards propagation of effect. Our earlier discussion of the "velocity of propagation of action", which is huge though not infinite, is much more compatible with Newton's but not at all with Einstein's intuition and fully supportive of the common-sensical conclusion that *real* particles call for *real* mechanisms, which when applied to the photons themselves call for huge velocities of propagation of effect not at all limited to the velocity of light.

The "graviton" theory on the other hand, namely, the probabilistic quantum-mechanical response to Einstein's attempt to solve the problem of gravity, requires a fundamentally different qualitative picture of gravity. It calls for a veritable flood of particles exchanged between bodies. If real bullets were exchanged between the Earth and the Moon over billions of years, the two bodies *would be moving apart*. Gravitons must instead provide "hooks", not unlike those envisioned by the alchemists, which alone can counteract the centrifugal force acting on the Moon! In other words, whereas all known particles have momenta that repel, gravitons must have "momenta"(?) that attract! Besides, the problem cannot in principle be resolved before the nature of the fundamental particles becomes known, which as we have already seen is impossible ever to happen, because "gravitons" must be "exchanged" between fundamental particles also. The global questions of gravitation, specifically Mach's principle, seem to be intrinsically beyond the reach of the concept of the graviton, and so are the gravitational effects upon light and the question of *how* photons maintain their velocities.

The findings of this work allow the following resolution of the problem of gravity: *Unless the phenomenon of gravitation applies between two fundamental particles, it applies nowhere. As* a result, we cannot hope to resolve the phenomenon in the large before we resolve it at its root. The incommunicability of

the fundamental particle (in the sense that it stands as a whole apart and distinct from all other ones) compels us to reject the notion that gravitation is a derivative feature of matter deriving from the properties of mass. We shall never know what it is that makes up the fundamental particle, whether in the free or the bound state, and so we cannot state that gravity derives from the properties of whatever it is that inhabits the particle. The logically simplest picture that we can draw is that (a): *Gravity is the fundamental and exclusive method of interaction of fundamental particles, a phenomenon the analysis of which stops there and can proceed no more*! (To insist upon going further is to insist upon an infinite regression of structure and atomicity *that cannot be supported on the evidence of the value of h* which, as we have seen, calls for a definite value of mass *indivisibly inhabiting* the fundamental particle); and (b): As a result of (a), *Gravitation is a pure Law universally obeyed by all fundamental particles*. If all fundamental particles had been freed, beginning at T = 0, today they would extend to the ends of the Universe and would in effect be inside each other. This did not happen. Heavier photons and ponderable bodies, themselves comprised of fundamental photons are co-inhabiting the space already occupied by, and within which, photons of longer and longer "wavelength" are dispersed. The problem of action at a distance thus loses significance: It can no longer be stated that the boundaries of a ponderable body are well defined, for they are not. All bodies expand, all bodies lose photons, all bodies have been losing photons since T = 0, and as a result all bodies are in reality *inside each other* though, of course, heavy photons and ponderable bodies retain their distinct centers of gravity and the latter their "incompressibility". *This must remain the most we can possibly glean of the problem of gravity*!

The fundamental picture we obtain is that of fundamental particles and pure law, together resulting in the interaction we call gravity.

As far as gravitation is concerned, *this is the end, or the beginning, of the road*! Yet, specifically here, the picture is crystal clear in its basic components and totally unconfused. Nature does not allow infinite regression nor a circular argument, and it fully satisfies our common sense. The child in us all can ask for no more, though its question as to "Who made the Law" must wait for a bit longer. However, the picture also clearly suggests that gravitation is the end, or the beginning, of the road of all physics! lf all objects resolve into fundamental particles, then, *all* other forces too are no more than expressions of the force of gravity!

4.5

THE DISTINGUISHABILITY OF THE LAWS OF NATURE AND THE ULTIMATE REALITY OF BEING

If we were asked to give a definition of the "physical law" on the basis of current understanding, we would not be substantially off the mark if we replied: "Physical objects possess certain inalienable characteristic properties which cause them to interact with each other in specific ways. The physical law is the (mathematical) formulation at least of the qualitative nature of the interaction studied. The more quantitatively exact the mathematical formulation, the more precisely is the physical law defined". The main triad (just below called first) of "things" or ideas that enter the above definition are "properties of objects", "interactions","laws". The process of discovery of physical law by humans proceeds in this exact order: First, we observe that different bodies have different properties. Then, we find that bodies interact. Then, through disciplined study, we determine the law "controlling" the interaction. At the end of the previous Section (4.4), our analysis of the fundamental particle led us to recognize a basic relationship between a different triad (just below called second) of "things", namely, fundamental particles, pure law and gravity (interaction). The two triads differ markedly, especially in view of the conclusion reached at the close of the previous Section that gravitation, or more precisely, the second triad is the end of physics. If so, the first triad must reduce to the second. We have since found nothing that would cause us to change our minds. As a result, we must conclude that the ordinary properties of physical objects, their interactions (other than gravity itself) and the physical laws (other than the Law of Gravitation) are what they are only because in each case we examine accumulations of very large numbers of fundamental particles, which together comprise the ordinary physical bodies. As a result, their observed properties are due to the *number* of the fundamental particles that make them up. We are compelled to say "number", because we cannot attribute the properties of the ordinary bodies to the properties of their fundamental particles. The perfect indivisibility of the latter precludes the *easy* assignment of some, *any,* specific property to them. For example, when a radio station sends out a signal, the receiving antenna receives the signal in the form of photons. The photons received are not absorbed by any particular fundamental particle(s) in the receiving station but are incorporated in the entire ensemble of fundamental particles, which together comprise the receiving station. The receiving ensemble is thereby disturbed and counteracts the input by releasing acoustic

energy (i.e., in reality, photons) at the loudspeakers and heat (i.e., "low grade" photons) everywhere in the ensemble. The properties of the bodies do indeed change with the degree of aggregation: beyond a certain aggregation threshold, they no longer have the same properties they had before. Bright "golden" yellow pyrite has deceived many. When it is finely ground, it turns black and deceives no one. So also, chemical properties vanish when the atom is split. These examples suffice to demonstrate that the transition from the ordinary triad of "things" (properties—interactions—laws) to the final triad (fundamental particles—Law of Gravitation—Gravity) should not upset us at all. It is the notion of atomicity, rather than infinite regression to ever smaller entities, as necessitated by the finite rather than zero value of h, that calls for an end to the process of cutting smaller and smaller portions. The "final" cut necessarily produces the fundamental particle. No smaller portion exists. At this final stage, the ordinary triad reduces to the final one.

Thus to return to the process of discovery of "physical law", we can avoid distinctions on which we no longer wish to concentrate attention by stating that the general process of discovery goes according to the following "reaction":

$$(\text{Matter}) + (\text{Interaction}) \rightarrow (\text{Law}).$$

However, we would be very much mistaken if we insisted that this is the natural order of things. A lawman is to be pitied deeply, if he believes that the purpose of the legal system is the creation of law for its own shake! A rank-and-file bureaucrat will be more inclined to say so, but then only because it tends to make him indispensable. In reality, a bureaucrat does not care about the law at all, but only about the preservation of the office, even when there is no purpose for it in sight! Nature demonstrates an awesome economy of means and a consistency of order based on a minimal logical set of Laws. We are compelled to conclude that Law in Nature is only a means to a purpose. The same will be said by any enlightened human as regards human law, too. So, we shall make no mistake in stating that in Nature the correct process follows the path:

$$(\text{Matter}) + (\text{Law}) \rightarrow (\text{Interaction}).$$

Since in the final analysis matter is fundamental particles, the law is the Law of Gravitation and the interaction is gravity, and in view of the incessant universal expansion, which, as we have already seen, is the other side of the Law of Gravitation, we have no other option but to conclude that gravity is there only in order to moderate and delay the expansion: Without gravity, the expansion would proceed with the initial infinite velocity and the Universe would not exist. Still, we find that despite its delaying tactics, gravitation only postpones the inevitable, because, the final physical objective is indeed expansion to infinity, which will be indistinguishable from the disappearance of all form! What then, may one ask, is the objective of the Universe? What value can there be in the Universe when it has finally expanded to infinite size? Obviously, none! And we are not here to argue against this statement. But *we are* here to argue that we are mistaken to focus attention at this perceived physical objective. We do so only because for several centuries now we have taught ourselves the "lesson" that we

should look at "things" for their "value" in terms of the "philosophy" of experiential materialism. The Universe teaches us that we have been very badly mistaken in holding such a view. Its lesson is *not* in the "physical objective" that in the end is totally worthless, as it has always been. If gravity is there in order to delay things, we open-mindedly, at this stage, *must* conclude that there *must* be a reason (the issue of there being Reason or not, we shall leave for later), that the Universe must be "waiting" for somebody or something. In view of the expansion, gravity exists only in order to give physical objects the opportunity to take shape and form. But this taking of shape and form simply *cannot* constitute a reasonable excuse for the delay if there is nobody to perceive them and take advantage of other simultaneous "opportunities" possibly also offered by the delay. Thus gravity exists *in order that "somebody" see things and appreciate them as they are,* somebody who cannot see things if they proceed any faster, but also somebody who is not altogether beyond hope of ever seeing things! I submit that that "somebody", slow but not infinitely slow, is none other than *us*! Man! Seeing things as they are then means that we should not despair at the thought of the utter physical meaninglessness of the final stage of the Universal Expansion, the ultimate but guaranteed Nemesis of experiential materialism, nor focus on the interaction (gravity) itself that only delays things. There is no value in the latter either! There remain only two other things on which we may seek solace: Matter and the Law. If there is value in matter, it must be in the accumulation of it, or else, where can it be? Here, we should consider the parable of the rich man who accumulated more grain than his warehouses could contain; So, he decided to build new, larger warehouses. That night he died. The Universe teaches us that the very principle of accumulation is indeed bankrupt as a guiding philosophical principle, for we cannot even hold onto our accumulations. They *shall* disperse into nothingness, as they *cannot* be sold or consumed, on a planet that already suffocates of heat and lack of life-giving oxygen that we keep on turning to unbreathable poison! [And indeed, as these lines are being revised, on March 10, 2009, the world-wide financial crisis created by the heedless global drive to accumulate ever more, regardless of the *limited real* wealth the planet can in fact produce through honest sweat and bear with a clear conscience, teaches us a lesson that no spiritual leader or politician of some recognition has yet found in himself the basic manly honor to admit loudly enough to penetrate our so thick and hardened skins!] And so, we are reduced to the Sherlock Holmesian principle: "Eliminate the impossible. What remains, however implausible at first sight it may appear, is nevertheless the truth". *The Universe compels us to concentrate upon the Law*! *Not* the "laws of physics" that have led us nowhere upon which we now stand, but its own Law that is one and the same from beginning at $T = 0$ to end at $T = \infty$, forever unchanging and unchangeable, forever unconfused and unconfusing, forever exact and unerring. Let us examine more closely some natural laws.

Firstly, the Law of Gravitation: In addition to what has already been said, we must consider the following: Neither the Law nor the interaction can possibly be real innate properties of matter, for if they were, they should exist intact in any piece of matter, independently of its circumstances and surroundings. So,

they should also characterize a single indivisible piece of matter: a one-fundamental-particle universe should then possess these two "properties" along with its other properties, whatever they may be. But if we were to "observe" such a universe we would not find anything at all! Gravity exhibits itself only when *at least two* pieces of matter exist, and therefore *it is necessarily a separate quality of physical reality shared by the (minimum of) two particles rather than a separate and distinct property of each*. One may object, still, that gravity is a "latent" property of each particle that becomes apparent only when at least two particles exist. But the validity of this statement *cannot* be demonstrated. Without objective means of knowing what is the true nature of the mass m_o hiding inside the fundamental particle, we cannot show that gravity "has" to result, nor indeed can we explain at all what we mean by "latent" property of a fundamental particle. Here is an analogy: Take two identical computers, interconnected, set to go. Yet, they wait idly! The reason is that the "program" is not yet fed into them. *Only* when the program is fed, will they know how to interact. Conversely, their interaction shall be different for each program. *The interaction is determined externally by the program fed*. Otherwise, both computers remain totally "blank". Now, if an "intelligent" machine (made of myriads of parts, that together one may, in one's wildest dreams, conceive of as capable of mutual self-activation), is still unable intelligently to go about its "business" (for what *is* its "business" without an externally fed program or "constitution"???), *it is logical* to conclude that the indivisible fundamental particle is even blanker than a myriadly more complex computer. The fundamental particle will react to produce an interaction according to how it is programmed. One can think of an infinite number of forms for the function $f(m_o^2)$. There is nothing in Logic or anywhere else that compels all those forms to reduce logically and spontaneously to the Newtonian Law of Gravitation! We are compelled to conclude that there is nothing to demonstrate that two fundamental particles obey Newton's Law totally on their own. They do so, only because *they have been told* to do so! The program, Newton's Law, the *exact* form of $f(m_o^2)$, is a command *entered* into the Computer, the Universe. It is its fall-back principle which alone guarantees that the Computer will not run wild in its "calculations" and issue utter nonsense as a printout. No matter how advanced the Computer, according to Gödel, it has to fall back on a "Law" that it cannot argue with, if it is to make sense, a law *externally introduced*. *The Law of Gravitation is introduced externally, and therefore it is a law of the third class* (see p. 263).

Secondly, the Law of the Velocity of Light. In view of the Law of Gravitation that extends all the way back to $R = 0$ at $T = 0$, it is incumbent upon us, if we are to salvage as much of the "laws of physics" as we can, to conclude that the velocity of light is determined as explicated in this work. But this can only be true if the distribution of mass in the Universe is also as obtained in this work. Otherwise, the velocity of light totally loses all significance. It is totally beyond human capacity to conceive of how things could have developed on their own *in this specific way*. The radial distribution of mass acts certainly within the law of *instantaneous* conservation of momentum, but the latter is *insufficient to cause the particular distribution of mass* needed to maintain the velocity con-

stant everywhere at constant T. One can imagine an infinity of distributions that guarantee the total momentum to be always zero. Out of that infinity, only one distribution permits the velocity of light to be constant everywhere at constant T and independent of direction. One may object that we have not gone everywhere in the Universe to make the simultaneous determination that alone can prove the validity of the claim here made. True! But in the narrow confines of our own space, we have not found the velocity of light to depend on direction. But again, we must be the first to dismiss the weight of local, here and now, evidence as proof or even indication of universal reality. The argument must be a logical one: We can dismiss the implications of the velocity of light as here extracted from the Law of Gravitation, only at the risk of losing all significance of c. There can be no arguing that light is gravitationally affected, that light is part of the Universe. Therefore, the Universe can be made up in only one way, if c is to retain, even instantaneously, the properties assigned to it by the "laws of physics"!

We have found no quantum of time. The Planck time as a natural unit is another illusion produced by our insistence on accepting the universal validity of the here and now "laws of physics". If the World is as here presented, *and indeed if it is to make still better sense it must be even more tightly regulated by law than heretofore presented,* it does not appear logical to expect that time dissolves into "quanta". Mechanical clocks, even atomic ones, beat, but this is only because definite amounts of action have been built into them by the clockmaker. In Nature, the unit of action h is itself a function of the universal age as here determined and it is illogical to turn the argument around and make h rather than T a fundamental physical dimension of the Universe. Even if we did that, *we would still be forced to accept the continuity of h,* its passing continuously from one value to the next, as we found here on account of its dependence on T. Whether we accept T or h as a fundamental dimension, the logical need for the continuity of the values each one can assume cannot be avoided. T rather than h *is* the simpler dimension. In view of our earlier findings, "time" for the inhabitants of the Universe *is indeed measured in "cubits",* as we have already been told: "Τίς δὲ ἐξ ὑμῶν μεριμνῶν δύναται προσθεῖναι ἐπὶ τὴν ἡλικίαν αὐτοῦ πῆχυν ἕνα;" (Matthew 6, 27; Luke 12, 25)*. (It is to the credit of Orthodoxy that for two thousand years she did not dare tamper even with what is still thought and called "mystical", that is now shown by the entire Universe to be precisely the Order of Things, set even into the nature of light itself that is par excellence the exact opposite of anything "mystical". Modern translators and laicizers, in their ignorance and folly, thought they could make "corrections" in things they did not understand!!!). At the same time, we were also told that there is nothing we can do about it. We measure our age in terms of length, whether by a pendulum clock or an atomic one, and if we want to know our age more accurately, we better not "cheat" with the cubit! But the age of the Universe is not determined by any material clock, that is, it is not decided within the Universe. The Universe is what it is *because its age is what it is at any one moment*. The Universe, no more than we, can affect its age, which is necessarily established independently and outside of it (Gödel, again) and only then entered into its Laws. *Only thus can confusion*

* "Which one of you, however much he tries, can add to his (current) age one cubit?"

be avoided! The immaterial "true clock" by which the universal age is measured needs *no* quantization and thus the Law determining the moment by moment velocity of light is *not* one springing from within the Universe, on *both* counts (the one being the *universality* of its momentary value, and the other being its numerical momentary value itself that needs for its determination the independent preestablishment of the momentary value of the universal age). Just as a clock and a trigger that turns a computer on or off *are not* strictly speaking parts of the computer! Thus, despite the obvious logical and physical dependence of the velocity of light upon the radial distribution of matter in the Universe, no mechanism exists *in* the Universe that is capable of regulating the exact, moment by moment operation of either of these laws. *Both laws* are *externally imposed laws of the third class*.

Thirdly, the Law of Universal Expansion. In a Universe expanding from zero volume, the greatest simplicity is obtained if its constituent parts also expand according to the Hubble Law*. And yet, expansion will probably be the last quality to be admitted as a universal intrinsic property of all bodies! (The notions comprising current thinking relating to universal expansion is evidence of that. Since Hubble, how universal expansion affects "ordinary" bodies has *not* been contemplated even as a most timid question!). By current standards, to be admitted as such, it must be dependent upon their internal structure and constitution and vary according to them. By current thinking, the same "must" be true of the entire Universe: Its expansion must be dependent upon its internal structure. And yet, its expansion *only parametrically* depends upon the universal constants G and M, but crucially upon ρ and T. As argued in the previous paragraph, the age is an inevitability not an innate property, nor indeed is position one of the properties of a body, and as a result, universal expansion at $0 < \rho \leq 1$ cannot be an innate property of the Universe due to its internal constitution. *The Law of Universal Expansion is externally introduced, and therefore it is a law of the third class. In general, all laws involving T are externally imposed laws of the third class*. The Law of constant G and constant M are also laws of the third class. The Universe is what it is *because* G and M (along with T) are what they are: Quantities fixed from the outside that together with a few other basic laws give the Universe its shape and form. (lf one wonders whether evidence of these laws also exists in the Scriptures, one may consider the statement in Luke 12, 7: "ἀλλὰ καὶ αἱ τρίχες τῆς κεφαλῆς ὑμῶν πᾶσαι ἠρίθμηνται" **. No audience can possibly comprehend the statement of conservation of mass, if it does not comprehend that even such an "insignificant" thing as one's head's hairs *have all been given numbers,* in other words, *have all been identified, each one separately,* and are all called upon to play their part. As for the constancy of G, this author admits that his current knowledge and understanding of the Scriptures do not allow him to quote a verse! But even if none is found, neither defenders nor detractors should rush to conclusions. An unscientific world needs no science to believe in

* Proportionally to the ratio of their linear dimension to the radius *of* the Universe.

** "but also the hairs *of* your head have *all been given numbers*"

God. A scientific one was given G three hundred years ago and did not realize what in fact had been given: the key to unlocking the mysteries of the Universe "out there". It rejected that cornerstone as just another stone, a mere proportionality constant! Lest this author be considered to be taking undue pride, let him hasten to say that although he realized the implications of G and the dependence of D and c upon T within the fateful first twenty minutes or so of this long expedition, it has taken him twelve whole years to put these pages together. He certainly cannot be proud of that! And several more months, now, to revise them!).

Perhaps, all this is just as it should be. Perhaps until now, the need to call in through G the last and final, the most authoritative witness upon the stand in the court of science, the Universe itself, was not as great as it is now! With this witness now speaking, we shall have absolutely no excuse not to take its word. If the times call for the Universe to speak up, perhaps things have become truly desperate! In that case, science has its work cut out for it: either disprove the findings of this work, or brace up and proclaim the inevitable conclusion that logically emerges. For as we have explained before, a law of the third class is first formulated in the mind *and only afterwards enforced upon the world "out there"*. As we argued before, laws of the third class found to be crucial to the functioning of the Universe, logically-necessarily-sufficiently call for the postulation of the Mind that first conceived them, and the Will that applied them in order to produce the greatest conceivable engineering feat, the Κόσμος.

The basic Laws of Nature that control the entire Universe necessarily introduce their Author. *They are the only evidence He can bring of His presence* to the court of Science. If His evidence is again dismissed without demonstrated proof of its invalidity, then His continued rejection will no longer be possible to justify on the statement that "science suffices". It shall then become obvious that we shall have decided to reject Him, not because of any objective reasons, if any such ever existed, but because to do otherwise would totally upset our habits *and our plans*! It is *not* true that science cannot prove the existence of God. God being Spirit certainly cannot be contained and placed upon the scientific "balance", as it were. Fools, were/are those who thus sought/seek to prove or disprove His existence. What Plato decried in his example of the acousticians (see p. 264) was the too great attention paid to the evidence of experiment, given its limitations. For twenty four centuries, we have not heeded his words, it now seems. We have chosen to be even more Aristotelian in our scientific pursuits than Aristotle himself would today have liked! Attached too close to our experiments, we do not detach ourselves enough to realize that *"experience" fools,* and to let our heads do the dutiful rest! The Aristotelian approach *is required, only up to a point*. From then on, one *must* become Platonic, if one hopes to comprehend the higher Reality of the Perfect Ideas. Thus, if we reject Him, even after we come to the end of Science and *our* Logic, because we do not like what we find there, the mistake will be only ours.

We can push Science and Logic to the extreme. But whether we do so or not from here on, we must realize that we are damned if we do yet pay no heed, and damned if we do not and thus continue to abuse them both, by pretending to be their humble servants and priests, collecting the offerings of the faithful, but re-

fusing to enter their sanctum sanctorum for the fear of the ultimate discovery. Scientists, generally but not without exception, dislike talking about God. What the reasons for it are must finally be faced, otherwise we remain mere technicians, uncomprehending manipulators of bottles and knobs. As has already been argued before in this work, the objective Reality is one, and so is the Truth that gives it meaning. The paths of ascent may look different down at the bottom of the hill, and one may foolishly deride the other for choosing "that" rather than "this" path to knowledge. But at the apex, all paths *must* converge. It is in the nature of the terrain. Up there, Science and Theology fuse together and become indistinguishable. To argue otherwise, is to demonstrate a fundamental inability to breathe in the rarefied atmosphere of the Summit, whether it be the result of a self-imposed limitation on reasoning, or of a "philosophically" imposed disposition to keep one's sight on the lowlands rather than at the towering glistening Summit up above!

It is for this reason that we cannot talk of the Universe and straight-facedly evade the question of God. When we study the face of La Gioconda, is it the molecules of paint that we study, or do we simply try to reconstruct in our imagination the true face of the original model? Unless we totally lack artistic appreciation, in which case we have no business in a museum, we do neither, because those were simply parenthetical means. What calls out for study is the artistry of da Vinci. How can it matter whether or not he signed his name down at the corner? Is the artistry diminished by the presence or absence of the signature? And to come to the real thing, those who do not believe in God, what exactly are they prepared to accept as proof of Authorship? Where exactly do they want to see His Monogram? In what language to they want it written? Is it possible for anyone who *can and finally must speak* to speak and yet to be said of him that he has not spoken and thus that he does not exist? Or to have spoken in *his* manner, and yet be said of him that he has not spoken, simply because *we* (who indeed are *we*, after all?) want him out of the picture? Although this indeed is the practice that today passes for highly refined "political art", what do its practitioners think they display beyond their inner emptiness or calculation or both? So, if, *inevitably, everyone speaks, whether by speaking or not speaking, unavoidably of himself*, whether he knows it or not, *so too God has spoken and signed His Name everywhere*! By the awesome simplicity and coverage of the Laws of Nature, their absolute logical tightness, their externality without which the Universe would degenerate into chaos and anarchy! In the presence of intense light everywhere, there is no avoiding it no matter where we turn, how shut we keep our eyelids! We are bathed in light and we know it. When one embarks upon the journey of Cosmology, he in effect embarks upon eventually, and sooner than he realizes, studying Theology! The Universe by the mere fact of its being a Κόσμος rather than the opposite, ἄκοσμος, a disorderly melange, has finally brought us to face its own and our Designer and Creator, our Δημιουργόν! It is in the Nature of Things! If the Light blinds us into a better sight of Things as they truly are, Plato's unfulfilled dream, as St. Paul said that it happened to him on the way to Damascus, the only thing that we stand to lose is our present blindness that passes

for sight! Yet, admittedly, we all shall need all the courage we can muster, for "no one ever saw the Face of the Lord and lived", (as before, that is!). When we demanded that He come down from the Cross upon which we had just affixed Him, before we would believe in Him, *surely we did not know what we were asking. Now, more than then, we know that no one ever, before or since, spoke with His* Authority. Now we know that our head's hairs are not insignificant but fully relied upon in the Scheme of Things, that our age indeed can only be comprehended in "cubits", not because some "ignoramus" so once wrote, but because *the Universe itself has no other means*!

Now, it seems, the Universe has done its assigned work. It has managed to attract our attention to its Laws. What we find is indeed Plato's Reality. For nothing other than God Himself is truly real. Nothing else exists that *is* in and of itself. Nothing has value unless it *is* in and of itself. The Universe itself most definitely, we now find, is *not* in and of itself. Neither the current "laws of physics" nor the findings of this work have succeeded in penetrating the thick "mystery" of what it is that we call mass or G or time or space or even "life" itself! Perhaps, *indeed most likely*, when *all is ligh*t, there is *no* mystery at all in any one of them! Perhaps, none of these is significant, or even real in itself. They are only "things" without intrinsic value (for if they truly had intrinsic value worth knowing about, God would *not* have kept it from us);"things" that only God knows how to manipulate in order to bring into being the reality *we know exists* around us, a reality that does *not* derive from their intrinsic nature but only from the underlying Law that *He* established to be their guide! And so, this certain knowledge of ours, too, has *not* come out of *those* "things". The logic we all possess, the "common sense", so much abused and misunderstood, innate in us, does *not* result from the above "things" that make the world. The Universe is only the vessel to contain the human mind in its physical confine, wherefrom alone for the present it can raise questions that even the Universe cannot surpass, thus demonstrating that we, as minds, are *not* of "this" world. The fundamental particles, units of mass-matter that we thought we "knew" can ask no questions! So, by the mere fact that *we* ask questions, *we* demonstrate, if demonstration were indeed needed, that *we, in our true self,* are *not* what those particles are! The innocent child wants to have answers to questions that we "grown-ups" have decided to put aside! It was time the question were asked: "Who is really grown up? Us or the children?" The Neanderthal Man was once thought to be the "missing link"! Now, we know that he was highly cultivated, for he honored his dead! *No* animal does so!!! Perhaps then, he was closer to God, the only knowledge that truly counts, the memory of Eden being brighter in him. We, despite our "sophistication", "culture", even "science", or perhaps because of them, are closer to the brink of the abyss! Can anyone really, seriously argue against the proposition that we are *not* the better ones—being on the brink?

Scientists prefer to close their books on Cosmology with some empty talk of optimism that is pulled down out of the thin air. I beg to differ. In my humble opinion unless science brings us to face ourselves and our reasons of why we do or do not do what, why we believe or do not believe, it has failed us miserably.

Science was not meant to be an opportunity to have fun in playing with bottles, test tubes, knobs, telescopes, microscopes or whatever, at our, or better still, someone else's expense, always ready to offer us an excuse why not to see beyond our noses, inside ourselves, that is! So, the probabilistic quantum theory wanted us participants in a silly, utterly meaningless game? The deterministic Universe makes us see that we indeed are participants in a game of true significance and unsurpassed meaning, a game of Fire and Light where only true gold can possibly endure! A fellow scientist once commented: "God did not ask me whether I wanted to be Man rather than stone!", openly implying that he might, who knows, have chosen the latter, and demonstrating his total incomprehension of what he was asking! For how do you ask something that does not yet exist what it wants to be? Alas, only now that we do exist, can we make the choice, as some have evidently already done! We can cut off our sensory organs, we can poison our consciences, we can still return to the state of the ever blind, unfeeling fundamental particle, the "stone" of my friend. That will be by far the worst choice. For it is the choice of the lukewarm bystander who does not even want to watch from the distance the Battle of Israel, Contender of God, lest he be drawn into it. Of the others, some enter the battle as friends, synergistically. And some as enemies, antagonistically; but as long as there is still a spark of objectivity left in them, the Loving God will continue to do battle with them, always nudging that spark to grow into full-fledged reasoning, so that they be able to shorten the Gap of Faith that they still have, as we all do, to jump over. It is the lukewarm, those who have poisoned their souls and shall not join the battle that "He will vomit from His mouth". So, the choice is still ours, as has always been! Only now, the time seems to be running out!

4.6

THE END OF SCIENCE AND THE CONTINUING JOURNEY OF LOGIC. EPILOGUE

The Universe has completed its testimony. It has demonstrated that the logicality of its Laws demands the existence of an outside Authority to compose them and inscribe them upon the ensemble of blank fundamental particles. Is this testimony sufficient proof of God's existence, or are there perhaps still undiscovered possibilities? The options are quite simple: Either there is one God, or there is no God, or there are many gods. The Universe has offered us its unique positive and sufficient evidence in support of the proposition that there is only one God. We are obliged either to take this evidence at full face value, or to explain how the Laws of Nature developed into such a tightly-knit set in His absence. Barring the One God, what is there out there that could give the "impression" of His presence?

No God, but chance? We have argued repeatedly that chance does not produce harmony. One only has to listen to an orchestra, as they begin to tune their *musical* instruments, to obtain a small measure of cacophony produced by chance, to hear how that cacophony vanishes *with time* as all instruments fall into tune as a result of the *conscious symphonic effort of all musicians* to tune into each other. In the Universe there are about 6×10^{120} instruments, all blank. Without any capability of consciousness at least of the outside world, and with chance alone as the single guiding principle, all these instruments must have fallen into perfect tune *in zero time* at $T = 0$! But then without an outside Authority other than chance, *what keeps them in perfect tune ever since*? It is *not* enough to invoke spontaneous chance just once at $T = 0$. It is also necessary that chance act spontaneously and sufficiently frequently (in fact, *every next Planck "chronicle"*, if the theory be right) and reproducibly *ever since* in order to create the seamless appearance of Law if there be no Law at all. What is the probability that all 6×10^{120} particles choose Newton's Law of Gravitation out of an infinity of options every so often? What *rational* gambler continues to bet on the *seamless continuity of this happenstance deep into the future*, unless he *believes* that there is *no* happenstance at all but the dice *are all* fixed? Now, you tell me: Are all scientists gamblers, or stubbornly unconfessing believers? If not in God, then in what???

Polytheism-Pantheism? In Man's darkest hours, when memory had mostly faded, Man almost forgot all about the One God. The veracity of this statement is

easily demonstrated by the *fact* that there has been a nation that never practiced polytheism, except once, briefly at the foot of Mount Sinai, when Moses was engaged elsewhere! In those and still earlier times, the "One God" proposition was not at all an obvious one. The rest of the world believed in untold thousands of gods. The Greeks being both believers and philosophers, never stopped talking about them, or in other words, theologizing, and pretty soon, they realized that the polytheistic system made no sense to their philosophical mind that called for Order that the almost constant imbroglios upon Mount Olympus could not possibly provide. Socrates arrived by Reason where the Jews had been all along by faith. When a particular monotheistic faith finally came along that made true sense to their Reason, the Greeks adopted it as their own, perfected it as best they could *given the then available knowledge*, and became the chief champions of the New Faith. *Polytheism gave way as a philosophically insupportable proposition*. There are some who believe that "natural" philosophy requires that we continue the march beyond where the Jews and Greeks took it, to the total abolition of the notion of even one God. But if we abolish the One God, we shall fall prey to those 6×10^{120} other ones! That all those gods behave on their own as here presented *cannot* be taken for granted. No god can be obliged. He has only himself to answer to. "Capriciousness", that is, the objective appearance of each god doing as he pleases, *cannot* then logically be ruled out. If every three of us can produce four or even six opinions, what obliges all those gods to have only one? Logic? But Logic does not exist before they *all* agree! Logic can only be the voice of homophony, not the prerequisite that makes agreement possible, because if it is such a prerequisite, it must stand separate and above them all, and so they are not gods at all! To the *rational* philosopher, accepting 6×10^{120} gods is fully equivalent to regressing directly back to the darkest of the dark times of Man! When Mount Olympus could not house harmoniously only twelve gods, surely, the Universe is too small to house 6×10^{120} of them!

The concluding argument is quite simple: *Science requires that we do not abolish Logic. And Logic requires that the proposition stop there*: *at the Feet of the One God*!

Some cosmologists have marveled in their closing statements at the "apparent" contradiction of the Christian proposition that God made the World according to Law but miracles, which are nothing if not the suspension of that Law, are still possible. This is a question that appears frequently in various forms, asked especially by those who believe in the "impossibility" of a miracle given the "inflexibility" of the Laws of Nature. We now have all the tools we need to discuss and dispose of this supposed contradiction. I suppose, it is absolutely true to say that there is not one rational self-respecting scientist or engineer who designed and built a most elaborate experiment in his laboratory, set everything on automatic, then locked the door behind him, threw the key away and never bothered with his setup again! Now, if *not* one *such human can be produced*, is it not far far too much to say that God behaves in such a fashion? That He set the Laws of Nature inflexibly and forever and abandoned the World to its fate? The proposition that the Laws of Nature are totally beyond the Power of God to interfere

with is totally laughable when we human scientists always check and adjust our setups, which from within them must undoubtedly appear as nothing short of a change in the laws of their universes, which is exactly that! A *god who cannot, or will not if necessary, adjust his own Laws of Nature, in aiming for a worthy cause, if the freedom of no man is violated and no whim is favored, is not worth talking about and is not at all the God of Christians*. No self-respecting scientist or thinker should erect his own straw man, call him the God of the Christians and proceed to destroy him. So to do demonstrates at best a naïveté that is unbecoming of servants of science who must never forget that they are *also* servants of Logic. The God we are talking about here is the One Who established those Laws and thus is their master and not their servant. Surely, we now know that upon the blank fundamental particles, *any* Law can objectively be written, because the law is introduced separately and distinctly from them. So, there is nothing to prevent the same fundamental particles from obeying a different law when so ordered and being recalled to the original track according to the exclusive prerogative of the Lawgiver. If we do it within our means, then certainly, so can He! Thus, the impossibility of miracle should not be predicated upon the inflexibility of the Laws of Nature, for they *can* be changed, nor upon the inability of God to produce a miracle, for He clearly is above the Laws of Nature. The possibility or impossibility of a miracle can only be predicated upon its objective need, in God's *not our* Judgment, and upon our own receptivity or unreceptivity of its outcome.

The question of miracle thus posited falls outside of science *but not* outside of Logic. Yet, it deserves to be discussed briefly here, in order to explicate the Orthodox Christian notion of Miracle, so that the difference between that and whatever conception of miracle each one of us denies be made clear. I shall choose a central point of the Faith to make the argument. Surely, none of the readers of this work can believe that, if there is a God Almighty *but not unreasonable*, we humans can fix Him on a cross and be done with Him! Again, no one seriously believes that it is beyond such a God's Power to appear amongst us as one of us! Who are we to place constraints and limitations on what such a God can or cannot, may or may not do? It displays a pitiful intellectual immaturity to say that "He did not descent from the Cross when so challenged, ergo he is a false God". The Greek text is *clear* (Matthew 27, 45; Mark 15, 33; Luke 23, 44): A *total three hour-long* darkness between twelve and three o'clock, τοῦ ἡλίου διαλείποντος, *not* διαλιπόντος ("as/while the Sun became *steadily* absent", *not* "just for a *short while*", which means that the Sun *was steadily* visible before, that the sky *was* clear and then for three hours it became absent from the sky, but *not* because the sky suddenly turned cloudy) in Luke's words! Those were *not* words meant to fool later generations, but facts that *all* those present *had* experienced themselves. It is in the *Living* Tradition of the Church that the New Testament was kept and transferred and the Living Tradition is *not* to be laughed at in the present supposedly "sophisticated" era when big lies are shamelessly not only just told but also *consciously* written as true history, for here we are talking about a period when the books we call Gospels were transmitted mostly by the word of the witnesses' mouths before they were written down, and the witnesses were

not shown to be beyond their senses. People then still respected the word of mouth, and anyone who finds this difficult to believe only has to read Plato, certainly an unimpeachable source, and then consider the respect with which the Living Tradition of the Church kept intact, even after they were put down in written form, supposedly "contradictory" versions of the Gospels. Then, there is the matter of his Resurrection! The Lord did *not* belong to *that* generation of men to be resurrected just as mere flesh, that in time, as is mere flesh's due, *would* again return to the tomb! He belonged to Eternity, both as ever Living Spirit *and* as flesh that *He* then turned to light, of which, as in this work was shown, *all* massive bodies *and so too also the flesh, are* made! Before this work had shown what it did, people could raise naïve objections. No more! The early Martyrs of the Church who died rather than betray their Faith, surely knew *first-hand* whether they were telling lies or the truth. They had been eyewitnesses of the events claimed. What could they have hoped to gain if they had decided to die for what they *knew was a* lie, *if it were a* lie? So, the three-hour-long darkness was *not* a lie! The Resurrection was *not* a lie! The thousands that believed on the Day of the Pentecost were *all* eyewitnesses at least to those pre-Resurrection events. When St. Peter told them "Whom you crucified", he was not accusing them of Deicide, *for that had already been forgiven, but he was calling upon them as eyewitnesses to events* in *which they themselves had participated*! The Jewish priests, surely present, did *not* challenge him for telling lies, they *knew* he was *not*! *Their men had stood guard*! Yet, people who saw those events still did not believe in that very minor miracle! What they had asked for, which was denied them, *was to see God* in *all His Glory* descent from the Cross. But their eyes, as ours too, could *not* possibly endure such a spectacle, nor their skins the heat of it. (Those who saw A- and H-bombs go off can certainly give us but a tiny a glimpse of what *that* request would have meant!). If by God's Grace, they had still survived such a Descent, what *objective spiritual* value would their thus *forced* "faith" have? It is childish to attach human motives and weaknesses to God and judge Him according to our measure, specifically now that our "laws of physics" have shown their limitations *and* their advantages! *We always like to* show off! But what would *He have* gained if He had taken up the challenge? What other than secure our everlasting fear, our constant trembling, *not our free faith*; that henceforth we would be doing the "good"(?) like automata out of sheer petrifying terror, not out of our illuminated inner conviction that doing the truly good for good's own sake, *regardless of reward or punishment, is* what makes us truly free and thus worthy co-owners of His Kingdom of the Spirit?! We prefer to have slaves around us rather than friends, just ask *any* "boss"! In this World, God already had 6×10^{120} slaves, the fundamental particles. He needed no more of those, or He would have produced more! Us, He wanted as friends! There is no *higher* honor! *It is* only *when Man's Free Will will not be lost in the face of a Miracle that a Miracle is possible at all*. This cannot be overemphasized. To continue to have difficulty with this *fundamental principle* governing the God-Man relationship can only be due to spiritual immaturity, to our hypocritical lip service to Freedom. To continue to deny as a fundamental principle God's ut-

most respect of our Freedom is to demonstrate how little freedom *we* are willing to accord others. Those who still do not want to believe in God or his capacity to produce a Miracle, only have to look around. Every tiny "insignificant" object around us *is* a Miracle in an expanding Universe that exists only because there is a Law that sustains everything, beyond *all ordinary* human comprehension. If they can produce a cause that brought that Law into being and a purpose other than as here stated, *without a Lawgiver, initial and final justification of all Reality around us and in us,* with which they feel *intellectually fully comfortable,* I for one would surely like to know about it!

Before ending this work, we *must* touch upon a few other very pertinent questions, which though strictly speaking outside of science are nevertheless crucial to the whole subject of Reality we have been discussing.

Many people, preeminently scientists and materialistic philosophers, have difficulty accepting the idea of the Universe as created, on the supposedly logical argument that if we do so, we then are permitted to raise the questions "Who created God" and "Who created Whom, Who created God", which start us off on an infinite logical regression toward a supposedly impossible to show and thus supposed nonexistent first cause. They prefer to cut this whole enquiry short at the first opportunity by holding that the Universe will do just fine, thus proclaiming themselves to be atheists as a matter of logical necessity and simplicity. The trouble with their argument is that *they do not deny the idea itself of everlastingness* (both past and future), they only prefer to see it applied to the Universe. But even if this argument held at all in earlier times, *it can no longer still do so*! Because now we have exhausted examining the limitations of the Universe: Since the Universe on its own is incapable of establishing the Law it obeys, *God is logically required*. Since the Universe now unquestionably did have a most definite beginning some billions of years ago (their exact number is immaterial, the law itself introducing the *age* of the Universe suffices), it *cannot* logically have been everlasting. Thus, everlastingness, which even the atheists do not deny, cannot logically be ascribed to the Universe, it must be conferred exclusively to God. On the other hand, the infinite regression mentioned above can only have meaning for things or beings *coming into* being and *cannot* be applied to anything everlasting. Just as the atheists were satisfied not to ask the question "Who made the Universe" on the grounds of its own assumed to be simpler everlastingness, now that Logic compels us to confer everlastingness exclusively to God, we all must be equally satisfied, and with far greater justification, with the total groundlessness of the question "Who made God". We can deny God His everlastingness, *only if we deny the idea of everlastingness altogether*! Are the atheists prepared to do so? If so, *they* then shall indeed fall into the trap of infinite regression which they tried to avoid in the first place! If in the face of all Logic they still choose to fall into the trap, what will they say in defense of their own logical inconsistency? Their choice of atheism will then have been demonstrated *by them* to be due *not to Science or Logic* but only to *their* resolute denial of God *in order to avoid the wider implications of His existence*! *There is no logical escape other than conferring the attribute of everlastingness exclusively to God*!

But we are not finished yet! As occasionally, the principle "No thing comes out of nothing" is held as an argument in support of the everlastingness of matter on the grounds that matter can only come out of matter. This can no longer be held, because the Creation of the Universe at T = 0 pertains to *all* that constitutes the Universe. We no longer may conceive of anything "material" without the concepts of G, M, T and the Laws that relate them, specifically in view of the fact that T is *not* time from everlasting to everlasting *but only the finite age of the Universe*. Logically then, we are reduced to having to apply the principle *no further* than to the Creation itself of the Universe, in which case it means that "the Universe was created by God". The principle *cannot* be applied to God, because He is *not* an ordinary "thing" requiring application of reasoning pertaining to ordinary "things". He *alone* belongs in a category entirely of His own, a category having no other members! Otherwise, that is if we insist on demanding that His category "must" have other members, we *must* be prepared to propose *reasonable* answers as to what happened to those in the long lineage of whom God is the last member! Being unable to propose *such* reasonable answers, now that we are faced on the one hand with the *need* that the Universe have had a Creator Who also was its Lawgiver, given its own inability to come out of nothing all by itself together with the Laws it obeys that, on the other hand, as such *are only products of Mind and not of nothing at all, as our own experience of lesser laws informs us*, we have no option other than accepting *His singula*r everlastingness, that we thus establish as a *logical necess*ity precluding all questions as to His origin! If we still insist on talking about the origin of God, the short answer is that God, besides all else that we attribute to Him, *also is* His own origin and His own cause, that the Greeks mean by the term ἀΐδιος that expresses His everlastingness. Thus, the existence of the One God is not only required by the logic of Science as we showed earlier, it is also required by Logic.

Many people, scientists preeminently, are quite well prepared to accept a totally nebulous and diffuse notion of God. Their scientific intuition tells them that there is out there an Energy, a Power and a Force. Science suggests as much, they are prepared to admit. But they have extreme difficulty with the proposition of a *Personal* God. They forget that laws are products of *minds, not just of brains*, that the two are *not* synonymous! Despite all its advances, Science has *not and will neve*r succeed in reducing personhood to scientifically measurable quantities. But that offers no excuse for dismissing the idea of a Personal God. If we dismiss His Personhood, we must also be ready to dismiss our own personhoods! If Science "does not support" any personhood, God's or ours, are the mathematicians, physicists chemists, astronomers ready to cease regarding themselves as persons? Even if we deny the personhood of others, as has been done and is still being done for obvious reasons, we shall surely never deny ours! Science has its limits and now we are in a better position to know where they more or less are. But Logic extends far beyond. And *Logic suggests* unquestionably *that a person is far superior to a thing*. Logically, God is either a Person or a non-person. In the latter case, He must be a "Thing of sorts". So, as long as there is amongst us even one who still adheres to the notion that at least *he, or only he, is* a person,

we all cannot logically deny personhood to God; unless *he*, or even *we* show *him* or *ourselves* equally superior to God, just as He is to us! To do otherwise is equivalent to declaring that we as persons are far superior of Him as a "Thing of sorts", that nevertheless brought us, Its superiors, into being as, for all we know, the final occupants of the Universe! In that case, we *must* give a logically satisfactory answer to the following question: If God is not a Person, how could the Universe, unquestionably a thing and not a person, creation of another "Thing of sorts", namely, a World totally without inkling of the notion of personhood, create so many persons of us? Nothing comes out of nothing! Or own *created* (since by the matter in us, we have *followed* the Creation of the Universe and thus we have been created *in toto) personhood* did *not* come out of nowhere in a world totally devoid of the idea of person! Thus, our own personhood is *sufficient* proof of a, *the* Personal God. Our personhood logically demands *His* Personhood as a cause. We as persons are *not* superior to Him. We are ordinary "human" persons, dressed in humus. He *is The Person, totally free of the need for such clothing*!

The question of a Personal God that we have just discussed has created problems not just for atheists and agnostics but for hundreds of millions of believers also, for it introduces directly to and forces us to face the Realm of the Relationships of Persons *in a* unique and exclusive manner. It is only natural to expect that if the impersonal world, the Universe, is "complex", then the World of Persons must be far more complex. This is unquestionably so. How then are we to begin to comprehend the latter? There can be no question that, now that we have relegated God to nonexistence and for as long as we continue to do so, it is here that our incomprehension is at its thickest, judging by the blunders we all commit and accumulate daily. Many people, scientists and philosophers, too, of modern vintage, have espoused that we can begin to impose some order upon the World of Persons by applying to it the "lessons" of science from the impersonal world of "physics". After all, according to current thinking, we are no more than the molecules that make us up; the notion of personhood in us is only some "peculiarity" of highly organized matter, which is rather difficult to deal with "scientifically", which therefore can be dispensed with! It is this notion alone that has reduced us to mere numbers, to contemptible consumables in war; or in the euphemistically called "bloodless wars" of "peace", which is where human value is devalued the most. We prepare for the ultimate catastrophe precisely because we have ceased to think of each other as *persons,* unique entities of real unrepeatable value, each one of us a pearl of the most exclusive rarity, fragile and perishable and thus even more worthy of attention and care while it lasts, and have consciously chosen to "measure" each other as numbers, mere units of obedience in production or consumption, whether of ideas, mostly bankrupt, or of goods, mostly of dubious quality. It is the inevitable development in a world that has abolished God, a world that has learned the "lessons" of chance and relativity all too well and seeks to establish order by arbitrary fiat of government of all kinds, elected by people, regardless of whether they constitute a majority or a minority, totally unfit to choose their own governments, if we can, as we *must*, judge by the inability of the latter to govern and lead intelligently. Specifically at

these latter times, and in full view of these and impending developments, many people ask "If there is a God, and if God is a Person, where is He now that we need Him the most to show us the way and save us?" There is another question not too dissimilar: Problems and catastrophes are not only man-made. Non-man-made "acts of God" pose directly a dilemma in the hearts of *many* otherwise bona fide "believers". What are we to answer? These are too serious and deep subjects to deal with here in a work that probably has already overextended its stay! Yet, it appears that *we must* take the time to give a brief, if necessarily rather incomplete, idea of what Logic suggests to be the correct resolution of these problems. We shall deal with them separately, as their nature demands.

Firstly, the Man-made Problems. To have learned the aforementioned "lessons" from science is by far the greatest mistake humanity ever committed. The deterministically fully meaningful Universe we have presented in this work exposes totally all claims of scientificity made on behalf of chance and relativity. The Universe is governed exclusively by Law totally unconfused and unconfusing. *This is* the *correct lesson*! As *such* law is required for the operation of the Universe, we can safely take it as a given that, the far more complex World of Persons *must* logically be governed by a far more comprehensive, and if it is to make ultimate sense and avoid chaos, far simpler yet far more powerful Law. Judging by the *very real* effects that personhood creates in the inanimate world out there, for example by *the conscious decision of a person* to explode the H-bomb, say, the reality of person is no more to be doubted than the reality of mass. Just as mass was proven earlier to be not at all an illusion created by the field but really the other way around, so too personhood *is a very real entity indeed* that can be ignored only at grave risk of limb, life and Logic. And so is the Law that determines the relationships of Persons. The Laws of Nature can only bear a relationship to that Law as Plato's images bear a relationship to the idea of Reality.

In analyzing the problem of the Miracle above, we asserted the "negotiability" of the Laws of Nature in the Hands of God. The Law that alone can lead to the perfect resolution of problems in the World of Persons *is totally non-negotiable ever*. If it were, it would play favorites with some of us at the obvious expense of others and of Logic, and it would lead not to Harmony but guaranteed constant chaos. It is of this Law that the Lord spoke when He said that "it is easier for heaven and earth to pass than for a single dot to drop from the Law" (Luke 16, 17). That Law is no other than the Moral Law, in the eyes of which none of us is a mere number but a Sacred, if not yet Divine, Unit *totally* to be respected. In the physical world, the two principal ideas, namely, gravitation and expansion are indeed the *opposite* sides of the *same* coin; they are antagonistic. But in the World of Persons, the two principal ideas, namely, Moral Law and Personal Freedom are *synergistic,* they make an *indivisible whole*. In the physical world, the law of gravitation was inscribed upon the units of that world. In the World of Persons, the Sacred Units *are free, freely to inscribe upon themselves* (Romans 2, 14-15) the non-negotiable-ever Moral Law that alone can result in Harmony. How do we know what the Moral Law demands? Simple: *"Do unto others (all others) as you would* have them *do* unto you". Surely, we *all* know how we like

to be treated! What more do we need to know? It is the awesome sense of Freedom, that *includes the clear knowledge that demands of us to submit freely to our innermost sense of what we thus know that it must always be done and to accept full responsibility for everything we do in violation of this Law that scares us*!

Having not acquired that sense, we are scared of the fear of the unknown! Because, neither schools nor churches do any longer instruct pupils and members even in the rudiments of the *united* Moral Law and Freedom! They only instruct first blind obedience to their dictates, and only then what in the *practical* absence of God (as even prelates and bishops, *in order to please*, assert that the existence of God "cannot" be proven!) must only be the most ludicrously dangling from nowhere "rules"(?) of behavior (for how can they be *true* rules) based on "situation ethics" in a world that is totally, hopelessly relative! The young are not at all without justification when they disdainfully reject out of hand the "dictates" of such ethics that has nowhere to stand. We have already seen how the child searches for the First Cause. It comes naturally in the still uncorrupted young to reject an *a*causal system! It is the adults that refuse to repair their own ways!

As for the churches, in order not to see their stalls simply collect dust permanently unoccupied, so diluted have they made the wine that comes under the title of "Duties of the good Christian" that is guaranteed quickly to emaciate the most robust spirit in almost anyone of us!

And as for governments, *all* governments, the last thing they truly want to see is the *correct* sense of the Moral Law to spring forth from the souls of the citizenry, for that would be the end of *all* governments as we know them. In ancient Democratic Athens, the state was paying for the theater tickets of the poor. Not only for the dramas of Aeschylus, but also for the "obscene comedies" of Aristophanes! For they both were correctly recognized to be lessons in the Moral Law that society and the state could not do without. The golden age passed, irretrievably it now seams, as society, *supposedly* better informed, ignores what the ancient "Theater" was teaching. Today, not only do governments everywhere not pay for the theater tickets of the poor (not without justification in view of the mostly utter trash that now passes as theater), not only do they not guarantee them even work, that alone assures a piece of dignified bread in the mouths of the citizenry, but instead they assert most boastfully as a matter of high principle the abolition of Moral Law and Freedom, in the guise of the so-called separation (yet *in fact, secret collaboration*!) of Church and State—last and weakest impediment in the frenetic downhill race, that only the truly blind cannot really feel (absorbed as they are in winning that *unguaranteed* daily bread) the far more pressing need for that other "bread" that alone can feed and fill our souls.

Then again, today, by and large, we do not want to be Free, we want to be granted license, that is to say, total absolution from responsibility for anything we desire and do! We do *not* want to act freely self-guided according to the unerring dictates of Logic in us, within the bounds of the *Logical Moral Law,* we want to see the total abolition of the latter! We do not want to recognize the logically imposed synergism of Freedom and the Moral Law, we prefer the constant antagonism of humanly legislated "law" and license. Not being Free ourselves and tending to the licentious, we deny Freedom to others: Disobedient to the

Moral Law ourselves, to ourselves we grant license, to others we deny it. And in full shamelessness and pretended incomprehension we expect God to save us, "*if* He be out there, *if* He want us to believe in Him"! For we should not lose sight of the *conditionality* under which we will, or so we say, grant Him our "faith"!

But there are some things that even God cannot do! Because God is a Person, *The* Person, *He too* has a choice to do good or evil, which are only potentialities of *choice of a person*, though He *freely* chooses *always* to do good, which thus becomes inseparable from Him. As a Person, He, better than anyone else, knows how a person is to be treated: With the utmost respect. That very same respect He has already accorded us first, from the beginning, for He has always wanted us to be His *friends* , essentially His equals in the Realm of the Moral Law and Freedom! Thus, *He cannot interfere with our Freedom*. For if He did, He would automatically abolish the Moral Law, that is to say, His own self-respect, and would eliminate the very distinction that sets *us* apart from "stones". When we cry out Heavenward for "help", is this really what we want to get from Him? God to abolish the Moral Law, grant us permanent license to do what we please, help us commit, with total disregard of consequences, all manner of immorality so that it no longer be called *that, but still be that all the same*? Surely, ill-bred children can be both illogical, for they are still immature, and demanding, which fully reflects the upbringing they receive from their elders. But when "adults", "scientists", even "philosophers" descend to such abysmal depths that they no longer can see the light shining up above, the most ill-bred child is definitely an angel by comparison! Certainly God *cannot, will not, shall not* descend to such depths to oblige us. *He* has no need of our "faith", thus *conditionally* promised! More simply, *He no longer needs us. By the Laws of Nature and from on the Cross, He has fully proved Himself*! *We need Him*! To find Him, we do *not* have to look far or up. Only just inside us!

Secondly, the "Acts of God". If God is always there to save us from every scratch that we may suffer as we stumble along, how can we outgrow the pain of the flesh *and* of the Spirit? If God is there to save us from sickness or the natural catastrophe, how can we sick and healthy, safe and destroyed alike, contemplate the beyond the confines of this life? We have been instructed (even from within the Old Testament) to regard as evil everything we dislike (starting with the prohibition of eating the proverbial apple, or else we would not have eaten it!), to swallow unchewed the "spiritual" food we are fed (we do *not* ask why indeed *we* were expelled from Eden, while the Tempter *remained*, or why we pray that "Our Father … lead us not unto temptation … but deliver us from evil"), we regard sickness as evil, death as the greatest evil of all! *Only Socrates saw death as deliverance, peacefully certain that he truly was going to a far better world*!

Even *today*, not even supposedly Christian "philosophers", never caught not to speak with a long series of reservations and qualifications, comprehend what it means to stop death on a *limited* planet, *naturally unable to deal with the continuous increase of never dying, always multiplying population*, under the sacred churches' command that we not stop procreating (to ask for comprehension from the priesthood is to ask the impossible)! So, the outcome is indeed certain!: Man

being free, *could* have chosen not to commit a sin. If death is the dues owed for sinning, on a *sinless yet limited* planet, how indeed could death be avoided as a result of starvation and asphyxiation due to unlimited overcrowding? The "faithful" are at last caught: Their God committed a grand error in placing Man with such orders on a limited planet!: The atheists rejoice! But did He really? And are they off the hook?

In an expanding Universe that from the beginning *was* meant to die, *this* sort of "life" *was meant to* be transitory. Death in it is *not* evil, but the Deliverer! Socrates *was* right! God wants us to be ever-ready to die. Sickness and natural calamity lurk *deliberately*. *They* are the means par excellence by which the Spirit in us is trained. Those of us who *by any means at all* constantly attract undue attention to the here and now, to the "happiness" of/in this "life", as if this be all there is, misread the evidence of the Universe and mislead us all into loving and chasing the trivial rather than the all-worthy.

Even if misery is not man-made, it can certainly be man-alleviated. If our pockets are inexhaustible in funding the means of the destruction that we prepare, by far worse than any natural "act of God" that ever hit Man, we certainly *can* afford to help the victims of natural disasters. It is hypocritical in the extreme to charge God with "indifference" or even "cruelty" now that we cannot relegate Him to nonexistence, because He does not save us from natural or self-induced wounds, because we are not prepared to face the full consequences of our own deeds and learn from past mistakes. God *meant us to* be brothers to each other, to carry each other's load through life, but to this day we keep asking the fratricidal "am I my brother's keeper?" Surely, we must carry our own load and then some—*if* we can. But just as much as we like to be left alone, behind, by the wayside, in the face of the advancing, cruel, sadistic enemy who takes no prisoners, just as much should we be prepared to abandon others to their "fate" in life. Only when we have done our duty to our brother and then some, in the Spirit of Love that never asks for itself, only when we have reached the point of ultimate, *objective* desperation and have received no help from God, may we have, *perhaps, some* justification to point the finger Upwards. For even then, to the extent that we are prepared to point the finger, our faith has not yet met the minimum requirement for entry unto His presence. But we are nowhere near that point yet.

Before then, charging God with cruelty, is our way of shameless hypocrisy for finding it more profitable to raise the finger in accusation of Him rather than in assistance of one of us. If the objective need for a Miracle is there, and Man's Free Will is not in question, the Law of Nature is certainly *negotiable*. But the Moral Law is *not* negotiable ever! We must "live" and "die" on this Earth and it shall *not* pass, ever! It is incumbent upon us all to put this Final of all Lessons, that *our being Persons in this Universe* logically compels us to reach, deep in our thick skulls, or we have signed and irretrievably sealed the deed of our undoing!

As we stated in the Preface, so it must be repeated here. For it is terrible to stand in the face of the Truth, the danger of error being ever-present. I do very much pray that my logic has not gone astray, that the Spirit did not abandon me in my own blabber and fulminations, that I committed no sin against the Spirit. Whatever mistakes I have committed are fully mine. *The Spirit never errs*! I have done all I possibly could to eliminate errors and arbitrariness. Still, it is possible for things not to be precisely as I have managed to put them together. My reasoning from beginning to end was based on the most incontrovertible evidence Nature herself and Reason offer: That Nature is and can only be best studied on the basis of the Most Elegant Design Hypothesis introduces directly to the Least Set of Laws. And Laws of universal coverage were found to operate in Nature beyond and sometimes in contradiction to those currently accepted, Laws that cannot spring forth from matter itself but are, rather, imposed upon it from the "Outside". A deeper and amazing level of Law was thus disclosed from which no "detail" ever escapes. So, when "my" findings are examined and corrected, the correction will *not*, because it no longer can, be in the direction of less Law, where current conceptions lie in relation to the findings of this work, but in the direction of the Complete and Perfect Law, which can only speak of the Λόγος of the Lawgiver. The time has come to surrender this document of personal search to you Reader-Brother, so that together we may search further in that direction. The language was at times strong indeed, to awaken the Spirit in us, but the voice, believe me, was always soft, almost a whisper as befits our presence upon Holy Ground. Brother, beware of those who come the other way around, dressed in sheepskins. By their big yet poisoned "smiles", or loud voices, or empty talk, by their conceit and their calculation shall you indeed know them!

This whole discussion is not without its reward. For we now know where the limits of Science, or more generally of the Aristotelian method, are, and what Pure Logic, or the Platonic method, is capable of, especially when built upon the former that has provided the objective evidence of us, *Persons in the Universe*. Now, we know how to interpret the despair of Plato's "acousticians" who have already declared the Universe as being without discernible purpose! To a Platonist, the Universe is full of purpose! Its Laws that forever beacon us back to its Divine Birth at the instant of the Lord's glorious Command "Γενηθήτω φῶς!", speak not just of the reality of this material Universe, but of a far Higher, of the Absolute Reality beyond the confines of this ultimately illusory though indeed we think it real world of G, M and T! They speak of the World of Pure Spirit, of the Λόγος of Cause and Purpose, of the A and the Ω of Being, all in One. Science did its work. And so did Logic. Now, we must bend both knees and bring our head to the ground in front of the Burning Bush, for we have only scratched the surface of the Moral Law and without a long apprenticeship in *that* we are not yet ready to face the rest of the Truth squarely in the Face, though we have arrived at His very doorstep and our faith only needs one small, natural step really to take us over. We still need His Warmth to purify the gold in us, before we can lift our eyes to meet His and become as if one with Him!

PART FIVE

ADDENDA

ADDENDUM I

ON THE GEOMETRY OF SPACE AND TIME

Consider a perfect cubic "crystal" (or a three-dimensional lattice). The simplest method of identifying the atoms in the crystal (or the nodes in the lattice) is to refer them to the corresponding atoms along the "principal" axes of the cube. By a generalization of this method, any point at all within the crystal, even between the atoms in some "interstitial" position, can be represented by *uniquely corresponding* points along the three principal axes. These points are determined by the intersections of these axes by planes through the specific point in question within the crystal drawn parallel to the other two principal axes. A further generalization can be made by placing identical cubes in contact with the initial cube in all directions and so on, so as to fill all space. By removing all materiality from the "atoms" comprising the crystals, the overall lattice is reduced to a three dimensional orthogonal system of purely immaterial, mathematical lines that fills all space. This is the Euclidean-Cartesian system of reference and upon this idealized construction has the claim been made, first by Descartes and then by Kant, that Euclidean geometry (meaning no more nor less than the above idealized frame) is a priori given as the "natural", or God-given, reference system of empty space, though in fairness, Descartes did not believe in the actual existence in Nature of perfect vacuum. This however in no way detracts from the validity of the view that the orthogonal Euclidean reference system is the simplest that can possibly be devised in order to refer to it other mathematical points in the *mathematical universe* corresponding to physically empty space.

There are several ways in which a reference system can become more complicated. Tetragonal, rhombic, monoclinic systems are progressively more complicated. Complication is obtained at the cost of loss of cubic symmetry, namely, of orthogonality and of the triple equality $dx = dy = dz$. The most extreme complication is obtained in the triclinic system in which all symmetry is gone while $dx \neq dy \neq dz \neq dx$. A generalized frame made up of triclinic infinitesimal elements (dx, dy, dz) in which contiguous elements have nearly identical common sides consists of generally curvilinear axes replacing the three orthogonal axes of the cubic system. This system is known as a three dimensional Riemannian space which is mathematically, though not always physically, equivalent to the three-dimensional Euclidean space. The term "equivalent" needs, however, some explanation.

The discovery of the general multidimensional (three- and higher-) spaces

by Riemann followed the discovery of the general two-dimensional space by Gauss. Gauss' system can fairly be described in the following way: A system of lines replaces the system of lines in the x-direction in the Euclidean system. Any such system is acceptable as long as not two lines touch or cross over. A second similar system of lines with a similar internal restriction can be conceived to replace the system of the y-lines of the Euclidean system. When two such systems of lines are superimposed at some non-zero but otherwise arbitrary angle at any one point, in such a way that every one line of the one system crosses every line of the other system but only once, one obtains the two-dimensional Gaussian continuum, a simple example of which is usually given by an undulating, hilly terrain, the Gaussian reference system of which does not generally project on a horizontal plane placed beneath the terrain as a Euclidean system. As far as two-dimensional continua go, the surface of a hilly terrain is indeed a very simple one. Any two-dimensional continuum, however crumpled, bent, or anomalously distended, distorted or twisted, but as long as it nowhere touches on itself, is a Gaussian continuum. As a result, a two-dimensional Gaussian continuum *partakes of all three Euclidean dimensions*. A Gaussian continuum is a three-dimensional Euclidean surface. A Gaussian continuum mathematically or physically fully equivalent to a Euclidean plane is a rather trivial case, and no good mathematical or physical reason can be given as to why such a system should generally be preferred over the Euclidean system. It is probably for this reason that Gauss did not generalize his continuum to cover the entire (physical) space of the three Euclidean dimensions: There is no, easily specified in mathematical language, condition, such that the three Gaussian surfaces, corresponding loosely to the three Euclidean planes x-y, y-z, z-x, may only meet once at a single point and nowhere else in the infinite Euclidean space, *and nowhere will any two of them run parallel to each other*. It must have appeared to Gauss totally unnecessary to develop such a complicated three dimensional Gaussian system to survey the Euclidean three-dimensional space, when the three Euclidean-Cartesian co-ordinates were both fully adequate for the task and unsurpassed in simplicity.

The generalized mathematical three-dimensional continuum developed by Riemann must by analogy be considered to be capable of representing in three Riemannian dimensions *more* than the three dimensions of ordinary Euclidean space, just as a Gaussian surface is in fact a three-dimensional Euclidean surface. To constrain the three dimensions of the Riemannian space to the three dimensions of the Euclidean space thus seems to be a totally unnecessary waste of "mathematical resources" (as undoubtedly Gauss must have felt), namely, if the former system is developed in such a way as only to be fully equivalent to the latter.

But even in the latter wasteful case, there is a very important difference between the Euclidean and the Riemannian systems. Whereas all space can be filled with the Euclidean elemental frames (dx,dy,dz) being pulled at random out of the "bag" and placed contiguously together, because all elemental frames are identical to each other and they all are such that dx = dy = dz, so that assembling, disassembling and reassembling the entire network involves no more than some

translation and rotation, this cannot be done with the corresponding Riemannian elemental frames: once the Riemannian network filling all space has been constructed, its every elemental frame must be numbered and its place and orientation carefully noted, before the network can be disassembled and the "cubes" placed in the bag. Once randomly mixed, they can practically never again be put together to reconstruct the previous network filling all the world, even without consideration of translation and rotation!* Rather than trying to reconstruct the initial Riemannian frame, one will probably waste less time starting all over again. If the Riemannian "cubes" are pulled out of the bag at random, and as long as they are not too different from the Euclidean elementary cubes, when placed contiguously, *they will create a jagged Euclidean network, not a Riemannian one*! This discussion brings home the difficulties two surveyors would face who would set upon constructing a *single* Riemannian network, each starting from his own place in space, each using his own tools, each forbidden to use Euclidean geometry including translation and rotation, and only permitted to communicate with the other by, say, radio.

Another equally important difference between Euclidean three-dimensional space and Riemannian multidimensional space as used in relativity theory is that the former is homogeneous in the sense that the three dimensions x, y, and z are physically identical to each other, and only differ in direction. They are three and only three because only three directions can be specified in (physical) space independently of each other, namely, when they are orthogonally disposed. Any other direction is then analyzed to the original three regardless of how the latter are oriented in space. This quality is totally lacking in the four-dimensional so-called "continuum" of spacetime. Most critically, the fourth dimension, time, is not physically identical with the other three and therefore it cannot form a homogeneous physical continuum with them despite the remonstrations of relativists that spacetime is a physical reality and not merely a mathematical construct.

It seems that this confusion has arisen from the *representation* of time in ordinary physical diagrams of pre-relativistic physics as another dimension of length, in place, say, of y in Cartesian co-ordinates. For example, a point moving along the "straight" line x is represented by the curve in Fig. IA. The diagram, however, *only states,* that the point was in position x_1 at time t_1 and in position x_2 at time t_2. In other words, only the *motion* of the point is represented by the diagram. The point itself *never* in fact left the x-axis along which it moves in space, *nor* the t-axis along which it moves in time! *The point is nowhere else in the "two-dimensional" field depicted by (x,t), except and permanently so, on both axes x and t simultaneously*. It is always on the physical unidimensional (spatial) line x *and at the same time* on the physical unidirectional (temporal) line t. This

* It should be realized that the notion itself of rotation has meaning *only* as long as its axis is a Euclidean straight line. Also, in endeavoring to reconstruct a Riemannian network, the notion of translation can only be easily understood if referred to an already existing Euclidean network. Otherwise, the "directions" in space of the earlier and now reconstructed Riemannian networks cannot be made identical. Thus a Riemannian network seems to need a Euclidean one for its complete specification and Kant was fully justified in claiming that the Euclidean space is given a priori.

should suffice to bring home the meaning of inhomogeneity of x and t, and the fact that the "space" ("surface") (x,t) has no physical but only mathematical significance describing in fact only the velocity of the point and *nothing* else. To illustrate further this fundamental difference, let us consider the Pythagorean theorem as applied to the two cases shown in Figs. IB and IC, where y represents length in the direction shown (thus being homogeneous to x) whereas t represents time. In the former case (Fig. IB), the *length* $\alpha\beta$ is given by $(\alpha\beta)^2 = (\Delta x)^2 +$

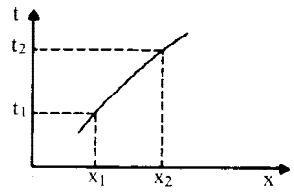

Fig. 1A

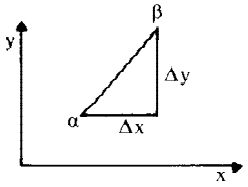

Fig. IB

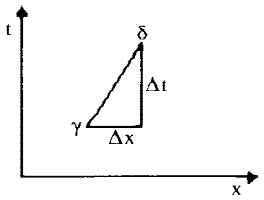

Fig. IC

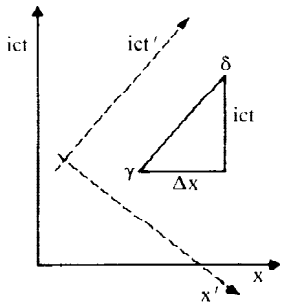

FIG. ID.

The conventional space of relativity.

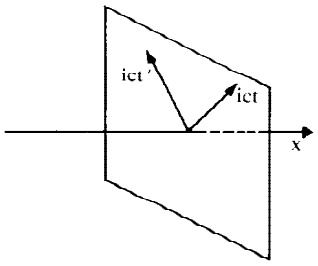

FIG.IE

The only logically permitted space of relativity

$(\Delta y)^2$. The addition indicated on the right-hand side is permitted because the quantities Δx and Δy are both of the *same nature*, and only for this reason do they result in $(\alpha\beta)$ which also partakes of the same nature as the other two. *The first lesson in addition is that only similar things can be added, and dissimilar things cannot be added by reason of their dissimilarity*. When a boy and a donkey are put together, one does not get anything more than a boy and a donkey. There is no single quantity that can be generated by the addition of the two, and

thus, the two do *not* add up. In the latter case (Fig. IC), we get $(\gamma\delta)^2 = (\Delta x)^2 + (\Delta t)^2$, which is precisely what the rules of arithmetic forbid, as explained just above. Yet, it is precisely such a pseudo-Pythagorean expression, presented in the deceptive form of complex space, where Δx is replaced by $v\Delta t$ and t by $ic\Delta t$, which there now results in $-\Delta s^2 \equiv -(\gamma\delta)^2 = v^2(\Delta t)^2 - c^2\Delta t^2$, where Δs^2 is *purported* to present the "interval" (here expressed as a length) of "spacetime". Logically, however, the situation has not changed, because the "interval" is still equivalent to a "transformed", but still *non-existent*, "boydonkey". Thus in effect, what both arithmetic and Euclidean geometry forbid, relativity accepts as physically real and invariable for all observers.

The relativistic reasoning just presented hides the following logical steps: First, the space (x,t) is converted to the space, (vt,ct) where $x = vt$. This conversion is only carried out in an attempt to comply, and force an outcome in agreement, with the basic rule of arithmetic cited above. What is being forgotten in the process of this conversion and geometrical representation of relativity is that the lengths $v\Delta t$ and $c\Delta t$ are both purely spatial quantities and therefore properly belong *only* along the x-axis of the space (x,t), where *all* lengths must be constrained given the suppression of the y- and z- dimensions of the ordinary 3-dimensional space. Thus, the conversion from the space (x,t) to the space (vt,ct) *does not* logically permit the substitution of the homogeneous element y (now defined as equal to ct) for the inhomogeneous element t. But even with this logically forbidden substitution, one only gets the Pythagorean theorem in its correct 2-dimensional, planar form and *nothing more*. *As* a result, relativity is forced to make a second conversion: It replaces space (vt,ct) with the complex space (vt,ict), but gives no logically or physically satisfactory explanation of why this replacement is proper. In fact, no explanation can be given other than the desire to obtain what relativity considers as the proper outcome, namely, the result $\Delta s^2 = c^2\Delta t^2 - v^2\Delta t^2$. Popular and semi-popular presentations of the subject do not mention this logical manipulation. Even "professional" presentations do not feel constrained to explain the physical significance of $ic\Delta t$! For there is none! It *must* be remembered here that in the Pythagorean theorem, not only the squares but also the straight quantities (that is, the lengths) make physical sense. Not so in relativity: There, only the quantity Δs^2 is claimed as the "interval", the nature of Δs is not stated.

Logically speaking, therefore, relativity is still and always confined in this purely mathematical complex space and the happenings therein. How these mathematical manipulations affect, and are demonstrated by, the physical reality out there, the theory does not attempt to explain epistemologically. In effect, it only takes advantage of mathematically corresponding physical occurrences to claim its physical proof. The *inner* connection of those phenomena to the pure mathematical content of the theory is nowhere discussed.

The relativistic expression $\epsilon = mc^2$, given the claimed masslessness of the photon, ϵ, and the ponderability (i.e., massiveness) of m, remains epistemologically unexplained. The "equivalence" of mass and energy is hidden behind the replacement of c by its, claimed as "physical", value of 1, where the fact that this

"1" is *still a* physical size retaining the dimensions of velocity and not at all a pure numeral is conveniently overlooked. (See e.g. B. Russell: *"The ABC of Relativity"*, George Allen & Unwin, 1969, p. 100, where the logically forbidden "sum" $m + mv^2/2$ is given philosophical sanction and thus purported to pass logical and scientific muster!). How these subjects can find a fully satisfying logical explanation has already been presented in the main body of this work, where the purported as solely relativistic relationship between mass and velocity has also been obtained without recourse to relativity.

Special relativity is nothing more than the Lorentz transformations that relate the *mathematical* spaces (x,t) and (x´,t´) of the *same* general plane (X,T) by

$$x' = (x - vt)(1 - v^2/c^2)^{-1/2} \qquad t' = (t - vx/c^2)(1 - v^2/c^2)^{-1/2}$$

$$x = (x' - v't')(1 - v'^2/c^2)^{-1/2} \qquad t = (t' - v'x'/c^2)(1 - v'^2/c^2)^{-1/2}$$

where $v = -v'$ (so used here only for optical symmetry) gives the common relative velocity of the two co-ordinate systems K and K´. Relativity thus accepts that these co-ordinate systems can be subjected to arbitrary translation on their common "plane", to rotation about an axis *perpendicular* (the physical dimensions of such an axis remaining totally unspecified!) to that "plane", or both, Fig. ID. That such treatment is logically and physically (though, of course, not mathematically) forbidden by the fact that in a spatially unidimensional 2-manifold *all* lengths must be constrained in the single available dimension, as has already been argued above, is being ignored. Thus at best, translation can only occur along the x-axis. If it is still maintained that times t and t´ are different, *only tilting* of the "plane" *about the common* x- (and x´-) axis, in order to generate a new "orthogonal" direction for t´ can possibly be allowed (see Fig. IE). But then, the Lorentz transformations do not survive, nor are they sufficient!

The Lorentz relationships represent in mathematical language nothing more than the invariability of the "interval", which compactly states the total equivalence of all "inertial" observers and the invariability of the velocity of light for all such observers. But consider three very busy friends always travelling "inertially" (i.e., non-acceleratingly), who decide to meet most fleetingly and, in order to commemorate the event, to flash their "global" flashlights of blue, yellow and red upon the very moment of their meeting. Relativity holds that thereafter *each* of them always remains at the center of his own advancing light front! (Fig. IF). Non-relativists in agreement with Euclid and Newton suggest that this is impossible: *The moment of emission is unique, and at that moment because the three light sources coincided in space the world only saw a white flash of light being emitted*! *There is only a singular sphere of white light that can only admit of a single point in space as its center*! *The friends may not claim that each of them carries along with him the center of that singular and already past emission of his own color of light*! That singular moment of emission has *as uniquely of that moment already* been written in the Universal chronicles as a *past event independent of their following peregrinations*! A second example: Last night, as you were returning home, you flashed the high beams of your automobile. How sen-

sible can a statement be that you are still at the center of *that* emission even now as you are sitting at the desk of your office? Even if you claim that between last night and now you travelled rectilinearly at a steady speed? The relativists can only "explain" that the phenomenon, "strange as it may seem", is nevertheless correct, given the impeccable mathematics of the Lorentz transformation and the experimental (by *totally other* means!) "proof" of the theory already "in hand"! The non-relativists remain incredulous and for good reason, since no simpler nor

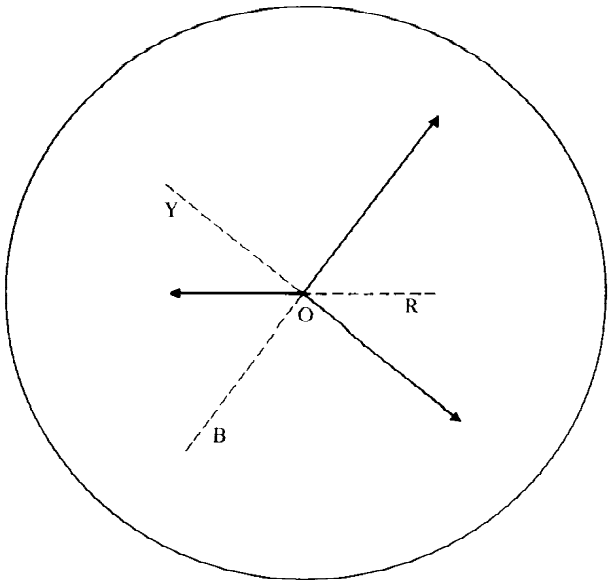

FIG. IF

Three friends emit a blue, a yellow and a red lash of light at the moment of their meeting at O. Relativity, contrary to Euclid, insists that each of them remains forever thereafter at the center of the advancing spherical front of *that singular flash* of his own light!

stronger *geometrical and physical* refutation of the theory can be found. The relativists, thereupon, engage in "proving" their own point using the Lorentz relationships, their only weapon.

The less spectacular and less straightforward but more imaginative and thus more likely to allow interminable debate related problem of the "twins" paradox has been with us since about 1920. Based on the Lorentz transformations, it is being held that a traveler travelling with nearly the speed of light travels nearly not at all in "spacetime", and thus he remains eternally ageless or almost, whereas his twin brother staying at "home" ages as normally. The travelling twin is depicted to be seeing his own brother age before his very eyes as he (the former) speeds forward but looks backwards though his rear window. No one has ever tested for himself the validity of this statement and no one ever will, given our

physical limitations, but the belief of the relativists in the validity of the statement is nonetheless absolutely steadfast given the impeccable mathematics of the Lorentz relationships, which in the final logical analysis is nothing other than the restatement in mathematical language of the *postulated proposition* that the velocity of light is constant as judged by all observers regardless of their own state of rectilinear inertial motion. When non-relativists confess incredulity, they are "explained" the relativistic "facts" in a language that is no more and no less than a phraseological restatement of the mathematics of relativity and asked to accept the "strange and surprising properties of spacetime" (a relativist's expression), to the validity of which the relativistic mathematics attest. If they still appear incredulous and continue to object, they are being called names: Consider the following: "Although the problem (the clock paradox—parenthesis added) first came into prominence around 1920 and Einstein gave a full resolution of it, even today it happens that half-learned journals publish long articles (from the pens of less than half-learned people—parenthesis in the original) which purport to show that Einstein was really a fool" (C. Lanczos: "*A. Einstein and the Cosmic Order*": Six Lectures delivered at the University of Michigan in the Spring of 1962; Interscience Publ., 1965, p.55). Now, the compliment will resolutely not be returned, but it is necessary to make the following remarks:

(a) Resolution of a dispute really means that the disputants resolve to consider a subject matter of dispute as having finally been settled: only then can it properly be called resolved. Thus, from the above excerpt itself, it is crystal clear that the matter has *not* been resolved at all, since its author still felt obliged in 1962 to use such language against the detractors. Matters on this issue *have not* advanced since 1962.

(b) Given Lanczos' own discussion of the clock paradox, which in no way can be considered as at all satisfactory, as are the pertinent discussions of the same issue by other relativists, one would expect them to reprint Einstein's own "full resolution of it", if they cannot improve upon it further. Now, neither in his "Meaning of *Relativity"* that has gone through several editions and printings, nor in his so-called "popular exposition" of *"Relativity"* has Einstein discussed, let alone resolved, the paradox, which is very curious indeed given the heat of the debate! His purported resolution of it, then, is none other than the mathematical language of relativity itself, which only states the constancy of the velocity of light for all observers irrespective of their rectilinear inertial motion. N. Calder ("*Einstein's Universe*", The Viking Press, 1979, p. 90) states that "Einstein himself remarked that it (the twin paradox—parenthesis added) could properly be understood only in General Relativity". But as W.C. Salmon ("*Space, Time and Motion*", Dickenson Publ. Co., 1975, p. 96) has remarked, "It is a general and fundamental principle of logic that contradictions in (it is more correct to say, arising from— parenthesis added) a set of premises can never be eradicated by adding new premises; the only way to get rid of a contradiction is by removing some of the premises of the original set". This statement is preceded by "while I do not deny the correctness of the general relativistic treatment of the clock paradox, I do agree... that it is somehow not completely satisfying intellectually. It is

after all, the time dilation of special relativity that is suspected of spawning an inconsistency. Contradictions are not best treated by invoking a more complex theory", and followed by "if the special theory does contain an inconsistency, we had better locate it, rather than covering it up with an augmented theory". Salmon continues to state: "of course, it may be replied that the clock paradox holds no difficulties for special relativity because it cannot even be formulated in terms to which the restricted theory is applicable, and so the question of inconsistency cannot even arise. This answer does not seem fully adequate, however, for it is possible to formulate a version of the clock paradox which does not involve any accelerations". He then proceeds to present a three-clock version "resolution" attributed to Lord Halsbury, after which (on page 98) he states: "in spite of these straightforward results, one might still harbor a suspicion that the clock paradox has not been fully resolved, for even though we are using three clocks instead of two, the *special theory of relativity says unequivocally that when clocks are in motion with respect to one another each is retarded with respect to all the others. Until we have shown that this general fact is compatible with our analysis we have not completely handled the clock paradox"* (emphasis added; emphasis on "each" in the original). In an attempt to show compatibility, Salmon then engages upon further detailed discussion of the problem, yet (on page 100) feels constrained to state: "the foregoing resolution of the clock paradox obviously depends heavily upon appeal to the relativity of simultaneity. Indeed, the concept of simultaneity constitutes the key to the entire special theory of relativity. The well-known length contraction and time dilation effects *rest directly* upon the relativity of simultaneity" (emphasis added). The problem of the paradox of the twins then *cannot properly be resolved without consideration of the logic of the premises themselves* upon which the Lorentz transformations are based. The problem of simultaneity will be discussed later in Addendum III. Here, we must only state that the above here stressed quotation from Salmon's p. 98 suffices already: For if *each* clock is retarded with respect to all others, given only two clocks, each must be retarded with respect to the other, which is precisely the point of the paradox!!! Since Salmon, a relativist, admits freely to the fact that "the special theory… says unequivocally…", which he never attempts to deny, and since he has already (on page 95) stated that "… but it is blatantly inconsistent to say that each is younger than the other…" (the clock paradox itself), it *must* be held that, despite his attempt to resolve the paradox he has not at all succeeded. No one else has done better. The clue of the failure lies in Salmon's own stressed "each", which, in the case of only two clocks, permits the observations to be characterized as "mutual"! This mutuality in the case of the twins thus is an integral part of special relativity that can never be "explained" away on the basis of the Lorentz transformations, and that is rooted in the very premises of the theory and thus *cannot* be eradicated without alteration of those premises.

(c) To recapitulate then, given Einstein's own insistence on the reciprocity of relativity as judged by two observers in relative rectilinear inertial motion, and given the need that the theory should take care of itself (its own theoretical notions, postulates, theorems or conclusions), it should appear that it is logically

necessary that the theory itself should provide, if truly correct, the resolution of this paradox, without recourse to any outside (namely, extra-theoretical) devices. In this light then, what one of the twins sees in his brother's face, the other sees also! It should not at all matter if one of the twins stays on Earth and the other goes to the stars. Earth and stars *are* extra-theoretical devices. As regards special relativity, only their own relative rectilinear non-accelerated motion and *its* effects need be considered. As has already been stated earlier in this work, there is *nothing* in the theory that prevents its application to a universe consisting *only* of the twins and their flashlights. In that case, even their accelerations will be identical (except for their signs) and the paradox carries over *with full force* into the area of general relativity, *without resolution*! Thus relativity is indeed faulted because it *cannot* on its own discriminate between two theoretically equivalent and equally valid options, that the theory itself spawns, only one of which however can at best logically be admitted as possible. The logical irresolution of the paradox lies at the roots of the theory, at the very principle of the constancy of the velocity of light as posited by the theory. It is this principle that must be rejected if the paradox is to be resolved. The Newtonian expanding Universe presented in this work shows the falsehood of the contention that there is not in Nature absolute motion, the falsehood of the belief in the constancy of the velocity of light as formulated in relativity theory, and the falsehood of the belief in the absence of absolute time: The age of the Universe T is identical for all observers and the interval $T_2 - T_1$ common for all. We all age identically. Since the Lorentz transformations were devised to explain the null result of the Michelson-Morley experiment, now that the conventionally accepted as correct analysis of that experiment has been shown in this work to be basically faulty, one can *no longer* hold to the view that the Lorentz transformations are physically justified, *nor* indeed any theory built upon them. The contraction of lengths is very much physical in its very nature, in the way Fitzgerald proposed and independent of all relativity.

The prolongation of the lifetime of the muon and variations in the behavior of atomic clocks during high-velocity flights have been accepted as showing the time dilation predicted by relativity. At best, this is premature. Because *hidden* in this conclusion is the assumption that neither the muon nor the atomic clocks suffer any constitutional (internal, physical) changes with a change in their state of motion. The constancy of universal mass, the logical necessity to have mass, real and concrete as any other ponderable mass, where energy is, the logical necessity to have a corresponding mass $(\delta m) = (\delta\epsilon)c^2$ added to a body when its total energy is increased by $\delta\epsilon$, all suggest that real constitutional changes do *occur* in all bodies with changes in their state of motion. It is then incomprehensible that the behavior of bodies, muons or atomic clocks or whatever, can possibly be independent of their constitution. In the face of the absence of any epistemological connection between the mathematical structure of the theory of relativity and the real world inside the moving bodies which world the theory deliberately yet naïvely ignores, the theory cannot possibly be held as having been proved by observations of this nature, observations that ignore the essence of things and are only concerned with their appearances.

ADDENDUM II

ON POSITION EXPANSION AND CONTAINMENT

This work has presented a notion of universal expansion totally different from that currently accepted. Some additional material must thus be added.

Relativity theory is basic to all current notions about the Universe. The relativistic concept of spacetime and our present understanding of the Universe have been integrated into a single whole that can hardly distinguish between the two. In 1922, Friedman found a solution of the equations of general relativity that permits a finite, rather than zero, density for all observed matter to be observed from a point at rest relative to immediately surrounding matter, under the following conditions: (a), The spacetime curvature is positive, which was taken to mean that the Universe was finite, "closed" and thus "boundless". (b), The "metric" is time-dependent and therefore so also is the observed density of globally distributed matter. (c), Matter is isotropically as seen by all observers everywhere, and therefore on the whole also homogeneously distributed over the whole of the three-dimensional space. This solution "found a surprising confirmation" in Hubble's discovery of the redshift of spectral lines in proportion to the distance of the light source. This discovery was interpreted as a Doppler effect due to the increasing source-observer distance, on the assumption that the processes generating the spectral lines are independent of the universal age. The Universe was thus "understood" to expand, yet remain "closed". Thus, light emitted in the past always remains inside the "closed" Universe. In the 1940-s and '50-s, Gamow proposed a theory of nucleosynthesis that included an early "opaque" radiation-dominated phase that ended when matter and radiation "decoupled" and the Universe became "transparent" at a temperature of about three to four thousand °K. Due to expansion, Gamow understood the Universe to be cooling down and estimated the present temperature to be about 25 to 30°K. In 1965, Penzias and Wilson discovered the 3°K very nearly isotropic background radiation. This was taken to be the light of the age of decoupling, that has been coming towards us at the center of our Hubble sphere for nearly as long as the Universe has been and being, in the process, Doppler-redshifted by about one-thousandfold, and thus to confirm the Gamow theory and all earlier associated theories and assumptions. In light of the expansion that has nowhere really to go since spacetime and the Universe are seen as one, in light of the notion that light has taken roughly ten billion years to reach us at the center of our Hubble sphere having started from some-

where in a much denser sphere of thus necessarily correspondingly smaller size, and in light of the additional assumption that galaxies and smaller organizations of matter are gravitationally bound and therefore of fixed size, there remained, it appeared, no other option but to conclude that galaxies do not really move in space, but rather that space itself, between the galaxies, expands. The 3°K light has been coming to us at the center of our own Hubble sphere travelling through space expanding in the opposite direction. The same, we believe, must be concluded by all observers, everywhere.

According to current notions, space resembles a rubber sheet uniformly stretching in every direction. Galaxies are considered to be spread confetti-like over this rubber sheet, in such a way that their centers of gravity are fixed on the points of the rubber sheet directly beneath them. The sheet is taken to be stretching without being affected by the galaxies it carries. The latter are merely carried along but do not themselves participate in the expansion of the sheet beneath them, and their individual volumes are in effect separated from the "underlying" space that contains them. It is only thus that galaxies can continue to be regarded as of fixed size and space to expand in all directions according to the Hubble Law. It is obvious that this picture is at variance with the ordinary and age-old understanding of the relation between volume of a body and space within which the former is being contained. The traditional view has been that volume partakes fully of the qualities of space, but, by being one of the properties of the body, it is carried around in space as the body moves around and only thus is it not permanently in the same place in space at all times, unless it is at rest, in which case, volume and the particular space it occupies become totally fused and indistinguishable in all respects. In the latter case, whatever happens to that particular segment of space occupied by the body, also happens to the volume of the body, and vice-versa. If this were, however, the current understanding, either the bodies too would have to expand with space (the rubber sheet beneath them), or they would have to be presented as *metallic coins embedded* in the rubber sheet. In the latter case, the sheet would expand *around* the coins but its expansion would no longer be uniform as required by the Hubble Law. Even if the coins were on aggregate uniformly distributed (additional assumption of global homogeneity in the large or very large scale), it is to be considered as certain that there would be some directions in which the coins would by chance happen to be more plentiful than in other directions over substantial, yet on the global scale still fairly local distances. The breakdown of the Hubble Law due to the embedment of non-expanding material systems in (the) space (of the Universe), (and there can be no doubt that this embedment is indeed the case of things as they are if space is an inextricable part of the Universe, of which all bodies are also its parts inextricably embedded in it), is totally separate of course from the peculiar motions of material systems. Since the latter motions are at any rate unavoidable, as our own solar system and indeed all scientific experience here on Earth suggest, one is forced to accept two totally separate kinds of motion: local relative to space, and the global motion of space itself. In the case of embedment, the motions of material systems can no longer be considered exclusively to belong to the one or the

other kind, as they obviously partake of both kinds, as they stretch or compress the rubber sheet during their motions. The limit set by the velocity of light is currently believed to apply to the "local" kind of motion only and not to the global stretching of space itself. Embedment of "coins" totally confuses the issue as to where the velocity limit applies. It is obvious that even without the notion of embedment, current theory suggests that the Universe is a great deal more complicated than could have been in the simplest case. In light specifically of the first quotation to follow, are we justified in charging the Universe with this added complexity? The only reason for which we have adopted the current notion of space expansion is that we find it incomprehensible that our cherished "standard" rods are themselves expanding and are thus not at all standard! We seem inclined to protect our current "physics" even at the cost of adding complexity to the entire Universe!

Consider the following quotations from E. Harrison's *"Masks of the* Universe" (Macmillan Publ. Co., 1985): "We still lack precise knowledge of how fast the universe expands. Also, we are not sure how expansion changes with time. Cosmologists feel confident that the expansion is slowing down, yet the figures quoted for the observed deceleration remain very uncertain and must be taken with a grain of salt" (p. 181). "Light travels at constant speed measured locally in the space through which it travels. Nothing in nature has an ordinary speed exceeding the speed limit of light. All ordinary or peculiar velocities are subject to this limit, but recession velocities are without limit" (p. 183). "Consider a galaxy outside our Hubble sphere. Light rays from the galaxy, emitted in our direction, hurry towards us and travel through space that recedes faster than the speed of light. Thus even the light emitted by the galaxy recedes from us" (p. 184). "A galaxy at the edge of the Hubble sphere recedes at the speed of light. Its rays emitted in our direction stand still relative to us" (p. 184)."Outside the Hubble sphere even light is receding. It would be a mistake, however, to suppose that our galaxy will never receive this light. The Hubble sphere itself expands, generally faster than the universe... A galaxy outside the Hubble sphere may one day be overtaken; it will then lie inside, and its emitted light rays at last will be able to approach our galaxy and be received" (p. 184).

Statements as those just quoted are fairly typical and characterize our present misty and confused "understanding" and they must be seen in the light of the first quotation. But even beyond that light, through the seemingly deliberate choice of the totally unqualified verb structure used, such statements succeed in blending together hard facts, hard-fact-based theory, mere scientific speculation *and* pure, pseudoscientific fantasy. The uninitiated reader is totally unable to tell these apart. Scientists and specialists, even when writing for the general reader have an obligation to the strictest accuracy language permits and to adherence to *hard* facts. They may, if they so desire, engage in speculation, or even fantasy, but they should always be circumspect and set at least the hard parts separate from the fantastical, and not present them in a way that is bound to confuse not only the general reader but also themselves as these quotations so clearly suggest: Not only do the above and similar statements touch upon the all-important issue

of simultaneity (discussed in Addendum III), but they also raise questions as to the relationship between the local and global kinds of motion: Moving as we do with the local velocity, which may, according to current theory be almost as high as the velocity of light, do we or do we not carry "our" Hubble sphere along? How is either to be proven or disproven? Is "our" Hubble sphere distorted because of our local velocity or not? How is either proven or disproven on a hard-fact basis? Science implies at least the *potential* resolvability of the issues it dares discuss (or else, it ought to close shop!), but these questions do not appear to be resolvable on the basis of current understanding, except through recourse to principles which in turn and by their very nature are always beyond our ability even to consider in the context of science. It is *not* science to take advantage of poetic license but still speak "with the voice of science" about things that are *now and forever* beyond our Hubble sphere and their light, as Harrison states, *recedes from us even as it comes towards us*! According to Einstein and still current relativity theory, even gravitation cannot act faster than light: It follows that what lies beyond the Hubble sphere cannot be considered as gravitationally bound to us at its center, and the same must be held as true for *all* Hubble spheres, so that the Universe as a whole, according to current theory, cannot be gravitationally interacting. Not only do we not know the cause of the expansion of space, we do not even know of a force that can cause the expansion to decelerate, and yet we feel confident that the expansion decelerates!!! (Now lately, we hear that the expansion of the Universe accelerates, but are *not* given a persuasive cause based on *some* theory, let alone in Nature herself out there!) And what causes our Hubble sphere to expand even "generally faster than the universe"? Does the expansion of the Hubble sphere accelerate or decelerate and what causes it to do so? Still, we feel confident!!! At least enough to speak with professorial authority about two different kinds of universal motion, when it appears that we have not yet mastered the details of even one!!!*

How truly confused is our present understanding can be judged directly from the inconsistency of the above quotations: For at the same time, we are being told that "a galaxy at the edge of the Hubble sphere recedes with the speed of light",

* In fairness, Harrison distinguishes between the Objective Reality that we all call the "physical Universe" (in the Greek sense of physical, meaning, Natural, not in the contrived sense of what pertains to the transient understanding that we call "physics"), which is a term that he himself has not employed in his book, and the "physical universe", which is his shorthand for our conception of what *we think* we are talking about in science and physical theory! But the general reader reads such books because he wants to know about the *solid Reality* we all agree *is* out there, *not* for reasons of mere curiosity, but in order to satisfy his perhaps subconscious yet overwhelming *need to become* philosophical and truly wise. Instead, he is only given opinion about what looks rather like a house of cards, which we call "current understanding" and have built and continue to be building on the quicksand of mostly arbitrary hypotheses of logically untested internal consistency. It is unfair to the reader, in reality aspiring to wisdom, to be told that he has to accept a priori, as intrinsic to its very nature, the incomprehensibility of Objective Reality. Rather, it would be wiser by far, when servants of science, speaking with its authority, stood/stand up to make such public pronouncements, to give us their *scientifically objective* assessment, or at least their educated estimate, of whether this supposed incomprehensibility is truly in the Nature of Things, or whether it is in fact more likely due to our own fragmented, haphazard, unwholesome reasoning, due, that is, to our undeservedly celebrated "knowledge" of our "universe" in Harrison's meaning of these terms.

while "the Hubble sphere itself expands faster than the universe", which is a contradiction in terms, because a Hubble sphere is *only* defined through the matter present in it up to its limit! Besides, if "there are as many Hubble spheres as there

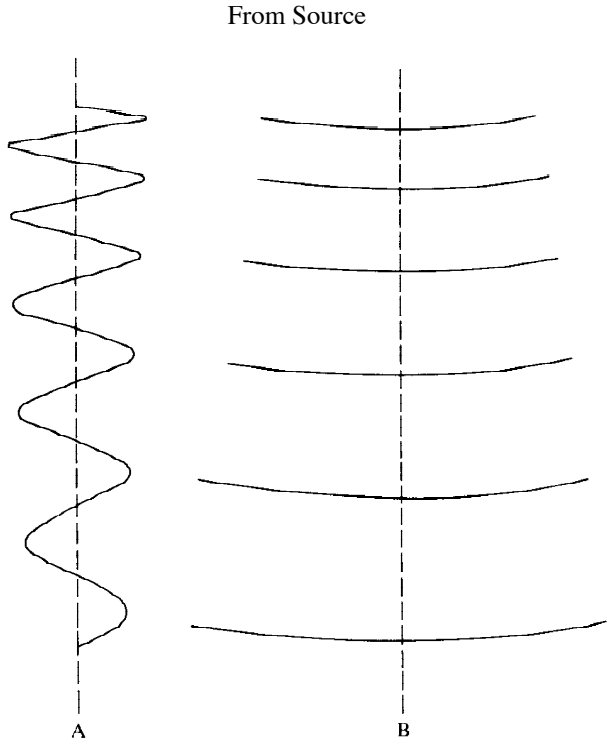

FIG. II

The Doppler Effect. Redshift due to relative recessive motion of Source-Observer.
The wavelength is taken to elongate nearer the Observer.
The Hubble Law demands that the more distant objects move faster
and thus that the expansion appear more pronounced nearer the Source.

are galaxies", and if "each galaxy has its own Hubble sphere" (p. 183), the Universe as a whole expands much faster by far than any one Hubble sphere by virtue of the expansion of space between galaxies, which goes on "without speed limit", so that it is logically inconsistent to hold that one, "*the* Hubble sphere itself expands, generally faster than the universe" of which it is but a very small part!

The same author explains how "a wave of radiation stretches as it travels rough space" (p. 185) by means of the picture in Fig. IIA. This in itself is a most remarkable statement, for it can only be true if the radiation left a mark of sorts, that we have been able to catch, on the space through which it has already travelled. In that case, the mark itself, but *not* the radiation that left that mark, should

be said that it expands, but the dilatation of the "waveform" should be upstream (farther away from the observer assumed to be looking at the oncoming radiation from the bottom of the page). The notion of space expansion in conformance to the Hubble Law requires that space appear to expand more at greater distances. Accordingly, the "mark" of radiation should appear elongated upstream, namely, in the remote past and the far off distance, and *not* as drawn. As drawn, the picture only reflects, in simple form, the Doppler effect, which refers to the relative motions of source, observer and transmission medium. The relative velocity dr/dt between two objects at distance r includes *all* contributions affecting velocity, regardless of their source. In other words, the Doppler effect will be identical whether the two objects move relative to each other in "stationary" space (the common relative motion), or whether they are *fixed* on their local spatial co-ordinates while space expands *between* these co-ordinates, as long as the two velocities are identical. The Doppler effect, thus being cause-blind, cannot be used as an explanation of *space* expansion, as it is now attempted.

Consider also the following quotations: "You must take my word that all forms of energy have mass... You must also take my word that spacetime curvature is, in effect, yet another form of energy. This curved spacetime around a star has distributed energy and therefore manifests its own effective mass" (p. 165). "A (real) galaxy, held together by its own gravity, is not free to expand with the universe" (p. 179). What is remarkable here is that spacetime, despite the "fact" that its curvature "is" energy and therefore also mass, is allowed in our theories to expand, but a galaxy is not! It may fairly be asked: How is it *proven* that a galaxy is gravitationally bound, but a photon (the basic form of energy, when as per the first quotation in this paragraph, not according to the findings of the present work, also has mass) is not? It is much harder by far to be proven as true that spacetime behaves differently from galaxies, when the photon is conceived as a particle of a definite amount of mass: If all forms of mass behave more or less similarly, then either photons (or "curved spacetime") as well as galaxies both expand, or both do not expand. What *hard evidence* do we have that masses do not behave identically, or at least similarly? The current understanding of expansion is *not* satisfactory.

The above analysis shows the *shaky* logical foundation of the current picture of expansion. The desire to avoid the anthropocentricism of the pre-Copernican conception; the desire to preserve our "laws of physics", ignoring that they indeed, but now in disguise, reintroduce the very anthropocentricism that some centuries ago we tried to avoid, since we now generalize to the whole Cosmos *our assumptions and our "laws"* of physics without *any* logical or observational basis for so doing; the desire to avoid the three thousand-year-old quandary of containment, which is more evident when we accept the notion of galactic recession as an ordinary motion through space, for it immediately separates the Universe from the space into which it expands, but which is conveniently confused and hidden from view when it is claimed that space itself expands in an extraordinary manner; all these desires have indeed conspired to bring about the present "understanding". Let us examine these problems more closely:

The pre-Copernican anthropocentricism was of a purely geometrical nature. Understanding of the underlying physics was then far into the future and on the basis of the then available "evidence" the claim that the World revolves around the Earth was the simplest logical explanation. The post-Copernican, or current, anthropocentricism holds that our position is not geometrically favored but our current understanding of the laws of physics is essentially complete and our assumptions correct: Thus regardless of where we may find ourselves, the (our) laws of physics hold true! And our picture of the World from this particular vantage point is independent of position! The Universe, accordingly, has an infinite number of centers, which is equivalent to no center at all! Still, the night sky presents an insurmountable problem: It is mostly black, which is contrary to the view that the Universe is of infinite extent and past, for then, light should be coming in from every direction of sight! With this double infinity excluded, it is "natural" to seek out a *peculiar* limitedness, finiteness of extent that excludes all boundaries. The analogue of the surface of the sphere is too close to mind to be ignored and, naturally, it has stuck! Einstein's original attempt to explain the World on the basis of general relativity *had to* include the cosmological constant. It was the "only" way out: The Universe was finite yet boundless and forever the same: static and ageless, and "spacetime" was the "surface" of a "hypersphere"! Please, do *not* ask any questions as to the *physical* nature of the latter! You do *not* want to embarrass the professor if you want to get your degree! Thus, it was thought, all paradoxes were being resolved, and all are "satisfied"! What was not realized was that the most glaring paradox of all, the darkness of the night sky was becoming even starker! Because, if, as general relativity holds, light in such a finite, boundless, ageless, static universe travels in great geodetic circles, *it is logically necessary that one see one's own image, regardless of direction of sight*!!! In other words, we should be intercepting the light of our own galaxy as it travels in all directions. *We should also be intercepting the light of every other galaxy in the direction exactly opposite to that of direct sight,* because any two points, the emitting galaxy and ours, suffice to define a particular great circle! Thus, the night sky of an Einstein universe should also be ablaze in blinding light in all directions! So, Einstein's own "solution" was at stark loggerheads against the *absent* most glaring evidence, the totally black backdrop! This was not realized. The discovery of redshift, interpreted on the basis of the Doppler effect, and the special dispensation given to space to expand, was thought to resolve the problem of the night sky. Well, it looks as though it does not: For if the expansion of the Universe is taking place with a velocity less than the velocity of light, the moment an observer begins to see his own image in all directions is only a matter of time. It is then hard to see why this has not already happened in a boundless, though no longer static Universe of *supposedly* infinite past! At any rate, this observation of ourselves should be the *most delayed* one possible, since our own light has to complete a whole great circle before it returns to us. This is not the case, obviously, with the light of other galaxies, which does not have to complete a whole circle before it reaches us directly or from the opposite direction. Even if it should be argued that the age of the Universe is not sufficient for this to have

happened for *all* galaxies, if the current cosmologists' view that the expansion decelerates were correct, there should already have been *some* cases of galaxies the light of which has already reached us *also* from the direction opposite to that of direct sight, especially when, one is tempted to say, the former route is shorter than the latter! Obviously, the shorter route will always be regarded as the direct sight route; but otherwise there is nothing to distinguish the two opposite directions, except the redshift of light received*. So, at a minimum, we should be seeing more light continually arriving from all directions, in other words, we should be discovering more and more "galaxies" out there, as the Universe ages! Not just only previously wholly unseen galaxies that only a moment ago were just beyond our Hubble sphere, but *also* the images of previously already known galaxies in directions opposite to those already known a moment ago. This is not what is being observed. Not one galaxy has been held to be its own image coming in from the opposite direction. On the contrary, current opinion holds that, with expansion, each galaxy will end up being ever lonelier than before in an ever darker, not ever brighter night sky being illuminated by ever more distant galaxies. This expectation of ever darker skies can only come to pass if space keeps on expanding with velocity always higher than that of light. The current view that the expansion decelerates, even if true, will thus never be verified and cannot possibly be reconciled with the absence of ever more light from the night sky.

Could it be held that the isotropic background radiation truly resolves the problem of the absent infinite images, or that it itself is precisely that infinity of images? Certainly, isotropy would be central to a picture of infinite images. What the isotropic background *does not* explain is the equality of intensity (hotness) under energy conservation: It matters not that the spectrum redshifts. Under energy conservation, the *same* total energy must be arriving per unit of time that was sent out, so that the temperature observed in all directions (and due to the energy flux of all wavelengths) should be equal to that at the source. This is not observed. Besides, we, at the perceived "center" of the background radiation and receiving the energy of the fireball all around us, should be acting as the focus of all the inward-pouring energy flux. How hot should we feel? Certainly, not less hot than the original fireball! Again, this is *not* observed. The background radiation is held to be coming to us *only* by the direct route, not by all (infinite in their totality) routes available to it in a closed, finite universe of great circles. But even the direct route light should have made us feel as hot as the original fireball. Current theory holds that the temperature drops with expansion. But this is the picture of expansion of ordinary gases adiabatically expanding through non expanding space, not the picture of space that "expands" yet in reality remains forever trapped in itself! If light in spacetime travels not at all ($ds^2 = 0$, remember), all light that "went out" must *with the same energy content* "come back in". If it should be held that all energy "is still going out", current theory would in effect be denied its sole means of verification on the global scale. According to current theory, to the "epoch of decoupling", observed in the 3°K background light, is be-

* Interestingly, if a galaxy by the direct route recedes, is it coming towards us by the *indirect* route? The theory is not clear! Yet, if light circumnavigates, so must galaxies, mustn't they?!

lieved to correspond a red shift of about one thousand. On the other hand, "the Hubble time is a measure of the expansion time of the universe, the time for the universe to double its size expanding at the present rate" (M. Rowan-Robinson: *"Cosmology";* Oxford Univ. Press, 1977, p. 52-53), to which there corresponds a velocity equal to that of light (always constant by current theory) and a redshift of value two. The "fireball stage" thus is much more ancient than the Hubble time, and the most ancient time that we can ever hope to see. All Hubble spheres must thus lie within this more ancient sphere, the light of which (the 3°K light) is *already* coming in from it (always according to theory!). So, one expects to have already seen the light from all objects lying at a lesser distance, yet beyond our Hubble sphere. If light can circumnavigate the world along a great circle as Einstein believed on the basis of relativity, it must already have done so. If more time is allowed, the more the great circles will "grow bigger"; but nothing in reality will be gained by waiting, since the entire Universe back to the age, the most ancient age observable, of the fireball is already in full view (since we "see" the 3°K light). Is it? Why then is the night sky mostly dark? And why do we *not* feel being so cold? The presence of the Sun is *no* good excuse: It *is* an anomaly!

An effort was made in the last two, deliberately long, paragraphs to bring together *all* current notions about closedness of spacetime, expansion, universal age, background radiation etc. A resolution, logically satisfying in all respects, as regards the internal consistency of the current views and their observational verification, or absence thereof, was impossible to reach. Does irresolution reflect merely failure on this author's part, or is it perhaps the inevitable consequence of the internal inconsistency of the notions making up our current understanding? The earlier quotations and their own lack of logical strictness suggest that irresolution does not lie with the authors but with the *false* current "understanding".

Before we leave off, we should examine the problem of containment. The notion of expansion as currently understood cannot logically be held to have adequately addressed this problem. Expansion logically implies the *ability* to expand, which physically requires that there be a continuum within which that ability, initially potential, may come to pass and thus be realized. Thus even if it should be claimed that space expands, its own expansion requires that it itself be contained within something bigger still. If spacetime, or only space, expands as the surface of a rubber balloon, as it is always likened to by the relativists, within *what* continuum is that "balloon" expanding? If spacetime, or only space, is the "surface" of a "hypersphere", what is this hypersphere made up of? We can hardly visualize (i.e., *think) of* the surface of a sphere without the notion of something *inside and something outside* that sphere. Even an empty sphere, a common understanding, is only empty of matter. It is not empty of space! If nothing beyond relativistic spacetime exists, and the latter is a "spherical surface", *it is necessary that neither on the inside nor on the outside of that hypersphere be anything at all, not even hyperspace*. Thus, spacetime must be a closed boundary surface "in" nothing at all, where this "in" loses all significance, yet this infinitely thin surface "within" this nothing must be held to comprise all objective reality! (Always according to the relativists—who have yet to think through *all* consequences of their theory, as it is here attempted!) But this supposedly "logical"

construction of words in support of relativity theory, to the extent that it can still be held as *logical*, leaves far behind the Physics, i.e., the Nature of the objective Universe out there, that it started out to elucidate! We cannot claim to be doing science if we ultimately aim at relegating this reality we all touch with our senses and our science to a mental construction that even linguistically can with extreme difficulty be comprehended—*if* at all! The problem of containment, in current theory, remains at least as unresolved as ever, if it is not in fact grown worse.

In juxtaposition to the above picture currently in our minds, the Universe understood in the *simple* terms of the present work permits a unique logical resolution: In the first place, the Universe, through the Law of Gravitation permits us *only* to examine *its own volume,* not space. The notion of density entering the relationships $G = (6\pi D_{ave}T^2)^{-1}$ and $D = M/V$ is entirely unambiguous in this respect. If space is, as indeed it is, the logical and physical requirement for expansion, and if the latter is unending, as is the case under constant G and M, then it is logically necessary that space, namely, the substratum upon which expansion can at all be conceived, be infinite. (If it is not, we are back into the problem of containment we discussed in the previous paragraph). Thus if V in the above expressions represented infinite space, D would be zero and G would be infinite and not finite as observed. Thus V is only the volume of the Universe. The latter is, in this regard, *not different* from any other, lesser body. Logically, it is far preferable to put all physical bodies on the same footing: If, according to common belief, an atom has its volume which is smaller than the volume of the molecule within which the atom is contained, if the molecule has its volume that is smaller than that of the pen that writes these words, if the pen has a volume that is smaller than the volume of my study and so on, we are finally inducted to consider the volume of the physical entity that we call the physical Universe, without any break anywhere in this chain of logical induction. Nowhere along the chain are we forced to introduce the notion of space. In a similar way, it may be argued that even motion within the "boundaries" of the physical Universe, referred as it is to *positions* of bodies within the Universe, does not require introduction of the notion of Space. Thus, the introduction of Space may be delayed until we consider the entire Universe as a whole. In light of these arguments based on the Law of Gravitation, Space, then, is logically necessary to introduce as the medium within which the Universe is allowed to expand. Our physics, our Universe (comprised of G, M and T) and our Logic thus remain intact *for as far as we can see*. There is nothing illogical in the notion of "an island Universe floating in Space", that this extension of Logic, based on the Law of Gravitation, permits. Our distaste, so far, of an "island Universe" is indeed an acquired taste, acquired at best prematurely, in light of what we still have to understand as regards the Universe (of G, M and T) before we venture logically or philosophically beyond its physical bounds.

The Universe of constant G and M and variable T is seen to expand, monotonically, away from its center that is also the center of expansion. Gravitation delays the initially infinite velocity of expansion. The Universe unrestrained by

anything outside itself remains *balanced* on that center: the instantaneous conservation of momentum is referred to *that* center. Light is part of the Universe. Its velocity is retarded. Light comprises all there is in the advancing universal front. The Hubble sphere comprises the entire Universe. We can do science only within these two, which are in effect one and the same thing. To do science we need rods and clocks and these are perforce material objects that can only exist within the Universe, *not* outside it. The three-thousand-year-old problem of containment that came down to us as the "spear of Archytas" finds a unique resolution in light of this work: "Archytas", namely a ponderable body, cannot get to the edge of the Universe to throw to the outside another ponderable body, his "spear" . Only the First Light is at the edge of the Universe and can only throw off itself, as it were. *Light cannot throw off lesser light*! To do so requires, under momentary conservation of momentum, that it recoil, in order to balance out the momentum of the "spear" thrown. For light this is not possible. It is for this reason that we can never see the advancing front of the Universe; we cannot see the "back" of a photon! In this sense, even at night we *only* see light, of which the course we intercept. Strictly speaking, we do *not* see darkness, for darkness has nothing to send back to us, and our optical instruments, including preeminently the human eye, only respond to photons. The resolution of the night sky (Olber's) paradox lies not in the expansion of space as current theory understands that expansion but in the fact that there needs be a ponderable body to emit light and that the time taken for the body to reach the position of emission and the time taken for light from there to reach an observer of necessity must sum up to the age of the Universe. This understanding of the night sky has yet to sink in! As also that, beyond the expanding universal front there is absolutely nothing tangible!

In ancient times, it was believed that the physical Universe was made up of four elements: Earth, Water, Air and Fire*. In more recent pre-relativistic times it was held to be made up of mass, length, time and space. In relativistic thinking the Universe is made up of spacetime. This is rather confusing though, because it is still being measured in terms of balances, rods and clocks, namely, instruments that partake of mass, length and time. To say that all these are manifestations of spacetime is equivalent to saying that spacetime in effect measures itself. As humans we may indeed hold that "Man is the measure of everything", but this can hardly be elevated to a physical principle: Man *cannot* measure himself by himself without any other tools, nor can he to any degree of accuracy so measure the rest of the World around him. Similarly, to the extent that relativity holds to the need of standard rods and clocks, it perforce holds to the need of a "standard spacetime" or "interval", by means of which spacetime attempts to measure itself. That after at least seventy years of relativity (more than one hundred years as of this revision), we still have not succeeded in converting any one of our ordinary scientific units and tools to suitable corresponding spacetime quantities shows how fugitive, or at best only mentally-constructual rather than realistic

* The correspondence to current terms is obvious: Earth was mass, as well as length; Water, the ceaseless motion of the sea, represented time; Air stood for space and Fire for energy.

"out there", the entire notion of relativity really is. To this day, and despite relativity, the Universe is still thought to be made up of mass, length, time and space. The present work shows that despite all our current notions, *our* Universe of constant G and M consists only of these two and T, yet requires Space as its extra-universal containant. Just as the ancients could not delve into the study of the nature of their four elements, so we too cannot delve into the study of ours. The study of the intrinsic nature of the four basic constituents must remain in principle outside the possibilities of science. What is remarkable is not so much the names we have given to the four constituents of the physical world as is their number: Four! In light of the underlying logic, it does not appear possible that this number be reduced, Einstein's gallant effort notwithstanding. The anthropocentricism of the pre-Copernican conception is gone, but so is the modern anthropocentricism entering in the guise of the immutability of *our* laws of physics. The Universe obeys other laws, *not* ours, and those laws make it impossible for life as we know it to be at the center or at the edge of the Universe. The local conditions, including the expansional velocity that fundamentally affects the geometry and structure of all ponderable bodies, reduce drastically the availability of suitable habitats for living biological organisms. By the mind in us, by our desire to transcend our local, physical and biological predicament, by our ability to grasp the entire gross picture of the World if not its ultimate detail, we cannot be said to be located here or there. This demonstrates yet once more, if an additional demonstration were needed, the difference, separability and distinction of our Spirit from our chain-bound bodies. Woe to those who have willingly chained, or have left to be chained even their Spirit!

ADDENDUM III

ON SIMULTANEITY

In "The Meaning of Relativity" (Fifth Ed., p. 28), Einstein has given the following definition of clock synchronization:

$$t_n = t_m + r_{mn}/c$$

where t_m is the time noted by a clock at point m when a light ray is emitted, which after travelling a distance r_{mn} arrives at point n at which time another clock there *is then set* to indicate time t_n as given above. In this definition the following assumptions are involved:

(a) Points m and n are at *rest* relative to each other *and their distance known in advance*. Einstein established this by fixing the two points on an "inertial system K" (loc. cit., p. 25). How a system K, namely, *the principal reference system in relativity* can be regarded as inertial, that is, either motionless or in uniform rectilinear motion *without* reference to any other system (for if that were possible, system K would no longer be the *principal* system), *has never been explained*. It is obvious that only a *second* reference system can be called inertial relative to a principal system, but there is *nothing* that can be said about the principal system itself!

(b) The speed of light is absolutely constant. This is a fundamental principle in relativity, which, in Einstein's opinion (loc. cit., p. 28), "states that the adjustment of clocks will not lead to contradictions".

Implicit in the above definition of simultaneity, and not stated by Einstein, are the following additional and not at all less significant assumptions:

(c) The ability to know the time t_m at the locality n *as soon as* the ray from m reaches n. Without this information *necessarily reaching, by the latest*, simultaneously with the ray (and *the theory is mute on the possibility of transmission of information with the speed of light and the possible effect of such transmission on the contents of such information*!), one clock or both must be transferred through space and this requires *additional* assumptions relating to the effects of motion upon the behavior of clocks. Such additional assumptions are not yet, *nor can they possibly be,* on the table upon which relativity theory is formulated; for if they were, the theory would have to recognize them, discuss them, and include them explicitly. The instantaneous broadcast-reception of information is forbidden by the theory on account of the limiting character of the velocity of light, while the unknown finite duration of message transmission by any slower than light velocity would make the aforementioned clock synchronization impossible.

IX

THE RELATIVITY OF SIMULTANEITY

UP to now our considerations have been referred to a particular body of reference, which we have styled a "railway embankment." We suppose a very long train travelling along the rails with the constant velocity v and in the direction indicated in Fig. 1. People travelling in this train will with advantage use the train as a rigid reference-body (co-ordinate system); they regard all events in

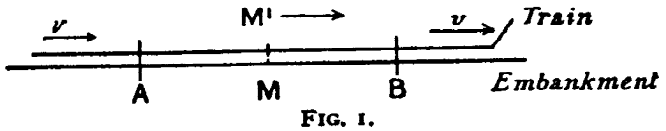

FIG. 1.

reference to the train. Then every event which takes place along the line also takes place at a particular point of the train. Also the definition of simultaneity can be given relative to the train in exactly the same way as with respect to the embankment. As a natural consequence, however, the following question arises:

Are two events (*e.g.* the two strokes of lightning A and B) which are simultaneous ***with reference to the railway embankment*** also simultaneous ***relatively to the train***? We shall show directly that the answer must be in the negative.

When we say that the lightning strokes A and B are

FIG. IIIA

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simultaneous with respect to the embankment, we mean: the rays of light emitted at the places A and B, where the lightning occurs, meet each other at the mid-point M of the length $A \longrightarrow B$ of the embankment. But the events A and B also correspond to positions A and B on the train. Let M' be the mid-point of the distance $A \longrightarrow B$ on the travelling train. Just when the flashes [1] of lightning occur, this point M' naturally coincides with the point M, but it moves towards the right in the diagram with the velocity v of the train. If an observer sitting in the position M' in the train did not possess this velocity, then he would remain permanently at M, and the light rays emitted by the flashes of lightning A and B would reach him simultaneously, *i.e.* they would meet just where he is situated. Now in reality (considered with reference to the railway embankment) he is hastening towards the beam of light coming from B, whilst he is riding on ahead of the beam of light coming from A. Hence the observer will see the beam of light emitted from B earlier than he will see that emitted from A. Observers who take the railway train as their reference-body must therefore come to the conclusion that the lightning flash B took place earlier than the lightning flash A. We thus arrive at the important result:

Events which are simultaneous with reference to the embankment are not simultaneous with respect to the train, and *vice versa* (relativity of simultaneity). Every reference-body (co-ordinate system) has its own particular time; unless we are told the reference-body to which the statement of time refers, there is no meaning in a statement of the time of an event.

[1] As judged from the embankment.

FIG. IIIB

(d) The ability to set the clock at n as prescribed above at an instant. This, however, is a problem common to all methods of synchronization and not unique to relativity.

In a footnote on the same page, Einstein stated: "Strictly speaking, it would be more correct to define simultaneity first, somewhat as follows: two events taking place at the points A and B of the system K are simultaneous if they appear at the same instant when observed from the middle point, M, in the interval AB. Time is then defined as the ensemble of the indications of similar clocks, at rest relatively to K, which register the same time simultaneously". This "more correct" definition of simultaneity was discussed in detail by Einstein in his "*Relativity*" (Crown Publ., Inc., 1961), the pages 25 and 26 of which are reproduced in Figs. IIIA and IIIB.

We specifically note here the particular sentence at the end of the first paragraph: "Also the definition of simultaneity can be given relative to the train in exactly the same way as with respect to the embankment". Accordingly, if points A´ and B´ were on the train *respectively and precisely opposite* the points A and B on the embankment, light from A´ and B´ would arrive at the point M´ simultaneously. But is this definition of simultaneity of events on the train correct? According to the theme developed in the third paragraph, Einstein believed, correctly, that a passenger at M´, "hastening towards the beam of light coming from B", "will see the beam of light coming from B earlier than he will see that emitted from A". But suppose that lights were installed *on* the train at positions A´ and B´ *and were carefully wired and adjusted to light up simultaneously* with the corresponding lights at A and B on the embankment, by means of switches so placed on the embankment and on the train that were triggering each other. Beams of light from A and A´ would then be simultaneous and would be chasing after our passenger at M´ identically. Similarly, beams of light from B and B´ would be simultaneous and would be going to meet the oncoming passenger seated at M´ also identically. It is now obvious that *light from A and A´ would reach position M´ simultaneously, and so will light from B and B´*. Now, if light from A´ and B´ reaches M´ simultaneously (according to the above definition of simultaneity relative to the train), so must light from A and B. So that if the definition of simultaneity given by Einstein is correct, the experiences described by him of our passenger at M´ cannot be true, and if those experiences are true the definition of simultaneity is incorrect! Which of the two options is the correct one? There can be no doubt that if the *entire* embankment is *absolutely* at rest and not only the middle point M, or if even the latter point *only is absolutely* at rest and the equidistant points A and B recede from, or approach, M *identically,* the Einstein definition of simultaneity for events on the embankment holds true. Also, there can be no doubt that the Einstein description of events observed by the passenger at M´ is correct: If $M´A = M´A´ = M´B = M´B´ = s$, the time required to meet the light from B and B´ is t´ in $s - vt´ = ct´$ and $t´ = s/(c + v)$. The time required for light from A and A´ to overtake M´ is t´´ in $s + vt´´ = ct´´$ and $t´´ = s/(c - v)$, so that $t´ < t´´$, as long as $v \neq 0$. It follows that the mistake was committed in assuming that the above definition of simultaneity also holds for events on the train as de-

clared in the quotation in the beginning of this paragraph, or more generally for events on any reference system without reference to its *absolute state of rest*. This discussion shows that *the question of absolute rest cannot be ignored* in a discussion of simultaneity and the requirement that the principal system K be merely an "inertial" system *is clearly too loose and insufficient*. A principal reference system K can only have meaning if it is *absolutely* motionless.

In light of the above discussion, it is important to see how the question of simultaneity is being resolved in the Newtonian expanding Universe. Referring to Fig. IIIC, an observer at O at universal age T observes simultaneously objects A and B. Light from these objects was emitted respectively at universal ages T_A and T_B. The general relationships are sought among T, T_A and T_B. We simplify the problem by assuming that points O, A and B have never participated in any other motion, but only in the recessional Hubble motion. Accordingly, the distances CO, CA and CB from the center of the Universe are respectively $\rho_o R_o$, $\rho_A R_A$ and $\rho_B R_B$ The distances AO and BO covered by light in the respective intervals $T - T_A$ and $T - T_B$ are respectively $R - R_A$ and $R - R_B$. The relationships

$$OA/\sin\alpha = CA/\sin\gamma_A = CO/\sin(180° - \alpha - \gamma_A)$$

and

$$OB/\sin\beta = CB/\sin\gamma_A = CO/\sin(180° - \beta - \gamma_B),$$

holding for triangles COA and COB, respectively, now yield respectively

$$(R - R_A)/\sin\alpha = (\rho_A R_A/\sin\gamma_A)[\rho R/\sin(180° - \beta - \gamma_A)]$$

and

$$(R - R_B)/\sin\beta = (\rho_B R_B/\sin\gamma_B)[\rho R/\sin(180° - \beta - \gamma_B)].$$

These yield respectively

$$R_A = R(1 + \rho_A \sin\alpha/\sin\gamma_A)^{-1} \quad \text{and} \quad R_B = R(1 + \rho_B \sin\beta/\sin\gamma_B)^{-1},$$

which are equivalent to

$$(T_A/T)^{2/3} = (1 + \rho_A \sin\alpha/\sin\gamma_A)^{-1} \quad \text{and} \quad (T_B/T)^{2/3} = (1 + \rho_B \sin\beta/\sin\gamma_B)^{-1}$$

and give

$$(T_A/T_B)^{2/3} = [(1 + \rho_A \sin\alpha/\sin\gamma_A)/(1 + \rho_B \sin\beta/\sin\gamma_B)]^{-1}.$$

Simultaneity of emission obviously requires that

$$\rho_A \sin\alpha/\sin\gamma_A = \rho_B \sin\beta/\sin\gamma_B. \quad \text{(III-1)}$$

The Einstein definition of simultaneity as regards the embankment is now seen to be realized in the simplest case by identifying M with O and setting $\gamma_A = \gamma_B = 90°$ and $\alpha = \beta$. In other words, in the simplest case, the embankment recedes from the center of the Universe equilaterally and transversely to the direction of motion of light from A and B to M here considered and, therefore, with regard to the point M and for light received there from the equidistant points A and B, the embankment can be considered as being *effectively* at *absolute rest*. The Einstein definition of simultaneity as regards *only* the train would be realized in a partic-

ularly simple manner if we identified M´ with O and set $\alpha = \beta = \gamma_A = 0°$ and $\gamma_B = 180°$. Under these conditions, the train would be speeding along CO away from C.

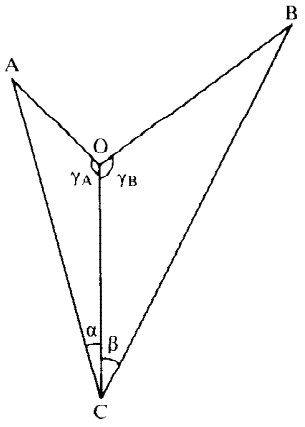

Fig. IIIC

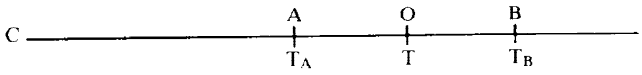

FIG. IIID

It is obvious that (III-1) now contains the indeterminate quantities 0/0 on both sides, and as a result, the geometrical construction employed is unable to provide an answer to the questions posited. But in this case, Fig. IIIC devolves into Fig. IIID, on the basis of which we can write

$$CO = CA + AO.$$

where

$$CO = \rho R; \quad CA = \rho_A R_A; \quad AO = R - R_A$$

and

$$CO = CB - BO,$$

where

$$CB = \rho_B R_B; \quad BO = R - R_B .$$

As a result,

$$R_A = R(1-\rho)(1-\rho_A)^{-1}; \quad R_B = R(1+\rho)(1+\rho_B)^{-1};$$

$$(T_A/T)^{2/3} = (1-\rho)(1-\rho_A)^{-1}; \quad (T_B/T)^{2/3} = (1+\rho)(1+\rho_B)^{-1};$$

$$(T_A/T_B)^{2/3} = (1-\rho)(1+\rho)^{-1}\,[(1+\rho_B)/(1-\rho_A)].$$

Simultaneity of emission from A and B obviously occurs when

$$(1 - \rho_A)/(1 + \rho_B) = (1 - \rho)/(1 + \rho)$$

It is now clear that when O, A and B participate in arbitrary peculiar motions, resolution of the questions of absolute simultaneity of events at A and B, as observed from O, cannot ignore those motions.

The distance CO is covered by light in time $T - T_C$, so that

$$CO = \rho R = R - R_C .$$

The observed age of the center thus is

$$T_C = T(1 - \rho)^{3/2}$$

(see p. 89). On the basis of the current velocity of light and observed age, the center is judged to be at a distance $c\,(T - T_C)$. Only for $\rho << 1$ is this approximately equal to the correct distance, since

$$c\,(T - T_C) - cT\left[1 - (1 - \rho)^{3/2}\right] \cong (3/2)\rho cT = \rho R.$$

ADDENDUM IV

THE RESOLUTION OF THE PROBLEM OF UNCERTAINTY

Billiard balls of identical mass and fixed size do not exhibit uncertainty as to their whereabouts after collision. This is shown in Fig. IVA, where if the radius of the balls is r and the distance between their antiparallel trajectories is d, the angle α is given by $\sin\alpha = d/2r$ and the incidence-recoil angle of each ball is 2α.

The situation is entirely different if the balls possess a spherically symmetrical vibratory motion, as suggested by the electron model developed in this work. In this case, the angles and velocities of recoil of the two balls depend upon the instantaneous properties of the balls at the moment of impact at the point of impact. Assume, to begin with, that at that moment the balls behave as ideally elastic hard spheres. This implies that no time lapse is involved in the impact, its duration being $\delta t = 0$, which, in turn, implies that the action involved in the impact has the non-physical value of $h = 0$. We immediately must conclude that this idealization cannot exist in the real world at $T \neq 0$, where, because h has a finite, non-zero value, a finite non-zero collision time interval δt is involved and therefore the collision is not at all elastic but in reality "plastic", however short the time interval δt. Still, it is of great inductive value to assume, as a start, that the spheres at impact are ideally elastic.

If relative to direction x, the balls have translational velocities v and –v, in the direction C C´, these velocities analyze to the components $v\cos\alpha$ and $-v\cos\alpha$ and in the direction transverse to C C´ to the components $v\sin\alpha$ and $-v\sin\alpha$, where $\sin\alpha = d/(r_1 + r_2)$, r_1 and r_2 being the instantaneous radii of the two balls (Fig. IVB). The vibratory velocities relative to their centers of the two balls must be added with the proper signs to the translational velocities in the direction C C´. If the vibrational velocities are v_1 and v_2, the balls impact with velocities $(v\cos\alpha + v_1)$ and $-(v\cos\alpha + v_2)$. Ignoring the effect of velocity upon mass, for equal masses and according to classical theory, the balls at impact simply exchange velocities, and recoil with respective velocities $-(v\cos\alpha + v_2)$ and $(v\cos\alpha + v_1)$. The angles of recoil, β_1 and β_2 are thus given by $\tan\beta_1 = -v\sin\alpha/(v\cos\alpha + v_2)$ and $\tan\beta_2 = -v\sin\alpha/(v\cos\alpha + v_1)$, and the incidence-recoil angles are $(\alpha + \beta_1)$ and $(\alpha + \beta_2)$. The periodic vibration of the balls will necessarily cause the incidence-recoil angles to range in an interval of values, even when the translational velocities remain fixed. An observer who ignores, or is unable to detect, the vibratory motions will assign to the balls radii $(r_o \pm \delta r)$ at all times and will have to devise a purely mathematical, i.e., statistical theory to account for the observed

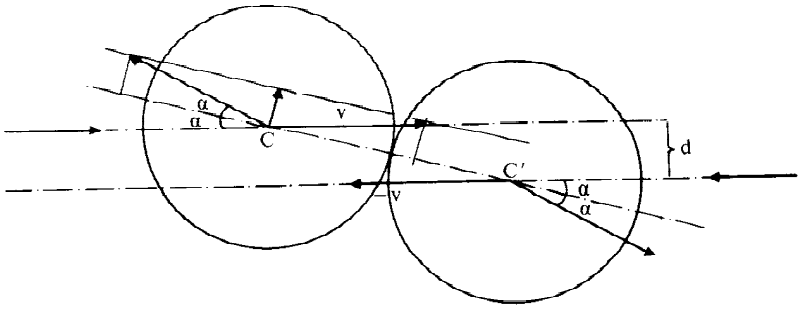

Fig. IVA.
Impact of hard balls of equal fixed size and antiparallel velocities.

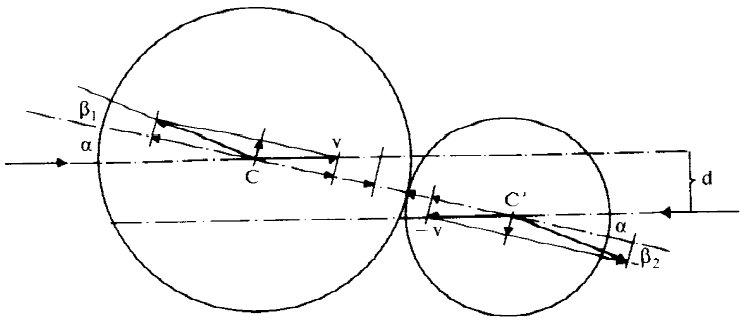

Fig. IVB.
Impact of hard vibrading balls balls of equal fantiparallel velocities.

variation of the incidence-recoil angles, not unlike what is presently happening in quantum theory.

In real life, because $h \neq 0$ and $\delta t \neq 0$, a proper account of the process of impact must consider *all* phenomena associated with it, which include the precise values with which the two balls first enter the collision at the beginning of the period δt, all the particular processes taking place in the interval δt, and the precise values with which the two balls finally exit the collision at the end of the period δt. Needless to say that at present we simply have no idea regarding the processes during the interval δt, nor can we even determine the exact properties at $\delta t = 0$ and $\delta t = \delta t$, because the very process of determination of these properties involves collisions such as the one we here endeavor to analyze. Since one of the balls can just as well be the particular electron of the detector and the other ball

the electron being detected, it is quite clear that, the act of detection (in effect the collision of the balls) will produce results (angles of incidence-recoil and velocities) that cannot be accounted for on the basis of hard, fixed-size, ideally-elastic ball theory. A statistical accounting is all that we can produce (for the moment at least), but this fact does not for a moment mean that the detailed processes producing the statistics are at all physically meaningless or inexact. It only means that no precise experimental accounting of them can be given, given the need for $h \neq 0$, that alone, produces and maintains the stability of form that saves this world from the constant chaos that would necessarily result if h were to remain at the value of zero, as discussed in Section 3.5.

This analysis fully justifies the notion, and in effect proves the existence, of "hidden variables" (i.e., classical mechanisms) obeying *classical* laws that make the world *intrinsically deterministic* in nature, despite the current opinion to the contrary. From our side, we must quite simply give up the notion that everything physical can be subjected to experimental verification. The finite, non-zero value of the unit of action, h, that alone permits our physical existence *and* this discussion, precludes this Aristotelian notion of experimentation ad infinitum. The currently continuing irresolution of "disturbing questions" associated with the current understanding of quantum theory is predicated upon the belief, of *both* sides to the continuing debates, in this Aristotelian notion. In a very real sense, not until we give up this notion, can we claim finally to have left the shackles of the Middle Ages behind us. Our science cannot be called truly advanced until we recognize fully, and do true justice to, the limitations placed by the Universe and its Laws upon everything physical that exists within it.

ADDENDUM V

THE RESOLUTION OF THE PARTICLE–WAVE DUALITY PARADOX

What is light? Does it consist of particles or waves? These are questions that have been debated for three centuries. Newton, on the basis of his optical studies, concluded that light consists of particles. Young in 1802 demonstrated that interference phenomena, similar to those already known from classical mechanical systems, also exist in association with light, and thus he "showed" that "light is waves". In this century, the photoelectric phenomenon and the Compton effect ("light has momentum") were shown to be compatible *only* with the notion of light as a stream or shower of individual particles, now called photons, and thus to justify Newton's conclusion. Yet, the phenomenon of interference "has defied explanation on any other basis than by assuming light to be a wave phenomenon" (F.K. Richtmyer, E.H. Kennard, T. Lauritzen: "*Introduction to Modern Physics*"; McGraw-Hill; 5th Edition; p. 99). Other phenomena, too, such as polarization and the entire electromagnetic theory are also most easily understood on the basis of classical wave theory. So, "under the weight of incontrovertible experimental evidence", we have decided to accept the view that light partakes of a dual particle-like *and* wave-like nature. However, specifically as regards electromagnetic phenomena, the search for "ether", the medium that was supposed to suffer the electromagnetic deformations that *are required* by classical wave theory, has been singularly fruitless. Ether has been declared as nonexistent and all search for it has been given up. Special relativity managed to transform away the nonexistent ether into the *supposedly physical* "spacetime" and to claim to have resolved the question. Yet, even today, the question "how, exactly, does spacetime undulate?" is just as refractory of a simple, easily understood answer as the question "how, exactly, can the vacuum (i.e., nothing at all) vibrate, which vibration is understood as harmonic electromagnetic deformations, or more simply, light?". The notion of "matter waves" first introduced by de Broglie and "verified" in the "strikingly similar" "wave-like" diffraction patterns obtained by X-rays and highly accelerated electrons bombarding powdered or polycrystalline materials (see, e.g., "*Introduction to Modern Physics*", *p*. 176 et seq.) has added to the notion of the "dual nature" of *both* matter and radiation. So today, the view has taken hold that the quantum theory clearly suggests a *particle* of energy νh, where ν is "only" understood as a *frequency of radiation:* in other words that, the notion of quantum, necessitated directly by the very old idea of atomicity, cannot be conceived but only through the existence of a continuous field subjected to some kind of undulations!

In light of all these notions, N. Bloembergen ("*Encyclopedia of Physics*"; VanNostrand-Reinhold; 2nd Edition; p. 499) stated:

> "The combination of the laws of quantum mechanics and electromagnetic theory gives a consistent description of the generation, propagation and detection of light. Since these laws describe many other properties of matter such as electronic structure, chemical binding, electricity and magnetism, etc., it may be said that the nature of light is well understood. In this context, it is not necessary and not even desirable to pose the question. 'What is it, precisely, that vibrates in a light wave in vacuum?'. The electromagnetic fields acquire meaning only through their relationships with detectors and sources. Human knowledge or understanding is here used in the operational sense that a relatively simple framework of physical concepts and mathematical relationships exists, which gives an accurate description of a wide variety of optical phenomena at present accessible to observation or verification in experimental situations".

But if so, what is thus claimed to be "well understood" is no more than the "operations" to which human knowledge (i.e., the human mind) subjects an existing "relatively simple framework of physical concepts and mathematical relationships..., which gives an accurate description of a wide variety of optical phenomena*...". In this manner, our inability to answer, in succinct and easily understood *physical* terms, the question "what is it, precisely, that vibrates in a light wave in vacuum?" goes unconfessed. The question itself is removed as "not necessary" and ostracized as "not even desirable". Here again, then, one finds another phraseological formulation of the current notion (in essence, the "anthropic principle") that physical quantities do not in fact exist *apart* from the "comprehending"(?) "human knowledge".

It is obvious that this kind of language only masks our basic ignorance of the precise nature of the *objective* (i.e., independently of the human mind existing) physical quantities the comprehension of which theory and experiment were once supposed to facilitate. We seem to have become mired in the convolutions of our own "comprehension" and have thus lost sight of what we once started out to investigate—the world "out there"! Specifically as regards the nature of light, if a particle is only understood in terms of a finite, geometrically delineated volume (i.e., its spatial extension) and in terms of a precise amount of mass and energy contained therein, and if vacuum is only what the word says (for if it is not, we have only managed to re-introduce the never-found ether!!!), no amount of linguistic manipulation can possibly bring together *these mutually exclusive* notions. The objective, "out there" reality calls for *a real physical quantity* (which therefore, *ipso facto cannot be the vacuum and thus can only be a real particle*), which alone can explain the phenomena associated with light. In other words, our task is to find a (or, *the)* particular configuration of particles in space that

* Thus since, etymologically, phenomena is *everything that appears to the senses,* including illusions of all kinds, to the extent that our knowledge cannot, or does not want to, differentiate between mere appearances and the reality that produces them, it cannot be said to be free of delusions.

under "suitable" conditions of observation gives rise to the thus observed "wave" phenomena.

To start from something simple, to associate the diffraction patterns of polycrystalline substances with "matter waves" is gratuitous. If matter waves exist, they must exist at all times whenever matter in any form exists, and not only when the latter is in polycrystalline form. So, not only the Debye-Scherrer, but *also* the Bragg-Laue *and* the amorphous matter patterns should all clearly exhibit the wave-like nature of "matter waves" associated with the matter bombarded. This is not observed. Monocrystalline materials give only spotty diffraction patterns, not waves, and amorphous materials give only a smear in which no pattern at all can be distinguished. We are thus forced to conclude that *reflections in preferred directions are always present,* but the patterns observed have absolutely nothing to do with a supposed "matter radiation" and everything to do with the crystalline formation of the matter bombarded. The circular patterns, which are nothing more than the summation of a very large multitude of spotty Laue images, obtain only when polycrystalline material is present at the target. After all, the entire field of X-ray diffraction spectroscopy is based upon, and made possible because of, this unique association of image and crystalline structure; it says next to nothing about the radiation used or supposedly excited. In other words, at least the X-rays reflected off a target, although part of the electromagnetic spectrum, are not at all "waves" but particles reflecting in precise directions depending upon the reflector.

Similarly, with radio emission. In classical wave theory, the energy is carried by the entire expanding circular or spherical front, over which the energy of the wave is uniformly distributed. As the front expands, the energy flux decreases uniformly; no particular direction is favored to receive, in the form of a single particle, the entire energy of the front (as is openly claimed in the context of current understanding when the energy of a "wave" is observed to "condense" in the form of a particle hitting a detector at a particular point). A radio transmitting antenna transmits a spherical wave pattern only because it is made up of a lot of polycrystalline material. There is no doubt that if the antenna were made up of a single crystal, the transmission would automatically become correspondingly directed. If transmission were always spherical regardless of the shape of the antenna, directional transmitting antennas would be impossible to construct. Such antennas are not impossible to construct.

We must conclude, therefore, that if the entire electromagnetic spectrum is composed of essentially similar "radiation", differing in the various parts of the spectrum only by the corresponding "wavelengths", and we have every reason to believe that this is indeed so, then, what we have called "electromagnetic radiation" does not at all exhibit the undulatory pattern of a classical mechanical wave *per unit* of "radiation". In other words, we are forced to conclude that physical (as opposed to conceptual, or theoretical) electromagnetism consists of a large number of "grains" or particles, which only on aggregate, when they emanate from a polycrystalline material, exhibit the "spherical" front associated with the structure of a classical wave.

Consider now the emission of a perfectly monochromatic, perfectly coher-

ent stream of photons, from an antenna connected to a transmitting station that is connected to "its own" generating station. Heat energy, itself also supplied in quanta, is there converted to electricity. A large number of particles of coal or gas burn to produce heat, the absorption of which is "totally disorganized and chaotic", although each heat absorbing event never fails to obey the law of action discussed in Section 3.5. Only when the ultimate detail is ignored can the apparently chaotic total picture support the view of the continuous flow of something: the generation of "electricity" and its "flow" to the transmitting antenna can then "without doubt" be considered to be a "continuous" phenomenon. The transmitting station-antenna system converts that "continuous" flow to the discontinuous transmission of distinct photons. The picture is entirely analogous to that of a dripping faucet: Water is supplied to the faucet "continuously", but there it separates into distinct drops. Just before the flow of water becomes "continuous", the drops can be imagined as identical "pearls in a string". Similarly, in the case of the "antenna", "continuously flowing" "electricity" separates into a contiguous stream of photons streaming like pearls in a string. In reality, in neither case has the individuality of the fundamental events been at all affected: Both water molecules and photons are still, as always, supplied in quantized form, i.e., in exact whole number multiples of the basic units. Theories of continuity are possible only when the individuality of events is ignored. *Despite claims of scientific rigor, such theories can never accurately describe actual natural events, that are always quantized.*

How does a contiguous stream of photons get to be seen as "continuous radiation" by a "receiver"? It is well known that optical "effects become apparent only when the (receiver) has a characteristic dimension comparable to the wavelength of the wave" ("*Encyclopedia of Physics*"; p. 497). Imagine, then, a linear flow of equal semitransparent spheres in contact with each other rolling past a very narrow observation slit of width dx, the length of which is equal to the diameter of the spheres, λ (Fig.V). The spheres are illuminated sideways, so as to be visible to an observer only in very narrow slices of thickness dx as seen through the slit. The intensity of light observed through the slit is thus proportional to the area of the disc (or to the mass and energy contained in the disc) passing in front of the slit. How is an observer recording the phenomenon *as seen through* the slit to describe it? Inevitably, he will *have to describe it as a periodic phenomenon of light and darkness, a* "*wave*". Solely from what he *can* see, he *cannot* give as a reason the flow of contiguous spheres!

The volume dv of a disc of thickness dx between x and x + dx is given by

$$dv = (\text{Area})\cdot dx = y^2 dx = \pi\left[(\lambda/2)\sin\theta\right]^2 dx = (\pi/4)\lambda^2\sin^2\theta dx.$$

Since

$$\left[(\lambda/2) - x\right] = (\lambda/2)\cos\theta,$$

it follows that

$$x = [(\lambda/2)(1 - \cos\theta),$$
$$dx = -(\lambda/2)d\cos\theta = (\lambda/2)\sin\theta d\theta,$$
$$dv = (\pi/8)\lambda^3 \sin^3\theta d\theta,$$

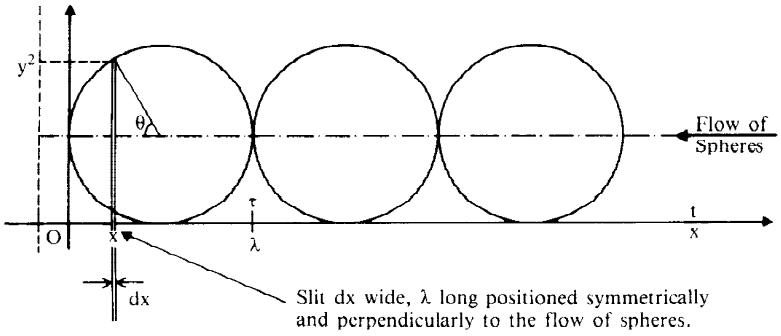

Fig. V.
Flowing spheres seen as a "wave" phenomenon.

where θ varies from 0 to π. The total volume of the sphere (with the first integration being carried from 0 to λ and the second from 0 to π) thus is

$$v = \int dv = (\pi/8)\lambda^3 \int \sin^3\theta d\theta = (\pi/8)\lambda^3(4/3) = (\pi/6)\lambda^3,$$

as it should be. Assuming the sphere to be of uniform mass density, we also can write

$$dm = (\pi/8)\lambda^3 D \sin^3\theta d\theta,$$
$$m = (\pi/6)\lambda^3 D,$$
$$d\epsilon = (\pi/8)\lambda^3 D c^2 \sin^3\theta d\theta,$$
$$\epsilon = (\pi/6)\lambda^3 D c^2.$$

With a knowledge of quantum theory, the observer will associate each observed "cycle" with the unit of action such that

$$h = \int p dx \text{ (with the integration being carried from 0 to } \lambda),$$

where p has the dimensions of momentum. Setting $dp = (dm)c$, the momentum of mass passing in front of the slit from $x = 0$ to $x = x$ is

$$p = (\pi/12)\lambda^3 Dc[1 - \cos\theta - (1/2)\sin^2\theta\cos\theta]$$

and upon integration

$$h = (\pi/12)\lambda^4 Dc. \qquad \text{(a)}$$

With a knowledge of alternating current theory, our observer is very likely to devise an "electromagnetic theory" of waves, corresponding to the phenomenon he observes, in the following way:

First, he writes an "instantaneous power" curve such that

$$d\epsilon = P dt,$$

obtained directly from the above, where also, $dx = cdt$, so that

$$P = (\pi/4)\lambda^2 D c^3 \sin^2\theta,$$

which is identical in form to the instantaneous power curve in current theory given by

$$P = V_{max} \cdot I_{max} \cdot \sin^2 \omega t.$$

Obviously, $\theta = \omega t = 2\pi f' t$, where f' is the frequency of the conceived alternation, being one half the frequency of the power curve (of the spheres passing in front of the slit). Then, he notes that since $c = \lambda/\tau$,

$$(\pi/4) \cdot \lambda^2 D c^3 = (\pi/4) \cdot \lambda^2 D (\lambda/\tau)^3 = (6/4) \cdot \lambda^2 \cdot \left[(4/3)\pi(\lambda/2)^3 D\right] \tau^{-3} = (3/2) \cdot \lambda^2 \cdot m \cdot \tau^{-3}.$$

Current theory assigns to voltage and current the physical dimensions

$$|V| = \mu^{1/2} M^{1/2} L^{3/2} T^{-2}$$

$$|I| = \mu^{-1/2} M^{1/2} L^{1/2} T^{-1},$$

where μ is the magnetic permeability of free space. Accordingly, the "voltage" and "current" corresponding to the observed phenomenon are assigned the values

$$V = \mu^{1/2} (3/2)^{1/2} m^{1/2} \lambda^{3/2} \tau^{-2} \sin\theta,$$

$$I = \mu^{-1/2} (3/2)^{1/2} m^{1/2} \lambda^{1/2} \tau^{-1} \sin\theta.$$

Conversion to accepted electrical units thus is only a matter of proper unit definition. Our observer thus has "successfully explained", on the basis of an electromagnetic theory of waves, a phenomenon (which unbeknownst to him consists of a flowing stream of "pearls in a string") of an altogether different nature! His theory is indeed a most scientific one, its correspondence to what *he* observes is indeed unique. What he observes can "indeed" be said to "defy explanation on any other basis than by assuming light to be a wave phenomenon". The quantum constraint (a) "prevents" him from delving too deeply, into examining the nature of the pulses he records. Yet, the reality of the actual phenomenon, as *we* know, is totally different!

Because $\sin^2\theta = (1 - \cos 2\theta)/2$, the electrical power curve consists of a constant part of value

$$(\pi/8) \lambda^2 D c^3$$

and a fluctuating part of value

$$-(\pi/8) \lambda^2 D c^3 \cos 2\theta.$$

If a second stream of spheres, parallel to the first *were simultaneously observed* through the slit, which stream, however, differed in phase by $\pi/2$, the combined constant part of the conceived electrical power curve would be

$$(\pi/4) \lambda^2 D c^3$$

and the combined fluctuating part would be

$$-(\pi/8) \lambda^2 D c^3 \left[\cos 2\theta + \cos(2\theta + \pi)\right] = 0.$$

If, in reality, the perception of light, whether by a human eye or a man-made instrument, depends critically upon the existence of, and the ability to distinguish,

distinct pulses (of action h, or of exact whole multiples thereof), whenever no pulses can be distinguished, as in the above instance of combined flow, no light will be perceived either. This phenomenon, then, seems to correspond exactly to the phenomenon of destructive interference. A phase difference of π will result in a combined fluctuating part of size

$$-(\pi/8)\lambda^2 Dc^3[\cos 2\theta + \cos(2\theta + 2\pi)] = -(\pi/4)\cdot\lambda^2 Dc^3 \cos 2\theta,$$

which allows pulses of double power to be perceived. This, then, seems to correspond exactly to the phenomenon of constructive interference. Our observer thus seems to have succeeded in constructing a fully acceptable scientific theory to explain a physical phenomenon totally alien in its basic nature to the theory thus posited! The flow of spheres in vacuo is presented as a "wave" phenomenon!

This example thus also serves to highlight the enormous difference that can exist between an objective phenomenon and our claim of it to be "well understood" even on the basis of a most up-to-date theory! It also punctuates and justifies our insistence throughout this work on the view that the objective world exists independently, and even in spite, of our own present understanding of it, and that a final understanding of it without any paradox is indeed possible; in other words, that the objective world is fully logical and consistent in its most ultimate detail independently of us.

ADDENDUM VI

THE ELECTRONS IN THE LITHIUM ATOM

I. The Three-Electron Atom (Li^o)

The model of the electron developed in this work can be applied to the three-electron Li ° atom in a way similar to that used in the case of the He atom. The energy levels are found to obey the following equation:

$$R = R_\infty \cdot (3/n_1)^2 \cdot (1 + n_2/n_1 + n_3/n_1) \cdot \xi^2,$$

which is totally analogous to Eq. 261. In the present case, electron "One" has Z = 3, electron "Two" Z = 2, and electron "Three" Z = 1. The respective quantum numbers are n_1 (corresponding to n in helium), n_2 (corresponding to q in helium) and n_3 .

The lowest energy levels of the Li ° atom as obtained from wavelengths tabulated by Stringanov and Sventinskii are shown in the upper part of Table VI-1, along with the corresponding wavelengths arising in transitions with Level 1 (the ionization level). It is seen that those levels (13 through 21) correspond to the series $3m = n_1 = n_2 = n_3$. The complete series m = 2 through 10 is present in the spectrum. The corresponding ξ^2 values are found to be very near to the value of 1/3. The ionization level corresponds to $3m = n_1 = n_2 = 6$, $n_3 = 18$. The corresponding ξ^2 value is about 0.3170, somewhat reduced from 1/3.

The similarity of the manner in which the spectra of hydrogen, helium and lithium arise is quite unmistakable. A definite pattern is thus shown to exist, according to which the simple Rydberg law is very nearly correct for all elements at energy levels far from ionization. Despite their extra electrons, far from ionization, atoms heavier than hydrogen behave essentially identically to it and they all have nearly identical energy levels, as the hydrogen atom. Only at first sight is this finding masked by the different, for each atom, quantization of the higher energy levels near ionization. The various chemical elements are thus shown to be made up *according to a unified pattern of amazing and heretofore unsuspected simplicity*. The arguments presented earlier in this work against the possibility of chance and in support of the existence of Design thus find additional and extraordinarily conclusive confirmation.

Missing form the upper part of Table VI-1 are the Levels 2 through 12, corresponding respectively to values n_3 = 17 through 7. These levels are shown in the lower part of the Table. Levels 4 through 12 are obtained by consideration of the transitions from and to Level 1, which give rise to the corresponding wavelengths shown in Column 3. The Table of S&S does not permit Levels 2 and 3 to be identified in a similar manner: the expected wavelengths fall outside the upper

TABLE VI–1
ENERGY LEVELS OF THE THREE–ELECTRON LITHIUM ATOM Li^{o}

$$R = R_{\infty}(3/n_1)^2(1+ n_2/n_1+ n_3/n_1)\cdot\xi^2,$$
$$n_1 = 3m$$

Level	R, cm^{-1} in Å	Primary Series	Quantum Numbers m	n_1	n_2	n_3	ξ^2
1	43487.19		2	6	6	18	0.317 031 5542
13	27462.5762	6240.4	2	6	6	6	0.333 680 7619
14	12194.1621	3195.6	3	9	9	9	0.333 368 3579
15	6887.9879	2732.3	4	12	12	12	0.334 766 7053
16	4389.9768	2557.4	5	15	15	15	0.333 374 3159
17	3084.0801	2475.057	6	18	18	18	0.337 254 7312
18	2257.1155	2425.414	7	21	21	21	0.335 953 9552
19	1722.2888	2394.355	8	24	24	24	0.334 823 4406
20	1356.1693	2373.548	9	27	27	27	0.333 678 9568
21	1094.8549	2358.917	10	30	30	30	0.332 572 5941
Series Limit:		2299.5277					
2	42076.5163		2	6	6	17	0.317 324 9178
3	40847.1043		2	6	6	16	0.319 055 0637
4	39766.6502	26877.82	2	6	6	15	0.322 119 9650
5	38299.0633	19274.78	2	6	6	14	0.322 164 1444
6	37787.9016	17546.05	2	6	6	13	0.330 578 9267
7	35670.6046	12793.31	2	6	6	12	0.325 058 5753
8	34328.9008	10919.07	2	6	6	11	0.326 433 3044
9	32994.8143	9530.73	2	6	6	10	0.328 008 7325
10	31674.3321	8465.352	2	6	6	9	0.329 875 8864
11	30298.3518	7582.169	2	6	6	8	0.331 322 8643
12	28579.1880	6707.07	2	6	6	7	0.328 971 8094

end of that Table. The determination of these levels is shown in Tables VI–2 & 3. The values of ξ^2 for levels 2 through 12 are found to fall between the value of 0.3170 for Level 1 and that for Level 13. The transition of ξ^2 values from one level to the next is not as smooth here as was found in the case of helium. This can only be attributed to greater inaccuracies present in the tabulation of the lithium spectrum. The energy levels shown in Table VI–1 are all based on the assumption that the wavelengths considered in their derivation are all correct. That this is not so is in fact shown in Tables VI–4 & 5, where the derivation of the values of energy Levels 4 and 13, respectively, from additional transitions is

TABLE VI–2
CALCULATION OF ENERGY LEVEL "2" OF THE THREE–ELECTRON LITHIUM ATOM Li^{o}

Level	R, cm^{-1}	Tabulated Wavelength in Å	Calculated x_2	Calculated Wavelength in Å
2	x_2			
5*	38299.0633	26877.82	42019.6032	26472.8639
6	37787.9016	24464.66	41875.4303	23317.5525
8*	34328.9008	12793.31	42145.4895	12907.1970
9*	32994.8143	11032.09	42059.2799	11011.1518
10*	31674.3321	9686.37	41998.1170	9613.3656
11*	30298.3518	8465.352	42111.2097	8490.2873
12	28579.1880	7582.169	41762.0262	7408.8736
13	27462.5762	6707.807	42370.0578	6842.7816
19*	1722.2888	2475.057	42125.3987	2478.0551
Average of 9 values:			42051.8436	
Standard Deviation:			172.5031 (0.41%)	
Average of 6 values (marked by *):			42076.5163**	
Standard Deviation:			60.0551 (0.14%)	

** Calculated wavelengths are based on this value.

shown. Specifically in the latter case, the close proximity of the three averages shown in Table VI-5 leaves little room for doubt that they all reflect the same energy level and that the tabulated values are not quite accurate. There is little difference between the values of these levels entered in Table VI-1 (obtained from a single transition each) and the corresponding values derived as shown in Tables VI–4 & 5.

II. The Two-Electron Atom (Li^{+})

Upon ionization, electron "Three" (of quantum number $n_3 = 18$) of Li ° departs with 3/5 of the ionization energy, since $n_1 = n_2 = 6$, resulting in $(1 + n_2/n_1 + n_3/n_1) = (2 + 18/6) = (2 + 3)$. The resulting two-electron Li^{+} atom thus emerges at the energy level of 2/5 of 43487.19 cm^{-1}, or 17394.876 cm^{-1}. The energy levels of Li^{+} are given by

$$R = R_{\infty}(3/n_1)^2(1 + n_2/n_1)\cdot\xi^2,$$

TABLE VI–3
CALCULATION OF ENERGY LEVEL "3" OF THE THREE–ELECTRON LITHIUM ATOM Li^{o}

Level	R, cm^{-1}	Tabulated Wavelength in Å	Calculated x_3	Calculated Wavelength in Å
3	x_3			
7*	35670.6046	19274.78	40858.7728	19318.0732
9*	32994.8143	12793.31	40811.3997	12735.1384
10*	31674.3321	10919.07	40832.6213	10901.8297
11	30298.3518	9376.71	40962.0792	9479.7940
12*	28579.1880	8126.378	40884.7933	8151.3435
13	27462.5762	7582.169	40651.4144	7471.3131
16*	4389.9768	2741.186	40870.5367	2742.9479
19*	1722.2888	2557.4	40824.5020	2555.9226
Average of 8 values:			40837.0149	
Standard Deviation:			88.4796 (0.22%)	
Average of 6 values (marked by *):			40847.1043**	
Standard Deviation:			28.6396 (0.07%)	

** Calculated wavelengths are based on this value.

fully analogous to Eq. 261, except for the value of Z = 3. In the present case, ξ^2 is expected to be near the value of 1/2. This is shown in Table VI-6. The ionization potential of 610079 cm^{-1} is found to correspond to the quantum numbers $n_1 = 2$ and $n_2 = 8$.

The shortest tabulated wavelength in the Li^+ spectrum, 168.741Å, is found to correspond to an energy level of 17454.8008 cm^{-1}. This and the above value of 2/5 of the first ionization potential differ by only 0.17% from their average. It is obvious that here we speak of the same energy level, the small difference being due to the associated errors.

For reasons yet unknown, the spectrum of Li^+ is not as easy to analyze as the spectra already discussed. Nevertheless, the four lowest energy levels and the corresponding wavelengths are identified as also shown in Table VI-6. An additional energy level, k-4, of 115410.276 cm^{-1}, is also found based on levels k – 1 and k – 2, as shown in Table VI–7.

There is uncertainty as regards the quantum numbers corresponding to the ionization potential of 610079 cm^{-1}. At this time there is no easy way to choose

TABLE VI–4
CALCULATION OF ENERGY LEVEL "4" OF THE THREE–ELECTRON LITHIUM ATOM Li^{o}

Level	R, cm^{-1}	Tabulated Wavelength in Å	Calculated x_4	Calculated Wavelength in Å
4	x_4			
1*	43487.19	26877.82	39766.6502	26965.7854
7*	35670.6046	24464.66	39758.1287	24341.6652
10	31674.3321	12237.67	39845.8202	12338.8928
11*	30298.3518	10510.60	39812.5547	10548.0390
12*	28579.1880	8921.14	39788.5198	8928.8911
13*	27462.5762	8126.378	39768.1815	8119.3804
14	12194.1621	3670.4	39439.1490	3625.2079
17	3084.0801	2732.3	39683.2822	2725.1887

Average of 8 values: 39732.7733
Standard Deviation: 127.5993 (0.32%)

Average of 5 values (marked by*):39778.8070**
Standard Deviation: 21.9176 (0.06%)

** Calculated wavelengths are based on this value.

between (a) $2m = n_1 = 2$, $n_2 = 8$ and (b) $2m = n_1 = 4$, $n_2 = 75$, both of which give ξ^2 values very near to 1/2, as shown in Table VI-6. As in the case of the helium atom, it is conceivable that ξ^2 is substantially smaller than 1/2, in which case the quantity $(1 + n_2/n_1)$ is larger than either 5 or 19.75 corresponding, respectively, to the above two cases. Nor is there an easy way to identify conclusively the energy levels lying between Levels 1 and k–4. In all probability, the known spectrum of Li^{+} is far from complete and a large number of transitions have not been identified because of their weakness. Either of the above two cases permits a large number of energy levels to exist between Levels 1 and k–4.

III. The One-Electron Atom (Li^{++}).

Upon ionization, Li^{+} produces L^{++}. The emerging atom, according to the quantum numbers assigned above to the level of 610079 cm^{-1}, must possess either 1/5 or 1/19.75, respectively, of the energy of that level, namely, it must be

TABLE VI–5
CALCULATION OF ENERGY LEVEL "13" OF THE THREE–ELECTRON LITHIUM ATOM Li^{o}

Level	R, cm^{-1}	Tabulated Wavelength in Å	Calculated x_3	Markings	Calculated Wavelength in Å
13	x_{l3}				
1	43487.19	6240.2	27462.5762	* **	6240.8022
2	42076.5163	6707.807	27168.5143		6843.2652
3	40847.1043	7582.169	27658.2661		7471.8896
4	39766.6502	8126.378	27461.0449	* **	8128.0716
5	38299.0633	9214.61	27446.7321	* **	9228.9623
		9217.32	27499.9228	* **	
6	37787.9016	9686.37	27464.1167	* **	9685.8935
7	35670.6046	12237.67	27499.1144	*	12184.7336
16	4389.9768	4273.107	27792.1523		4333.9514
17	3084.0801	4132.598	27281.9334		4101.8020
18	2257.1155	3985.520	27347.9443		3967.2317
19	1722.2888	3915.329	27262.9266		3884.8046
20	1356.1693	3838.15	27410.3881	*	3830.3258
21	1094.8549	3794.72	27447.2604	* **	3792.3673

Average of 14 values: 27443.063
Standard Deviation: 156.8028 (0.57%)

Average of 8 values (marked by*): 27461.3939
Standard Deviation: 29.1111 (0.11%)

Average of 6 values(marked by**): 27463.6089***
Standard Deviation: 19.3840 (0.07%)

*** Calculated wavelengths are based on this value.

either at 122015.8 cm^{-1} or at 30890.08 cm^{-1}. The spectrum of Li^{++} obeys the simple expression

$$R = R_{\infty}(3/n_1)^2 \cdot \xi^2$$

fully analogous to that for the hydrogen atom, except for Z = 3. The identified energy levels are shown in Table VI–8. Neither of the above two energy levels is present in the spectrum. The nearest levels of 109925.86 cm^{-1} and 27688.52 cm^{-1} are quite far away. There is no doubt that possible errors associated with

TABLE VI–6
ENERGY LEVELS OF THE TWO–ELECTRON LITHIUM ATOM Li^+

$$R = R_\infty (3/n_1)^2 \cdot (1 + n_2/n_1) \cdot \xi^2$$
$$n_1 = 2m$$

Level	R, cm^{-1}	Primary Series in Å	Quantum Numbers m n_1 n_2	ξ^2
1	610079		1 2 8	0.494 179 4828
			(2) (4) (75)	0.500 434 9193
k-3	108277.5327	199.282	2 4 10	0.501 186 0067
k-2	48328.5857	178.015	3 6 15	0.503 323 4792
k-1	27267.2832	171.582	3 6 6	0.496 961 8164
k	17454.8008	168.741	4 8 10	0.502 714 0234
Series Limit:		163.9132		

TABLE VI–7
CALCULATION OF ADDITIONAL ENERGY LEVEL OF Li^+

Level	R, cm^{-1}	Tabulated Wavelength in Å	Calculated $k–x_4$	Calculated Wavelength in Å
k–4	$x_{k–4}$			
k–2	48328.2762	1493.7	115276.4333	1490.72
k–1	27267.2832	1132.8	115544.1194	1134.52

Average value: 115410.2764
Standard Deviation: 189.2826 (0.16%)

Quantum Numbers of Level k–4: $m = 2, n_1 = 4, n_2 = 11$
Value of ξ^2: 0.498 588 0242

TABLE VI–8
ENERGY LEVELS OF THE ONE–ELECTRON LITHIUM ATOM (Li^{++})

$$R = R_\infty(3/n_1)^2\xi^2$$

Level	R, cm^{-1}	Primary Series in Å	Quantum Numbers	ξ^2
1	987657.8		1	1.000 034 874
2	247026.7824	135.02	2	1.000 489 835
3	109925.8593	113.93	3	1.001 730 798
4	61817.6000	108.01	4	1.001 476 517
5	39700.6477	105.49	5	1.004 954 150
6	27688.5190	104.17	6	1.009 278 160
7	20539.8161	103.40	7	1.019 063 352
8	15642.5832	102.86	8	1.002 006 805
Series Limit:		101.25		

the spectrum of Li^{++}, given the similarity of the spectrum to that of the hydrogen atom, are too small to account for such a large difference, which must, therefore, be attributed to the inaccuracy of the quantum numbers assigned to the second ionization potential. The possibility that Level 8, of 15642.58 cm^{-1} is the level at which Li^{++} emerges upon ionization of Li^+ (similar to the case discussed above of Level k of Li^+ emerging upon ionization of Li°) cannot thus be discounted. If so, Level 8 of Li^{++} must be an exact fraction of the ionization potential, 510079 cm^{-1}, of Li^+. It is indeed found that this fraction is very nearly 1/39, leading to the conclusion that $n_2/n_1 = 38$. For $2m = n_1 = 4$, $n_2 = 152$ and $\xi^2 = 0.2534253758$. For $2m = n_1 = 2$, $n_2 = 76$ and $\xi^2 = 0.063356344$. Both cases suggest a drastic deviation of ξ^2 from the value of 1/2 as Li^+ approaches ionization and a far more complicated spectrum.

ADDENDUM VII

THE GRAVITATIONAL DEFLECTION OF LIGHT

The analysis of the deflection of the path of light in a gravitational field in terms of "Newtonian" mechanics is carried out along the following lines: Consider an attracting mass m *assumed of constant* radius r_o and a "corpuscle" of light of mass m_p, from a distant star S* located practically at *practical* infinity, sent out along the path pp´, located at a distance b from the center of mass m. The gravitational attraction of m deflects the light from its original path and causes it to follow the path pAq´, which is a hyperbola symmetric at A, the point of closest approach, Fig. VII. An observer at E, acting on the belief that light travels along Euclidean straight lines, interprets his observation of light from S* as coming from a fictitious source S** located along the path q´q. Thus, the total deflection of the light path is 2ϕ, the angle pOq. The observer provides the following mathematical analysis based on the principles of conservation of energy and angular momentum and the notion of negative potential energies: If, at infinity, the velocity of m_p is v_p, and at A is v, these principles suggest that

$$(1/2)m_p v_p^2 = (1/2)m_p v^2 - Gmm_o/r_p$$

the negative sign being justified on the basis of the fact that at an infinite distance r the potential energy is zero and on the belief that the potential energy increases with r. (This belief, in turn, is based on the principle of conservation of energy and the "fact" that a body starting upwards, initially only with kinetic energy and zero potential energy, eventually reaches a point at which it has zero kinetic and only "potential" energy and finally returns to the ground with only kinetic and zero potential energy, thus being perceived to "duplicate" its original state). The angular momenta at infinity and at A are considered to be equal so that

$$m_p v_p b = m_p v r_o.$$

From these two relationships one obtains

$$(b/r_o)^2 - (2Gm/bv_p^2)\cdot(b/r_p) - 1 = 0$$

which has the solution

$$(b/r_o) = (Gm/bv_o^2) + [(Gm/bv_p^2)^2 + 1]^{1/2}.$$

The geometry of the hyperbola suggests that

$$(b/r_o) = \tan\phi + [\tan^2\phi + 1]^{1/2},$$

leading to the conclusion that

$$\tan\phi = Gm/bv_p^2.$$

Now, in the case of light, c is substituted for v_o and r_o for b, which permits one to write

$$\tan\phi = GM/rc^2 \ (= 2.12 \times 10^{-6} \text{ for the Sun})$$

and

$$\tan 2\phi = 2\tan\phi/(1 - \tan^2\phi) \cong 2Gm/rc^2$$

OC = OB = e
OA = OA´ = a
AB = A´C = b
OBA = ACA´ = ϕ
pOq = 2ϕ

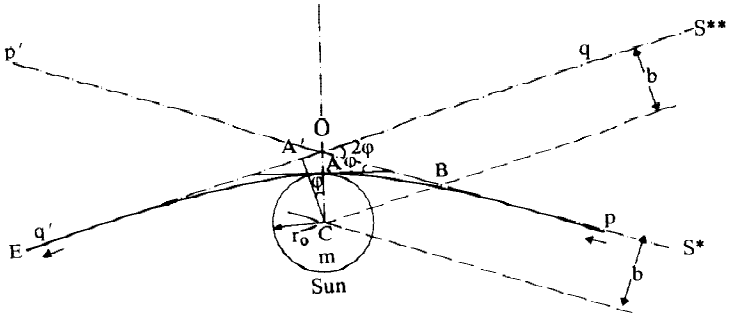

FIG. VII. Hyperbolic Deflection of Light Path at Closest Approach.

leading in the case of the Sun to the value $2\phi = 0.875''$ seconds of arc. The theory of general relativity predicted a value twice as large, $2\phi = 1.75''$, which is widely believed to have been verified by astronomical observation. (See, however, D.W. Sciama: *"The Physical Foundations of General Relativity"*, Doubleday & Co, 1969, p. 67-70). This has been considered to be one of the few crucial tests demonstrating the "wrongfulness" of Newtonian gravitation and the "correctness" of general relativity.

The present work permits a different analysis of this problem. Like ordinary bodies, the photon, too, has been shown in this work to have "kinetic and "potential" energy in equal amounts (pgs. 97-98). It has also been shown to be subjected to gravitational retardation which alone can account for the decrease in the velocity of expansion of the Universe, which is identical to the velocity of light. In these two respects, the photon does not behave differently from other bodies. This is further demonstrated by the analysis of the Michelson-Morley experiment, which is in effect *equivalent* to recognizing a velocity of light, relative to the interferometer as a whole, *different* from the absolute velocity of light, relative to the center of the Universe. This is the true significance of writing, say,

$ct_1 = L_1 + vt_1$ and $ct_2 = L_1 - vt_2$ on p. 66, which are identical to $(c - v)t_1 = L_1$ and $(c + v)t_2 = L_1$, respectively. Thus, if light takes times t_1 and t_2 to cover the same interferometer length L_1, this can only be due to its velocity relative to the interferometer being respectively $(c - v)$ and $(c + v)$. If this were not so, namely, if instead it were always true that $ct = L$ $(= L_1 = L_2)$ *regardless of direction),* one *would not* expect to observe *any* interference fringes, but *also,* one would have absolutely *no cause to* propose a contraction of lengths. Thus, at the base of the analysis of that experiment lies the recognition of a velocity relative to an observer in whose frame the interferometer remains motionless *different* from the absolute velocity. *Only* this can justify the contraction of lengths. (It is thus illogical, later, to accept the contraction of lengths as true but deny the relativity of the velocity of light, which makes that contraction possible and indeed mandates that contraction, which is what the theory of relativity does). Note also that, it is the very same reasoning used here which was applied by Einstein himself in his discussion of the problem of simultaneity, as already discussed in Addendum III.

In light of these basic similarities in behavior, it is necessary here too that we consider the *relative* velocity of light, relative that is to the attracting mass m. Consider the following correspondences:

	Universal age T_1	Universal age T_2
Absolute velocity of photon:	c_1	c_2
Absolute velocity of mass m:	v_1	v_2
Angle between vectors:	α_1	α_2
Velocity of light relative to m:	$c'^2 = c_1^2 + v_1^2 - 2c_1v_1\cos\alpha_1$	$c''^2 = c_2^2 + v_2^2 - 2c_2v_2\cos\alpha_2$.

(Included in these expressions is the possibility of relative velocities in excess of c, depending on the value of the cosines).

The similarities noted above of photons and ordinary bodies and the relativity of velocities requires that, relative to an ordinary body, the photon be considered to have a total energy equal to the sum of its relative kinetic and potential energies, each being positive. Under these conditions, it is obvious that a photon approaching a body *will* experience an increase in its *total* energy. The blueshifting observed by Pound and Rebka, namely, the *fact* that a photon acquires energy as it "falls" towards a body, reflects the increase in its total energy. The definition of force, in this case gravitational force, as the rate of change of momentum

$$f = d(m'v)/dt = m'(dv/dt) + v(dm'/dt),$$

where f, m´ and v are the instantaneous values of force, mass and velocity, requires that we consider both the change of velocity and the change of mass. The application of the gravitational force to a photon should result in a change in its relative velocity. However, because the absolute velocity of light is universally fixed at any one moment, a change in relative velocity due to the particular force under discussion can only obtain as a result of a change in the absolute velocity of the attracting body due to *this* particular force. For very massive bodies, such change is totally negligible. The change dv/dt in the relative velocity, due to the

particular attracting body, thus is effectively zero and the relative velocity value is effectively independent of the particular gravitational field and determined only by the otherwise established absolute velocities. It follows that the force reflects only the change in mass dm'/dt. The falling photon acquires mass as it falls through the field. Since the most basic carriers of mass are the fundamental photons, the field basically possesses, or consists of, (such) photons. The observed increase in energy (the Pound-Rebka blueshifting) *proves* the transfer of photonic mass from the field to the oncoming photon. This, then, than that given earlier (pgs. 61-2), is the correct interpretation of the Pound-Rebka phenomenon. When the change of mass is ignored, as was done there, there is no other way to account for the increase in energy except by assuming a corresponding but fictitious increase in relative velocity. (See also below).

A photon emitted by a distant star is being "retarded" by (now, in reality, *surrendering mass* to) the field of that star. As it approaches the Sun, it is "accelerated" by (in reality, *gaining mass* from) the field of the Sun. At some point between the two stars, the photon has minimal mass m_o. From that point on, it will gain more mass from the field of the Sun, while the mass lost to the field of the "mother" star is negligible. *Relative to the Sun,* the total energy of the photon at a distance ρr_o, at age T_1, is

$$(1/2)m_o c'^2 + Gmm_o/\rho r_o ,$$

At the distance of closest approach r_o, at age T_2, the total energy of the photon is

$$(1/2)(m_o + \delta m)c''^2 + Gm(m_o + \delta m)/r_o ,$$

larger than the former amount. The difference represents the energy $(\delta m)c''^2$ gained in the interim, as reported at age T_2, so that

$$(\delta m/m_o) = [1 - 2Gm/r_o c''^2]^{-1} [(2Gm/r_o c''^2)(1 - \rho^{-1}) + (1 - c'^2/c''^2)]$$

where

$$\begin{aligned}(1 - c'^2/c''^2) &\cong 1 - (c'^2/c''^2)[1 - 2(v_1/c_1)\cos\alpha_1 + 2(v_2/c_2)\cos\alpha_2] \\ &\cong 1 - (1 + 2\delta T/3T)[1 - 2(v_1/c_1)\cos\alpha_1 + 2(v_2/c_2)\cos\alpha_2] \\ &\cong -(2\delta T/3T) + 2[(v_1/c_1)\cos\alpha_1 - (v_2/c_2)\cos\alpha_2] \\ &\cong -(2\delta T/3T).\end{aligned}$$

The quantity in the last parenthesis is very nearly zero, if the absolute velocity of the body is a nearly fixed fraction of the absolute velocity of light, because the angle between the absolute velocity vectors changes very little, by 2ϕ.

For $\rho >> 1$ and a not entirely negligible fraction $\delta T/T$ of transit, to a first approximation, we have quite simply

$$\delta m/m_o \cong 2Gm/r_o c''^2 - 2\delta T/3T.$$

The classical determination of the hyperbola parameters is only approximately correct. This is due to the fact that the Sun is not absolutely motionless, and so, the oncoming photon does not remain on a true hyperbola relative to the moving Sun. A reasonable simplification can nevertheless be obtained by consid-

ering, at age T_2, that particular direction at distance b from the center of the Sun that would have been a true asymptote had the Sun remained motionless throughout. To the extent that the conservation of angular momentum can still hold approximately, over the period of transit, in an expanding Universe, we now write

$$m_o c' b \cong (m_o + \delta m) r_o c'',$$

where b, r_o and c'' all refer to the age T_2, of closest approach. It follows that

$$\begin{aligned}(b/r_o) &\cong (c''/c')(1 + \delta m/m_o) \cong 1 + \delta m/m_o - \delta T/3T \\ &\cong 1 + 2Gm/r_o c''^2 - \delta T/T.\end{aligned}$$

The geometry of the hyperbola shows that

$$\tan\phi = [(b/r_o)^2 - 1]/2(b/r_o),$$

so that

$$\begin{aligned}\tan\phi &\cong (2Gm/r_o c''^2 - \delta T/T)[1 - (Gm/r_o c''^2 - \delta T/2T)] \\ &\cong (2Gm/r_o c''^2 - \delta T/T)\end{aligned}$$

and

$$\tan 2\phi \cong (4Gm/r_o c''^2 - 2\delta T/T).$$

When the universal age factor is ignored and c'' is replaced by the known value for the velocity of light, the value $2\phi = 1.75''$ is obtained, *identical* to that predicted by general relativity.

The present theoretical treatment exposes many, if not all, sources of error and provides a better basis for evaluating the observed deflections. Deflection values (average per eclipse) cited by Sciama range from 0.93'' to 2.73'' and error estimates from 0.10'' (associated with averages of 1.70'' and 2.24'') to 2.67'' (associated with an average of 1.28''). It is clear that individual star deflections have ranged more widely than the averages suggest. The observed variation has so far been attributed solely to observational uncertainties; for without them, it threatens to embarrass even general relativity. One suspects, along with Sciama (loc. cit. p. 70), that knowing the "right answer" may already have affected both the observed deflection values and the assessment of their uncertainties. If so, the verification process itself gradually becomes ever more self-fulfilling.

Preeminent as a theoretical source of error must be considered the velocity of light c'' relative to the Sun. Velocity of light determinations are necessarily of the "two-way" type; only such determinations can avoid the uncertainties associated with the time of emission and reception at two different and other wise noncommunicating points. Distant light deflection measurements such as we can use are necessarily of the "one-way" type, in which c'' rather than c is the correct value to use. An additional theoretical source of error is the universal age effect, the term $\delta T/T$, which is totally ignored in general relativity and the current analysis of observation. Other theoretical sources of error are more difficult to evaluate. Preeminent as a practical source of error, and the first to be discounted before further consideration, is the still unknown contribution of solar refraction.

When ρ is only marginally larger than unity, the deflection becomes far too small to be measurable, but the problem transforms over to the Pound-Rebka phenomenon. Then,

$$1 - \rho^{-1} = 1 - r_o H^{-1} = \delta H[r_o(1 + \delta H/r_o)]^{-1},$$

$$\delta m/m_o \cong [1 - 2Gm/r_o c''^2]^{-1} \cdot (2GM/r_o^2 c''^2) \cdot \delta H\,(1 - \delta H/r_o)$$

$$\cong 2g\delta H/c^2\,(1 + 2Gm/r_o c^2 - \delta H/H,),$$

$$\delta E/E \cong (\delta m)c^2/mc^2 \cong 2g\delta H/c^2,$$

suggesting that in conformity with the measured solar deflection of light is the Earthian blueshifting value of 2.18×10^{-16}, twice the theoretical value allowed for by the current interpretation (see p. 61). Conversely, in view of a cosmologically fixed absolute light velocity, the gravitational redshifting is not due to retardation as such. (As already discussed, the effect of their attraction upon the relative velocity of star-photon does not have practical significance; the more massive the star, the even less significant the effect). Rather, it is due to the transfer of mass and energy from the photon to the field. This transfer, obviously, is proportional to the field strength. Thus, gravitational redshifting has nothing to do with the relativistic motion of frames*.

NOTE ADDED TO ADDENDUM Vll

The "similarity" of the present treatment to that of general relativity is only apparent: General relativity begins with a pure *mathematical* concept, the *complex* continuum (x,y,z, ict) which it postulates as a *physical* continuum (and calls it the "field" and "spacetime"); it then works out its "curvature" (another *mathematical* concept) and *quite arbitrarily postulates it as objectively equivalent to the physical quantity of mass*, and then *relies* upon the success of its predictions in the real world to justify ex post facto the validity of this entire purely theoretical procedure, without ever bothering to supply the *epistemological* connection between the purely mathematical initial theoretical premises and the real world.

The present work does *not* regard the field as a continuum but only as a composite at any point within the volume of the Universe of the effects of *all* matter in the Universe; it regards matter as *intrinsically granular though of varying geometrical "grain" size*. In relativity, the photon remains massless, its "materiality" is only "virtual" (meaning that the photon can under certain *unspecified* con-

* Thus, of the three effects explained by general relativity, unaccounted for remains only the question of planetary precession. Application of the ideas developed in this Addendum to the elliptical orbit of the planet involves the age of the Universe at the moments of aphelion and perihelion, their distance from the Sun, the velocity there of the planet and, in view of the universal expansion, a modification of Kepler's second law. The orbit does not close but spirals and precesses. However, even in the case of Mercury, a comparison with the observed precession is still not possible, because, the latter includes the effects of the other planets and the uncertainties of the observed orbit are too great to ignore.

ditions "somehow" condense into matter): the mechanism of the transition from "virtuality" to *Reality remains totally unexplained and mysterious*, yet passes as the quintessence of Science, not just by people who have never attempted to see through it, but even by the "experts" who *cunningly hide in it their unconfessed pseudo-"philosophical" inclinations for what they never stop calling the meaninglessness of all that exists*!

In this work, the photon *is* the carrier of mass. In relativity, motion and velocity is referred only to *arbitrary* frames; the relation of the physically concrete quantity of energy to the *apparent* (and possibly physically *unreal*) velocity of motion as seen from such frames is *never* satisfactorily explained. In this work, all motion is referred ultimately to the center of the Universe; relative to that center, *at which alone the sum of all momentum vectors constantly through not just time but the physically real age of the Universe sum up to zero*, velocities remain always real and so do the energies corresponding to them; real velocity changes call for real changes in energy and thus for the real addition or subtraction of real photons, sole carries of mass and energy, to or from the moving bodies; the existence of photons in the field is thus *mandated* both by the Reality and the Logic. It appears logical to expect that when bodies accelerate by their gravity, which is a *real* phenomenon and *not* a mere appearance, *real* photons in the field act to bring them together. How this is done, in other words, the materialization of the mechanism

$$\text{(Real Particles)} + \text{(General Pure Law)} \rightarrow \text{(a Real Physical Interaction)}, \quad \text{(a)}$$

the ultimate *mechanism, other than Law*, operating in Nature (see Sect. 4.4. and 4.5), *making the Universe to be both gravitating and expanding*, is the final physically (i.e. scientifically) unresolvable question, *in the face of the existence of both Particles and General Pure Law, that is now totally beyond question*.

From here on we proceed by Logic honoring the strictest unforgiving Logos alone!: *Raw* particles operating under *Law* is what the physical sciences study. We *cannot* ignore the Law! *Nor, on the singular evidence of the Universe, the Lawgiver Who established the Law*, unless we demonstrate *even one* operating law that established itself! The ultimate Real Physical Interaction is the Cosmos-Universe, in the Greek and Latin meaning of these *not in the least meaningless* words. Ergo, it follows that the Lawgiver undertook the real pains of the entire Creation comprising the above in (a) in order to provide (as *any self-respecting lesser lawgiver does*) the *complete* means for attaining the Purpose of it all:

$$\text{(such Particles)} + \text{(such Law)} \rightarrow \text{(a Real Physical Interaction)} \Rightarrow \text{Purpose}. \quad \text{(b)}$$

I say that, *no* lesser Purpose is worthy of the Lawgiver than *terminal* Holiness! The Universe, best speaker of its own Creator, is *not* here for anything less! *Thus* do I complete bridging the abyss seemingly separating Science and Theology! If *anyone,* "scientist", "theologian", "layman" has a yet higher Purpose in mind, *now* is the time to submit it for examination, providing *also* his *full Logical* consideration of it! Emotional, psychological and crass material considerations *are* excluded, for it is *they* that have brought us to the brink! Let us at last pay our respects to Logos! And have the Manly dignity to confess Him in public!

GENERAL INDEX