GALILEAN ELECTRODYNAMICS

Experience, Reason, and Simplicity Above Authority
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CONTENTS

EDITORIAL POLICY

Galilean Electrodynamics aims to publish high-quality scientific papers that discuss challenges to accepted orthodoxy in physics, especially in the realm of relativity theory, both special and general. In particular, the journal seeks papers arguing that Einstein's theories are unnecessarily complicated, have been confirmed only in a narrow sector of physics, lead to logical contradictions, and are unable to derive results that must be postulated, though they are derivable by classical methods.

The journal also publishes papers in areas of potential application for better relativistic underpinnings, from quantum mechanics to cosmology. We are interested, for example, in challenges to the accepted Copenhagen interpretation for the predictions of quantum mechanics, and to the accepted Big-Bang theory for the origin of the Universe.

On occasion, the journal will publish papers on other less relativity-related topics. But all papers are expected to be in the realms of physics, engineering or mathematics. Non-mathematical, philosophical papers will generally not be accepted unless they are fairly short or have something new and outstandingly interesting to say.

The journal seeks to publish any and all new and rational physical theories consistent with experimental fact. Where there is more than one new theory that meets the criteria of consistency with experiment, faultless logic and greater simplicity than orthodoxy offers, none will be favored over the others, except where Ockham's razor yields an overwhelming verdict.

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Short papers are preferred over long papers of comparable quality. Shortness often correlates with clarity; papers easily understandable to keen college seniors and graduate students are given emphatic preference over esoteric analyses accessible to only a limited number of specialists. For many reasons, short papers may pass review and be published much faster than long ones.

The journal also publishes correspondence, news notes, and book reviews challenging physics orthodoxy. Readers are encouraged to submit interesting and vivid items in any of these categories.

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From the Editor: What is this Special Issue?

This Special Issue was incorporated into our 2006 publication schedule after the beginning of the subscription year, and is distributed free to our subscribers, like the third Special Issue of 2005 was. These occasional extra Special Issues represent GED's response to the importance of current information being presented to us, plus the availability of adequate means to produce them, saved up over a period of several years, mostly due to improved desktop-publishing technology.

The theme here is recognition of, and possible resolution of, gaps and inconsistencies in our current understanding of gravity and cosmology. Things do not quite hang together in these areas of science, as we know them today.

The Santilli article provided the precipitating nucleus for the formation of this GED Special Issue. The other authors had been waiting, and I had been stewing too, for quite some time. After you read everything else, please read more From the Editor: 'The Editor's Agenda Concerning Gravity', page 60.

C.K.W.

And now, a letter from our files:

Inconsistancies in the Comological Concept of the Origin of the Universe

It is presently believed that the Universe originated at a single timeless, dimensionless point of origin 2×10^{10} years ago [1-4]. The first physical entity present is thought to have been radiation. There is no statement as to whether the radiation appeared, or, alternatively, preexisted at the single point. But it is clear that no natural entity could exist at a timeless, dimensionless point if this entity provided the means whereby either dimensions or time could be measured. For its existence, radiation requires spatial dimensions, for wavelength, and time, for frequency. It follows that radiation could not pre-exist at a timeless, dimensionless point of origin. The alternative is that radiation is a product of time and space, and is formed from these after they came into existence. This is a concept without proof.

In any case, it is held that radiation came into existence before matter and gravitation. Since matter and radiation exchange according to the Heisenberg Uncertainty Principle, matter is said to have formed from radiation. The first element formed would have been hydrogen. The formation of hydrogen atoms requires the presence of Coulombic force. The origin of this force is unexplained within the model.

When first produced, the hydrogen is supposed to have been uniformly distributed within the forming space. As a result, there were no isolated masses of hydrogen to exert gravitation independent of other masses. Unless it is postulated and proved that gravitational gradients existed in the forming space, the accretion of hydrogen under the conditions of uniform distribution could only have taken place under the gravitational attraction exerted by individual atoms of hydrogen. The mass of a hydrogen atom is concentrated in the proton. Taking the radius of a proton as approximately that of a neutron, whose radius has been evaluated as 0.87 ± 0.02 fm, and inserting this into the formula appropriate for describing the escape velocity of one body of matter from another, one finds a value for the escape velocity of 1.57×10^{-7} cm/sec for hydrogen atoms from hydrogen atoms.

(continued on page 52)

Nine Theorems of Inconsistency in GRT with Resolutions via *Isogravitation*

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This paper presents nine inconsistency theorems for general relativity theory (GRT), and shows that they ultimately originate from the use of Riemannian curvature and the abandonment of universal invariance (which is stronger than the customary covariance). These features cause GRT to be non-canonical at the classical level and non-unitary at the operator level, resulting under time evolution in catastrophic structural problems, such as lack of invariant basic measurement units, loss of stable numerical predictions, absence of reliable observables, *etc*. The nine inconsistency theorems are re-inspected via *isotopic* methods and the related new theory of gravitation known as *isogravitation*. This new theory offers swift and simple resolutions for all the inconsistencies identified in GRT.

1. Introduction

It is well known that electroweak theories have an outstanding scientific consistency (see, *e.g.*, Refs. [1]), but, despite attempts dating back to Einstein, the achievement of a grand unification with the inclusion of gravity as represented by general relativity theory (GRT) [2] has remained elusive.

Previously published works [3] have pointed out a number of axiomatic inconsistencies of grand unifications in the representation of matter, as well as of antimatter, whenever gravity is represented via curvature in a Riemannian space. These include:

1) The admission by electroweak interactions of the fundamental Poincaré symmetry, compared to the absence of a symmetry for any Riemannian treatment of gravitation, in favor of the well known covariance;

2) The essentially flat, thus canonical, structure of electroweak interactions, compared to the curved, thus non-canonical, structure of Riemannian gravitation, with resulting non-unitary character of quantum gravity and related well-known problems of consistency;

3) The admission by electroweak interactions of negative-energy solutions for antimatter, as compared to the strict absence of negative energies for any Riemannian treatment of gravitation.

An axiomatically consistent grand unification was then attempted in Refs. [3] via the iso-Minkowskian representation of gravity [4] because: **i)** iso-Minkowskian gravity admits a symmetry for matter that is isomorphic to the Poincaré symmetry, thus resolving inconsistency 1); **ii)** iso-Minkowskian gravity replaces the Riemannian curvature with a covering notion compatible with the flatness of electroweak theories, thus resolving inconsistency 2); and **iii)** inconsistency 3) is resolved via the isodual theories of antimatter [5], including the isodual iso-Minkowskian geometry [5g] that permits negative-energy solutions for the gravitational field of antimatter.

The present work presents a critical analysis of the axiomatic foundations of GRT via the study of nine theorems dealing with inconsistencies so serious as to be at times known as 'catastrophic'; that is, apparently requiring the abandonment of the representation of gravity via curvature in favor of broader views.

2. SRT Consistency and Limitations

Thanks to historical contributions by Lorentz, Poincaré, Einstein, Minkowski, Weyl, and others (see, *e.g.*, the historical accounts [2f, 2g]), special relativity theory (SRT) achieved a majestic axiomatic and physical consistency. After a century of studies, we can safely identify the origins of this consistency in the following crucial properties:

1) SRT is formulated in the Minkowski spacetime $M(x,\eta,R)$ with local spacetime coordinates, metric, line element and basic unit given respectively by

$$x=\{x^\mu\}=(r^k,t),\ k=1,\ 2,\ 3,\ \mu=1,\ 2,\ 3,\ 0,\ c_0=1 \tag{2.1a}$$

$$\eta=\text{Diag.}(1,\ 1,\ 1,\ -1) \tag{2.1b}$$

$$(x-y)^2=(x^\mu-y^\mu)\times\eta_{\mu\nu}\times(x^\nu-y^\nu) \tag{2.1c}$$

$$I=\text{Diag.}(1,\ 1,\ 1,\ 1) \tag{2.1d}$$

over the field of real numbers R, where we identify the conventional associative multiplication with the symbol $\times$ in order to distinguish it from the numerous additional multiplications used in the studies herein considered [3-10];

2) All laws of SRT, beginning with the above line element, are *invariant* (rather than covariant) under the fundamental *Poincaré symmetry*

$$\mathcal{P}(3.1)\ =\mathcal{L}(3.1)\times\mathcal{T}(3.1) \tag{2.2}$$

where $\mathcal{L}(3.1)$ is the *Lorentz group* and $\mathcal{T}(3.1)$ is the *Abelian group of translations* in spacetime; and

3) The Poincaré transformations are *canonical* at the classical level and *unitary* at the operator level, with implications crucial for physical consistency, such as the invariance of the assumed basic units (as per the very definition of a canonical or unitary transformation),

$$\mathcal{P} \times [\text{Diag.}(1\text{ cm},\ 1\text{ cm},\ 1\text{ cm},\ 1\text{ sec})] \times \mathcal{P}^{\text{tr}} \equiv \text{Diag.}(1\text{ cm},\ 1\text{ cm},\ 1\text{ cm},\ 1\text{ sec}) \tag{2.3}$$

with the resulting fundamental property that *SRT admits basic units and numerical predictions that are invariant in time*. In fact, the quantities characterizing the dynamical equations are the *Casimir invariants* of the Poincaré symmetry.

As a result of the above features, special relativity has been and can be confidently applied to experimental measurements because the units selected by the experimenter do not change in time, and the numerical predictions of the theory can be tested at any desired time under the same conditions without fear of internal axiomatic inconsistencies.

Despite these historical results, it should be stressed that, as is the fate for all theories, *SRT has its own well-defined limitations*. To begin, even within the indicated conditions of its original conception, SRT may well result not to be uniquely applicable due to its apparent biggest limitation, the inability to admit an absolute reference frame associated to the *ether* as a universal medium needed for the characterization and propagation of electromagnetic waves.

In fact, not only do electromagnetic waves need the ether for their existent formulation, but also elementary particles, such as the electron, are known to be mere oscillations of said universal medium. Rather than being forgotten just because vastly ignored, the issue of the privileged reference frame, and its relationship to the reference frames of our laboratories, is more open than ever, and may eventually force the use of an alternative formulation of SRT.

SRT is also inapplicable for the *classical treatment of antiparticles*, as shown in detail in Ref. [5g] and monograph [7f]. This is essentially due to the existence of only one quantization channel. Therefore, the quantization of a classical antiparticle characterized by special relativity (essentially that via the sole change of the sign of the charge) clearly leads to a quantum 'particle' with the wrong sign of the charge, and definitely not to the appropriate charge-conjugated state, resulting in endless inconsistencies.

At any rate, the insufficiency of SRT for the classical treatment of antimatter can be seen from the absence of any distinction between neutral particles and their antiparticles, a feature that propagates at the gravitational level, resulting in the current, virtually complete absence of quantitative studies as to whetehr distant (neutral) galaxies and quasars are made up of matter or of antimatter.

In fact, the achievement of the correct antiparticle at the quantum level has required the construction of the new *isodual mathematics* as an anti-isomorphic image of conventional mathematics, including its own *isodual quantization* and, inevitably, the construction of the new *isodual SRT* (for brevity, see Ref. [7d] and quoted literature). In this case, the isodual characterization of a classical antiparticle does indeed lead, under the isodual (rather than conventional) quantization, to the correct antiparticle as a charge conjugated state.

Special relativity has also been shown to be *inapplicable* (rather than violated) for the treatment of both, particles and antiparticles, such as hadrons, represented as they are in physical reality: extended, generally non-spherical and deformable (such as protons or antiprotons), particularly when interacting at very short distances. In fact, these conditions imply the mutual penetration of the wave-packets and/or the hyper-dense media constituting the particles, resulting in non-local integro-differential interactions that cannot be entirely reduced to potential interactions among point-like constituents

The historical inability of SRT to represent irreversible processes should also be recalled, and identified in the reversibility of the mathematical methods used by SRT, the reversibility in time of its basic axioms being a mere consequence. An additional field of inapplicability of SRT is that for all biological entities, since the former can only represent perfectly rigid and perfectly reversible, thus eternal structures, while biological entities are notoriously deformable and irreversible, having a finite life.

Mathematical studies of these aspects can be found in Refs. [6], while comprehensive treatments appear in Refs. [7] (Ref. [7e} in particular). For independent works, see Refs. [8-10]).

It should be stressed that the above issues are not of purely academic interest, because they have a direct societal relevance in view of the increasingly cataclysmic climactic events facing mankind, with resulting need of new clean energies and fuels.

In fact, it is well known that, beginning from the combustion of carbon dating back to prehistoric ages, *all energy-releasing processes are irreversible*. Hence, the continued restriction of research on manifestly irreversible processes to verify a manifestly reversible theory, such as SRT, may jeopardize the orderly search for new clean energies and fuels, thus mandating the laborious search for a suitable irreversible covering of SRT [7e].

Note that the use of the words 'violation of special relativity' here would be inappropriate because SRT was specifically conceived for *point-like particles (and not antiparticles) moving in vacuum solely under retarded action-at-a-distance interactions* [2f]. As a matter of fact, antiparticles were still unknown at the time of the conception and construction of SRT. Similarly, states of deep mutual penetrations of extended hadrons, as occurring in the core of neutron stars or black holes, where simply unthinkable at the inception of special relativity.

3. GRT Inconsistencies due to Lack of Sources

Despite its widespread popular support, *GRT* has without doubt been, in contrast to SRT, the most controversial theory of the 20-th century. This Section and the next review some of the major mathematical, theoretical, and experimental inconsistencies of GRT, all published in the refereed technical literature, yet generally ignored by scientists in the field.

There exist subtle distinctions between 'Einstein's Gravitation', 'Riemannian formulation of gravity' and 'GRT' as it is used. For our needs, we here define *Einstein's gravitation* as the reduction of exterior gravitation in vacuum to pure geometry; namely, gravitation is solely represented via curvature in a Riemannian space $\mathcal{R}(x, g, R)$ with spacetime coordinates (2.1a) and a nowhere-singular, real-valued, and symmetric metric $g(x)$ over the reals R, with field equations [2b,2c]

$$G_{\mu\nu} = R_{\mu\nu} - g_{\mu\nu} \times R/2 = 0 \tag{3.1}$$

The right hand side is zero: as a central condition for Einstein's gravitation, *for a body with null total electromagnetic field (i.e null total charge and null magnetic moment) in vacuum, there are no sources for the exterior gravitational field*.

For our needs, we define as GRT any description of gravity on a Riemannian space over the reals with Einstein-Hilbert field equations, with a source due to the presence of electric and magnetic fields:

$$G_{\mu\nu} = R_{\mu\nu} - g_{\mu\nu} \times R / 2 = kt_{\mu\nu} \tag{3.2}$$

Here k is a constant depending on the selected unit whose value is here irrelevant. For the scope of this paper it is sufficient to assume that the *Riemannian description of gravity* coincides with GRT according to the above definition.

In the following, we shall first study the inconsistencies of Einstein gravitation; that is, first the inconsistencies in the entire reduction of gravity to curvature without source, and then the inconsistency of GRT; that is, the inconsistencies caused by curvature itself, even in the presence of sources.

It should be stressed that a technical appraisal of the content of this paper can be reached only following the study of the axiomatic inconsistencies of grand unified theories of electroweak and gravitational interactions whenever gravity is represented with curvature on a Riemannian space, irrespective of whether with or without sources [3].

THEOREM 1 [11a]: Einstein's gravitation and GRT at large are incompatible with the electromagnetic origin of mass established by quantum electrodynamics, and thus they are inconsistent with experimental evidence.

Proof. Quantum electrodynamics has established that the mass of all elementary particles, whether charged or neutral, has a primary electromagnetic origin; that is, all masses have a first-order origin given by the volume integral of the 00-component of the energy-momentum tensor $t_{\mu\nu}$ of electromagnetic origin,

$$m = \int d^4x \times t_{00}^{\mathrm{elm}} \tag{3.3a}$$

$$t_{\alpha\beta} = \frac{1}{4\pi}\left(F_{\alpha}^{\mu} F_{\mu\beta} + \frac{1}{4} g_{\alpha\beta} F_{\mu\nu} F^{\mu\nu}\right) \tag{3.3b}$$

where $t_{\alpha\beta}$ is the *electromagnetic tensor*, and $F_{\alpha\beta}$ is the *electromagnetic field* (see Ref. [11a] for explicit forms of the latter with retarded and advanced potentials).

Therefore, quantum electrodynamics requires the presence of a *first-order source tensor* in the *exterior field equations* in vacuum, as in Eqs. (3.2). Such a source tensor is by conception absent from Einstein's gravitation (3.1). Consequently, Einstein's gravitation is incompatible with quantum electrodynamics.

The incompatibility of GRT with quantum electrodynamics is established by the fact that the source tensor in Eqs. (3.2) is of *higher order in magnitude*, thus being ignorable in first approximation with respect to the gravitational field, while according to quantum electrodynamics, said source tensor is of first order, thus not being ignorable in first approximation.

The inconsistency of both Einstein's gravitation and GRT is finally established by the fact that, for the case when the total charge and magnetic moment of the body considered are null, Einstein's gravitation and GRT allow no source at all. By contrast, as illustrated in Ref. [11a], quantum electrodynamics requires a first-order source tensor even when the total charge and magnetic moments are null due to the charge structure of matter. **q.e.d**.

The first consequence of the above property can be expressed via the following:

COROLLARY 1A [11a]: Einstein's reduction of gravitation in vacuum to pure curvature without source is incompatible with physical reality.

A few comments are now in order. As is well known, the mass of the electron is entirely of electromagnetic origin, as described by Eq. (3.3), therefore requiring a first-order source tensor in vacuum as in Eqs. (3.2). Therefore, Einstein's gravitation for the case of the electron is inconsistent with Nature. Also, the electron has a point charge. Consequently, *the electron has no interior problem at all, in which case the gravitational and inertial masses coincide*,

$$m_{\mathrm{electron}}^{\mathrm{grav.}} \equiv m_{\mathrm{electron}}^{\mathrm{iner.}} \tag{3.4}$$

Next, Ref. [11a] proved Theorem 1 for the case of a neutral particle by showing that the π^0 meson also needs a first-order source tensor in the exterior gravitational problem in vacuum since its structure is composed of one charged particle and one charged antiparticle in highly dynamic conditions.

In particular, the said source tensor has such a large value to account for the entire *gravitational mass* of the particle [11a]

$$m_{\pi^0}^{\mathrm{grav.}} = \int d^4x \times t_{00}^{\mathrm{elm}} \tag{3.5}$$

For the case of the interior problem of the π^0, we have the additional presence of short-range weak and strong interactions, representable with a new tensor $\tau_{\mu\nu}$. We, therefore, have the following:

COROLLARY 1B [11a]: In order to achieve compatibility with electromagnetic, weak and strong interactions, any gravitational theory must admit two source tensors, a traceless tensor for the representation of the electromagnetic origin of mass in the exterior gravitational problem, and a second tensor to represent the contribution to interior gravitation of the short range interactions according to the field equations

$$G_{\mu\nu}^{\mathrm{int.}} = R_{\mu\nu} - g_{\mu\nu} \times R / 2 = k \times \left(t_{\mu\nu}^{\mathrm{elm}} + \tau_{\mu\nu}^{\mathrm{short\ range}}\right). \tag{3.6}$$

A main difference between the two source tensors is that the electromagnetic tensor $t_{\mu\nu}^{\mathrm{elm}}$ is notoriously traceless, while the second tensor $\tau_{\mu\nu}^{\mathrm{short\ range}}$ is not. A more rigorous definition of these two tensors will be given shortly.

It should be indicated that, for a possible solution of Eqs. (3.6), various explicit forms of the electromagnetic fields, as well as of the short range fields originating the electromagnetic and short-range energy momentum tensors, are given in Ref. [11a].

Since both source tensors are positive-definite, Ref. [11a] concluded that the interior gravitational problem characterizes the *inertial mass* according to the expression

$$m^{\text{iner}} = \int d^4x \times \left(t_{00}^{\text{elm}} + \tau_{00}^{\text{short range}}\right) \tag{3.7}$$

with the resulting general law

$$m^{\text{inert.}} \geq m^{\text{grav.}} \tag{3.8}$$

where the equality solely applies for the electron.

Finally, Ref. [11a] proved Theorem 1 for the exterior gravitational problem of a neutral massive body, such as a star, by showing that the situation is essentially the same as that for the π^0. The sole difference is that the electromagnetic field requires the sum of the contributions from *all* elementary constituents of the star,

$$m_{\text{star}}^{\text{grav.}} = \sum_{p=1,2,\ldots} \int d^4x \times t_{p00}^{\text{elem.}} \tag{3.9}$$

In this case, Ref. [11a] provided methods for the approximate evaluation of the sum that resulted to be of first-order also for stars with null total charge.

When studying a charged body, there is no need to alter Eqs. (3.6), since that particular contribution is automatically contained in the indicated field equations.

Once the incompatibility of GRT at large with quantum electrodynamics has been established, the interested reader can easily prove the incompatibility of GRT with quantum field theory and quantum chromodynamics, as implicitly contained in Corollary 1B.

An important property, apparently first reached in Ref. [11a] in 1974, is the following:

COROLLARY 1C [11a]: The exterior gravitational field of a mass originates entirely from the total energy-momentum tensor (3.3b) of the electromagnetic field of all elementary constituents of said mass.

In different terms, a reason for the failure to achieve a 'unification' of gravitational and electromagnetic interactions, initiated by Einstein himself, is that the said interactions can be 'identified' with each other, and, as such, they cannot be unified. In fact, in all unifications attempted until now, the gravitational and electromagnetic fields preserve their identity, and the unification is attempted via geometric and other means resulting in redundancies that eventually cause inconsistencies.

Note that conventional electromagnetism is represented with the tensor $F_{\mu\nu}$ and related Maxwell's equations. When electromagnetism is identified with exterior gravitation, it is represented with the energy-momentum tensor $t_{\mu\nu}$ and related Eqs. (3.6).

In this way, *gravitation results as a mere additional manifestation of electromagnetism*. The important point is that, besides the transition from the field tensor $F_{\mu\nu}$ to the energy-momentum tensor $T_{\mu\nu}$, there is no need to introduce a new interaction to represent gravity.

Note finally the irreconcilable alternatives emerging from the studies herein considered:

ALTERNATIVE I. Einstein's gravitation is assumed as being correct, in which case quantum electrodynamics must be revised in such a way as to avoid the electromagnetic origin of mass; or

ALTERNATIVE II: Quantum electrodynamics is assumed as being correct, in which case Einstein's gravitation must be irreconcilably abandoned in favor of a more adequate theory.

By remembering that quantum electrodynamics is one of the most solid and experimentally verified theories in scientific history, it is evident that the rather widespread assumption of Einstein's gravitation as having final and universal character is nonscientific.

THEOREM 2 [11b,7d]: Einstein's gravitation (3.1) is incompatible with the Freud identity of the Riemannian geometry, thus being inconsistent on geometric grounds.

Proof. The Freud identity [11b] can be written

$$\begin{aligned} R_\beta^\alpha - \tfrac{1}{2} \times \delta_\beta^\alpha \times R - \tfrac{1}{2} \times \delta_\beta^\alpha \times \Theta \\ = U_\beta^\alpha + \partial V_\beta^{\alpha\rho} / \partial x^\rho = k \times (t_\beta^\alpha + \tau_\beta^\alpha) \end{aligned} \tag{3.10}$$

where

$$\Theta = g^{\alpha\beta} g^{\gamma\delta} \left(\Gamma_{\rho\alpha\beta}\Gamma_{\gamma\beta}^\rho - \Gamma_{\rho\alpha\beta}\Gamma_{\gamma\delta}^\rho\right) \tag{3.11a}$$

$$U_\beta^\alpha = -\frac{1}{2} \frac{\partial\Theta}{\partial g_\rho^{\rho\alpha}} g^{\gamma\beta} \uparrow_\gamma \tag{3.11b}$$

$$\begin{aligned} V_\beta^{\alpha\rho} = \frac{1}{2}\Big[g^{\gamma\delta}\left(\delta_\beta^\alpha \Gamma_{\gamma\delta}^\rho - \delta_\beta^\rho \Gamma_{\gamma\delta}^\alpha\right) + \\ + \left(\delta_\beta^\rho g^{\alpha\gamma} - \delta_\beta^\alpha g^{\rho\gamma}\right)\Gamma_{\gamma\delta}^\delta + g^{\rho\gamma}\Gamma_{\beta\gamma}^\alpha - g^{\alpha\gamma}\Gamma_{\beta\gamma}^\rho \Big] \end{aligned} \tag{3.11c}$$

Therefore, the Freud identity requires two first order source tensors for the exterior gravitational problems in vacuum, as in Eqs. (3.6) of Ref. [11a]. These terms are absent in Einstein's gravitation (3.1) that, consequently, violates the Freud identity of the Riemannian geometry. **q.e.d.**

By noting that trace terms can be transferred from one tensor to the other in the r.h.s. of Eqs. (3.10), it is easy to prove the following:

COROLLARY.2A [7d]: Except for possible factorization of common terms, the t - and τ -tensors of Theorem 2 coincide, respectively, with the electromagnetic and short range tensors of Corollary 1B.

A few historical comments regarding the Freud identity are in order. It has been popularly believed throughout the 20-th century that the Riemannian geometry possesses only *four identities* (see, *e.g.*, Ref. [2h]). In reality, Freud [11b] identified in 1939 a *fifth identity* that, unfortunately, was not aligned with Einstein's doctrines and, as such, the identity was virtually ignored in the entire literature on gravitation of the 20-th century.

However, as repeatedly illustrated by scientific history, structural problems simply do not disappear with their suppression, and actually grow in time. In fact, the Freud identity did not escape Pauli, who quoted it in a footnote of his celebrated book of 1958 [2g]. The present author became aware of the Freud identity via an accurate reading of Pauli's book (including its important footnotes), and assumed the Freud identity as the geometric foundation of the gravitational studies presented in Ref. [7d].

Subsequently, in his capacity as Editor in Chief of **Algebras, Groups and Geometries**, the present author requested the mathematician Hanno Rund, a known authority in Riemannian geometry [2i], to inspect the Freud identity for the purpose of ascertaining whether the said identity was indeed a new identity. Rund kindly accepted Santilli's invitation and released paper [11c] of 1991 (the last paper prior to his departure) in which Rund indeed confirmed the character of Eqs. (3.10) as a genuine, independent, fifth identity of the Riemannian geometry.

The Freud identity was also rediscovered by Yilmaz (see Ref. [11d] and papers quoted therein), who used the identity for his own broadening of Einstein's gravitation via an external *stress-energy tensor* that is essentially equivalent to the source tensor with non-null trace of Ref. [11a], Eqs. (3.6).

Despite these efforts, the presentation of the Freud identity to various meetings and several personal mailings to colleagues in gravitation, the Freud identity continues to remain generally ignored to this day, with very rare exceptions (Contact by colleagues concerning additional studies on the Freud identify not quoted herein would be gratefully appreciated.)

Theorems 1 and 2 complete the presentation on the catastrophic inconsistencies of Einstein's gravitation due to the lack of a first-order source in the exterior gravitational problem in vacuum. Theorems 1 and 2 by no means exhaust all inconsistencies of Einstein's gravitation, and numerous additional inconsistencies do indeed exist. For instance, Yilmaz [11d] has proved that Einstein's gravitation explains the 43" of the precession of Mercury, but cannot explain the basic Newtonian contribution. This result can also be seen from Ref. [11a] because the lack of source implies the impossibility of importing into the theory the basic Newtonian potential. Under these conditions, the representation of the Newtonian contribution is reduced to a religious belief, rather than a serious scientific statement.

For these and numerous additional inconsistencies of GRT we refer the reader to Yilmaz [11d], Wilhelm [11e-11g], Santilli [11h], Alfvén [11i-11j], Fock [11k], Nordensen [11l], and large literature quoted therein.

4. GRT Inconsistencies due to Curvature

We now pass to the study of the structural inconsistencies of GRT caused by the very use of the Riemannian *curvature*, irrespective of the selected field equations, including those fully compatible with the Freud identity.

THEOREM 3 [11m]: Gravitational theories on a Riemannian space over a field of real numbers do not possess time invariant basic units and numerical predictions, thus having serious mathematical and physical inconsistencies.

Proof. The map from Minkowski to Riemannian spaces is known to be *non-canonical,*

$$\eta = \mathrm{Diag.}(1,\ 1,\ 1,\ -1) \to g(x) = U(x)\times\eta\times U(x)^{\dagger} \quad (4.1a)$$

$$U(x)\times U(x)^{\dagger} \neq I \quad (4.1b)$$

Thus, the time evolution of Riemannian theories is necessarily non-canonical, with resulting lack of invariance of the basic units of the theory in time, such as

$$\begin{gathered} I_{t=0} = \mathrm{Diag.}(1\ \mathrm{cm},\ 1\ \mathrm{cm},\ 1\ \mathrm{cm},\ 1\ \mathrm{sec}) \to \\ I'_{t>0} = U_t \times I \times U_t^{\dagger} \neq I_{t=0} \end{gathered} \quad (4.2)$$

The lack of invariance in time of numerical predictions then follows from the known 'covariance', that is, lack of time invariance of the line element. **q.e.d.**

As an illustration, suppose that an experimentalist assumes at the initial time $t=0$ the units 1 cm and 1 sec. Then, all Riemannian formulations of gravitation, including Einstein's gravitation, predict that at the later time $t>0$ said units have a different numerical value.

Similarly, suppose that a Riemannian theory predicts a numerical value at the initial time $t=0$, such as the 43" for the precession of the perihelion of Mercury. One can prove that the same prediction at a later time $t=0$ is numerically different precisely in view of the 'covariance', rather than invariance as intended in special relativity, thus preventing a serious application of the theory to physical reality. We therefore have the following:

COROLLARY 3A [11m]: Riemannian theories of gravitation in general, and Einstein's gravitation in particular, can at best describe physical reality at a fixed value of time, without a consistent dynamic evolution.

Interested readers can independently prove the latter occurrence from the *lack of existence of a Hamiltonian in Einstein's gravitation*. It is known in analytic mechanics (see, *e.g.*, Refs. [2l, 7b]) that Lagrangian theories not admitting an equivalent Hamiltonian counterpart, as is the case for Einstein's gravitation, are inconsistent under time evolution, unless there are suitable subsidiary constraints that are absent from GRT.

It should be indicated that the inconsistencies are much deeper than that indicated above. For consistency, the Riemannian geometry must be defined on the field of numbers $R(n,+,\times)$ that, in turn, is fundamentally dependent on the basic unit I. But the Riemannian geometry does not leave time invariant the basic unit I due to its non-canonical character. The loss in time of the basic unit I then implies the consequential loss in time of the base field R, with consequential catastrophic collapse of the entire geometry [11m].

In conclusion, not only is Einstein's reduction of gravity to pure curvature inconsistent with Nature because of the lack of sources, but also the ultimate origin of the inconsistencies rests in the curvature itself when assumed for the representation of gravity, due to its inherent non-canonical character at the classical level with resulting non-unitary structure at the operator level.

Serious mathematical and physical inconsistencies are then unavoidable under these premises, thus establishing the impossibility of any credible use of GRT, for instance, as an argument against the test on antigravity predicted for antimatter in the field of matter [5], as well as establishing the need for a profound revision of our current views on gravitation.

THEOREM 4: Observations do not verify Einstein's gravitation uniquely.

Proof: All claimed 'experimental verifications' of Einstein's gravitation are based on the PPN 'expansion' (or linearization) of the field equations (such as the post-Newtonian approximation), that, as such, is not unique. In fact, Eqs. (3.1) admit a variety of inequivalent expansions, depending on the selected parameter, the selected expansion and the selected truncation. It is then easy to show that the selection of an expansion of the same equations (3.1) but different from the PPN approximation leads to dramatic departures from experimental values. **q.e.d**.

THEOREM 5: GRT is incompatible with experimental evidence because it does not represent the bending of light in a consistent, unique and invariant way.}

Proof: Light carries energy, thus being subjected to a bending due to the conventional Newtonian gravitational attraction, while Einstein's gravitation predicts that the bending of light is due to curvature (see, *e.g.*, Ref. [2h], Section 40.3). In turn, the absence of the Newtonian contribution causes other inconsistencies, such as the inability to represent the free fall where curvature does not exist (Theorem 6 below). Assuming that consistency is achieved with as yet unknown manipulations, the representation of the bending of light is not unique, because it is based on a nonunique PPN approximation having different parameters for different expansions. Finally, assuming that consistency and uniqueness are somewhat achieved, the representation is not invariant in time due to the noncanonical structure of GRT.

THEOREM 6. GRT is incompatible with experimental evidence because of the lack of consistent, unique and invariant representation of the free fall of test bodies along a straight radial line without curvature.

Proof: a consistent representation of the free fall of a mass along a straight radial line requires that the Newtonian attraction be represented the field equations necessarily without curvature, thus disproving the customary belief that said Newtonian attraction emerges at the level of the post-Newtonian approximation. **q.e.d.**

The absence from GRT at large, thus including Einstein's gravitation, of well defined contributions due to the Newtonian attraction and to the assumed curvature of spacetime, and the general elimination of the former in favor of the latter, cause other inconsistencies, such as the inability to represent the base Newtonian contribution in planetary motion as shown by Yilmaz [11d], and other inconsistencies [11e-11m].

A comparison between SRT and GRT is here in order. SRT can safely be claimed 'verified by experiments', because the said experiments verify numerical values uniquely and unambiguously predicted by SRT. By contrast, no such statement can be made for GRT, since the latter does not uniquely and unambiguously predict given numerical values, due, again, to the variety of possible expansions and linearization.

The origin of such a drastic difference is due to the fact that *the numerical predictions of SRT are rigorously controlled by the basic Poincaré invariance. By contrast, one of the several drawbacks of the 'covariance' of GRT is precisely the impossibility of predicting numerical values in a unique and unambiguous way, thus preventing serious claims of true 'experimental verifications' of GRT.*

By no means, the inconsistencies expressed by Theorems 3.1, 3.2, 4.1, 4.2 and 4.3 constitute all inconsistencies of GRT. In the author's opinion, additional deep inconsistencies are caused by the fact that *GRT does not possess a well defined Minkowskian limit*, while the admission of the Minkowski space as a tangent space is basically insufficient on dynamical grounds (trivially, because on said tangent space gravitation is absent).

As an illustration, we should recall the controversy on conservation laws that raged during the 20-th century [11]. Special relativity has rigidly defined total conservation laws because they are the Casimir invariants of the fundamental Poincaré symmetry. By contrast, there exist several definitions of total conservation laws in a Riemannian representation of gravity due to various ambiguities evidently caused by the absence of a symmetry in favor of covariance.

Moreover, none of the gravitational conservation laws yields the conservation laws of SRT in a clear and unambiguous way, precisely because of the lack of any limit of a Riemannian into the Minkowskian space. Under these conditions, the compatibility of GRT with SRT reduces to personal beliefs outside a rigorous scientific process. The above studies can be summarized with the following:

THEOREM 7 [7d]: Gravitational theories on a Riemannian space cannot yield the conventional total conservation laws of SRT in a unique, unambiguous and invariant way due to lack of a unique, unambiguous and invariant Minkowskian limit.

Another controversy that remained unresolved in the 20-th century (primarily because of lack of sufficient consideration by scholars in the field) is that, during its early stages, gravitation was divided into the *exterior and interior problems*. For instance, Schwartzchild wrote *two* articles on gravitation, one on the exterior and one on the interior problem [2d].

However, it soon became apparent that GRT was structurally unable to represent interior problems for numerous reasons, such as the impossibility of incorporating shape, density, local variations of the speed of light within physical media via the familiar law we study in high school $c = c_0 / n$ (which variation cannot be ignored classically), inability to represent interior contact interactions with a first-order Lagrangian, structural inability to represent interior non-conservation laws (such as the vortices in Jupiter's atmosphere with variable angular momenta), structural inability to represent entropy, its increase and other thermodynamic laws, *etc.* (see Ref. [7d] for brevity).

Consequently, Schwartzchild's solution for the *exterior* problem became part of history (evidently because aligned with GRT), while his *interior* solution has remained vastly ignored to this day (evidently because it is not aligned with GRT). In particular, the constituents of all astrophysical bodies have been abstracted as being point-like, an abstraction that is beyond the boundaries of science for classical treatments; all distinctions between exterior and interior problems have been ignored by the vast majority of the vast literature in the field; and gravitation has been tacitly reduced to one single problem.

Nevertheless, as indicated earlier, major structural problems grow in time when ignored, rather than disappearing. The lack of addressing the interior gravitational problem is causing major distortions in astrophysics, cosmology and other branches of science (see also next section). We have, therefore, the following important result:

THEOREM 8 [7d]: GRT is incompatible with the experimental evidence on interior gravitational problems.

By no means does the above analysis exhaust all inconsistencies of GRT, and numerous additional ones do indeed exist, such as that expressed by the following:

THEOREM 9 [11m]: Operator images of Riemannian formulations of gravitation are inconsistent on mathematical and physical grounds.

Proof. As established by Theorem 4.1, classical formulations of Riemannian gravitation are non-canonical. Consequently, all their operator counterparts must be non-unitary for evident reasons of compatibility. But non-unitary theories are known to be inconsistent on both mathematical and physical grounds [11m]. In fact, on mathematical grounds, non-unitary theories of quantum gravity (see, *e.g.*, Refs. [2j, 2k]) do not preserve in time the basic units, fields and spaces, while, on physical grounds, the said theories do not possess time invariant numerical predictions, do not possess time invariant Hermiticity (thus having no acceptable observables), and violate causality. **q.e.d.**

The reader should keep in mind the additional well known inconsistencies of quantum gravity, such as the historical incompatibility with quantum mechanics, the lack of a credible PCT theorem, *etc*. According to the ethics of science, all these inconsistencies should establish beyond a scientific doubt, or any otherwise credible doubt, the need for a profound revision of the gravitational views of the 20-th century.

5. Re-Inspetion of the Inconsistency Theorems via Isotopic Methods

In the author's view, the most serious inconsistencies in GRT are those of *experimental* character, such as the structural impossibility for the Riemannian geometry to permit unique and unambiguous numerical predictions due to the known large degrees of freedom in all PPN expansions; the necessary *absence* of curvature to represent consistently the free fall of bodies along a straight radial line; and the gravitational deflection of light measured until now being purely *Newtonian* in nature.

These inconsistencies are such to prevent serious attempts in salvaging GRT. For instance, if the deflection of the speed of light is re-interpreted as being solely due to curvature without any Newtonian contribution, then GRT admits other catastrophics inconsistencies, such as the inability to represent the Newtonian contribution of planetary motions pointed out by Yilmaz [11d], and other inconsistencies such as those identified by Wilhelm [11e-11g] and other researchers.

When the inconsistencies between GRT and experimental evidence are combined with the irreconcilable incompatibility of GRT with unified field theory and the catastrophics axiomatic inconsistencies due to lack of invariance [11m], time has indeed arrived for the scientific community to admit the need for fundamentally new vistas in our representation of gravitation, without which research is turned from its intended thrilling pursuit of 'new' knowledge to a sterile fanatic attachment to 'past' knowledge.

The nine inconsistency theorems identified in this paper define the axiomatic structure of the needed new gravitational theory, and quite rigidly so, as alternative is known to this author after decades of study. The only possible resolution of said inconsistency theorems requires that a new gravitational theory must satisfy the following requirements:

I. It must possess a single universal symmetry for all possible, interior and exterior gravitational models (to avoid the catastrophic inconsistencies caused by the conventional covariance and other reasons);

II. Said symmetry must be locally isomorphic to the Poincaré symmetry (to assure the true validity of conventional total conservation laws and other reasons); and

III. The new gravitational theory must admit a unique, unambiguous and invariant limit into SRT (as a basic compatibility condition of gravitation with SRT and other reasons).

To our best knowledge, the only new theory of gravitation capable of fulfiling the above conditions and bypassing all nine inconsistency theorems studied in this note (as well as resolve other inconsistencies omitted here for brevity) is that proposed by Santilli in Refs. [4] via the so-called *isotopic methods* (see Refs. [7c-7e] for comprehensive studies and references).

Alternatively, the latter methods provide an effective alternative study of the inconsistency theorems, such as those on total conservation laws (Theorem 7), interior gravitational problems (Theorem 8) and the inconsistencies of quantum gravity (Theorem 9) because the transparent and instantaneous solution provided by the isotopic methods confirms rather forcefully said inconsistency theorems.

The new theory of gravitation identified by the isotopic methods, and known as *isogravitation*, is based on the following simple main assumptions:

1) Factorization of any given (nonsingular) Riemannian metric $g(x)$ into a 4×4-dimensional matrix $\hat{T}(x)=\left\{\hat{T}_{\mu\nu}(x)\right\}$ and the conventional Minkowski metric η, Eq. (2.1b),

$$g(x)=\hat{T}(x)\times\eta \quad ; \tag{5.1}$$

2) Assumption of the inverse of $\hat{T}(x)$ as the new basic unit of the theory in lieu of the conventional Minkowskian unit (2.1c),

$$\hat{I}(x)=\left[\hat{T}(x)\right]^{-1} \quad ; \tag{5.2}$$

3) Reconstruction of the entire mathematical and physical setting of the *Minkowskian* (rather than the Riemannian) geometry in such a way as to admit $\hat{I}(x)$ (rather than I) as the new basic left and right unit at all levels.

Condition (3) is readily verified by lifting the conventional associative product $A\times B$ between two generic quantities A,B into a new product under which $\hat{I}(x)$ is indeed the new right and left unit [12a,4a],

$$A\times B\to A\hat{\times}B=A\times\hat{T}(x)\times B \quad , \tag{5.3a}$$

$$I\times A=A\times I\to\hat{I}\hat{\times}A=A\hat{\times}\hat{I}\equiv A \quad , \tag{5.3b}$$

for all elements A of the set considered.

The above liftings, called *isotopic* because they are axiom-preserving [12a], characterize a new mathematics today known as *Santilli isomathematics* [6], that includes new *isonumbers*, *isofields*, *isospaces*, *isofunctional analysis*, *isoalgebras*, *isogeometries*, *etc*. [7c-7d,10].

Since $\hat{I}(x)$ is positive-definite [from the assumed nonsingularity, the local Minkowskian character and factorization (5.1)], the resulting new spaces, first introduced in Ref. [4a] of 1983 and today known as [10] the *Minkowski-Santilli isospaces* $\hat{M}$, are locally isomorphic to the conventional space M.

Consequently, *the resulting Minkowski-Santilli isogeometry has no curvature, yet it admits all infinitely possible Riemannian line elements*.} Equivalent results can be reached by reformulating Riemannian line elements and related geometry (covariant derivative, Christoffel's symbols, *etc*.) with respect to the new unit $\hat{I}(x)$ (see memoir [4g] for geometric studies).

An important result is the achievement of the universal symmetry for all infinitely possible, locally Minkowskian, interior and exterior Riemannian line elements under the above reformulation, today known in the literature [10] as the Poincarè-Santilli isosymmetry $\hat{P}(3.1)$ (see: [4a,4b] for the first isotopies of the Lorentz symmetry at the classical and operator levels; [4c] for the first isotopies of the rotational symmetry; [4d] for the first isotopies of the SU(2)-spin symmetry; [4e] for the first isotopies of the Poincarè symmetry including the universal invariance of Riemannian line elements; and [4f] for the first isotopies of the spinorial covering of the Poincarè symmetry).

Since, again, $\hat{I}(x) > 0$, the new isosymmetry is locally isomorphic to the conventional one $\hat{P}(3.1) \approx P(3.1)$. In particular, *the generators of* $\hat{P}(3.1)$ *and* $P(3.1)$ *coincide, thus eliminating all controversies on total conservation laws ab initio*} (because, as recalled earlier, the rigorous formulation of conservation laws is that as generator of a symmetry, and certainly not of a covariance).

Moreover, the explicit form of the symmetry transformations (see [4] for brevity) is highly nonlinear, noncanonical and non-Lagrangian in conventional spacetime, yet the theory reconstructs linearity, canonicity and Lagrangian character in the Minkowski-Santilli isospace (for technical reasons interested readers have to study in the specialized literature).

Note the emergence of a unique, unambiguous and invariant limit from gravitational to relativistic settings given by

$$\mathrm{Lim}\ \hat{I}(x) = I \qquad (5.4)$$

under which the entire Minkowskian formulations, including the conventional Poincarè symmetry, are recovered uniquely, identically and invariantly.

The resolution of the inconsistency theorems then follows not only from the elimination of curvature, but actually from a geometric unification of SRT and GRT via the axioms of the special, unification based on the embedding of gravitation where nobody looked for it, in the unit of relativistic theories} [4g].

An axiomatically consistent grand unification inclusive of gravitation is then another direct consequence, but only after working out a consistent *classical* theory of antimatter [3].

Another important consequence is the emergence of an axiomatically consistent operator theory of gravity that is reached, again, via the embedding of gravity in the unit of conventional relativistic quantum mechanics [12b], where consistency is guaranteed by the fact that the new theory is topologically equivalent to the conventional theory.

Intriguingly, Einstein-Hilbert field equations remain valid in the Minkowski-Santilli isogeometry, being merely reformulated via the new isomathematics, plus the addition of first-order sources for compatibility with relativistic treatments, Eqs. (3.6) [4g], and then we shall write in the isotopic form

$$\hat{G}^{\mathrm{int}}_{\mu\nu} = \hat{R}_{\mu\nu} - \hat{T}(x)_{\mu\rho} \times \eta_{\rho\nu} \times \hat{R} / \hat{2} = \hat{k} \hat{\times} \left(\hat{t}^{\mathrm{elm}}_{\mu\nu} + \hat{\tau}^{\mathrm{short\ range}}_{\mu\eta} \right) \qquad (5.5)$$

where 'hat' indicates that the quantities are formulated on isospace over isofields.

The entire content of this paper and Refs. [3.4,12] can be restated by noting that the origin of the century-old controversies on GRT do not appear to be of physical nature, but rather of purely mathematical character because of originating from the treatment of gravitation with conventional mathematics. In fact, under the selection of a new mathematics more appropriate for the study of gravitation, all historical inconsistencies and controversies appear to be resolved while preserving Einstein-Hilbert equations in the reformulation (5.5) computed with respect to unit (5.2), in which case there is no curvature.

Physicists who are discouraged by new mathematics should be aware that the entire formalism of the new gravitation can be constructed very simply via the use of the following noncanonical/nonunitary transform

$$U \times U^{\dagger} = \hat{I}(x) > 0 \quad , \quad \hat{T}(x) = (U \times U^{\dagger})^{-1} > 0 \qquad (5.6)$$

where $\hat{I}(x)$ is the gravitational isounit (5.2), provided that it is applied to the *totality* of the formalism of the Minkowskian geometry, including unit I, numbers $c \in C$, products $A \times B$, functional analysis, metric spaces, Hilbert spaces, algebras, geometries, *etc*., as illustrated below

$$I \rightarrow U \times I \times U^{\dagger} = \hat{I}(x) \quad , \qquad (5.7a)$$

$$c \rightarrow U \times c \times U^{\dagger} = \hat{m} = m \times \hat{I} \quad , \qquad (5.7b)$$

$$A \times B \rightarrow U(A \times B) \times U^{\dagger} = \hat{A} \hat{\times} \hat{B} \quad , etc. \qquad (5.7c)$$

where for any $D = A, B,\ etc.,\ \hat{D} = U \times D \times U^{\dagger}$.

Invariance is easily proved by decomposing any additional noncanonical or nonunitary transforms in the isocanonical or isounitary form [6b],

$$W \times W^{\dagger} = \hat{I} \quad , \quad W = \hat{W} \times \hat{T}^{1/2} \quad , \qquad (5.8a)$$

$$W \times W^{\dagger} \neq I \quad , \quad \hat{W} \hat{\times} \hat{W}^{\dagger} = \hat{W}^{\dagger} \hat{\times} \hat{W} = \hat{I} \qquad (5.8b)$$

under which we have the following fundamental invariances

$$\hat{I} \rightarrow \hat{W} \hat{\times} \hat{I} \hat{\times} \hat{W} \equiv \hat{I} \quad , \qquad (5.9a)$$

$$\hat{A} \hat{\times} \hat{B} \to \hat{W} \hat{\times} (\hat{A} \hat{\times} \hat{B}) \hat{\times} \hat{W}^\dagger = \hat{A}' \hat{\times} \hat{B}' \quad , \; etc. \qquad (5.9b)$$

where $\hat{D}' = \hat{W} \hat{\times} D \hat{\times} \hat{W}^\dagger$, $D = A, B, ...$ and the invariance originates from the preservation of the isoproduct, $\hat{\times}' = \hat{\times}$ (since its change would imply passing from the assigned gravitational model characterized by $\hat{T}(x)$ to a *different}* gravitational model characterized by $\hat{T}'(x)$.)

In the hope of helping colleagues avoid writing papers that cannot stand the test of time, it should be stressed that *all the above results are crucially dependent on the "invariance of the basic gravitational unit"* Eqs. (5.2) and (5.9a). Isomathematics guarantees this invariance because, whether conventional or generalized, the unit is the basic invariant of any theory. This is why the unit (rather than any other quantity) was assumed for the only now-known consistent representation of gravita tion.

The papers that cannot stand the test of time are those identifying a symmetry of Riemannian line elements, without the joint achievement of the invariance of the basic unit, in which case the nine theorems of catastrophic inconsistency due to noncanonical and nonunitary structure [11m] remain in full force and effect, despite the achievement of a symmetry.

To close with an intriguing historical note, Albert Einstein himself could be considered the initiator of the above isotopic formulation of gravity, because of his historical doubt on the *lack of completion of quantum mechanics}* [2m]. In fact, as illustrated in Eqs. (5.6)-(5.9), *the isotopic isotopic lifting of relativistic quantum mechanics, known as hadronic mechanics [3-12] and related gravitational content, is nothing but a completion via a nonunitary transform* (for the relationship of isotopies with the E-P-R argument, hidden variables, Bell's inequality, and related matters, see Ref. [12f]).

Needless to say, studies on the latter reformulation are only at their beginning, and so much remains to be done. It is hoped that some of the open problems can be treated in a follow-up paper.

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Inconsistancies in the Comological Concept of the Origin of the Universe.

continued from page 42

From kinetic theory of gases the mean velocity of the gaseous hydrogen atoms at the present cosmic background temperature of 2.735°K is 2.38×10^4 cm/sec. These values show that hydrogen atoms will only accrete under gravity at a temperature of the order 10^{-11} °K. This is in direct contradiction to the concept of the origin of the Universe at a single point at which the initial radiation temperature has been given as 10^{12} °K and that the present Universe is cooling from this initial temperature. The result is that there could never have been a time or any part of space where the temperature required for accretion existed. Any accretion process also could not have involved the release of any potential energy that appeared as radiant energy, since such energy would have been absorbed by the atoms present. This would have produced a rise in the background temperature, increasing the mean velocity and causing the accretion process to be arrested.

The only alternatives to the above position are that kinetic theory is not applicable to atoms, or that kinetic theory of gases is not applicable at low temperatures. The former possibility is certainly not the case, since Otto Stern and others used silver atoms to verify the kinetic theory. The latter possibility is unproven. Thus the situation of hydrogen being the original matter of the Solar System cannot be said to have led to the formation of the Sun by accretion under gravitational attraction. Likewise, the formation of elements by a series of complex reactions within the bodies of stars such as the Sun cannot be supported. This being the case, then the origin of the Sun and the atoms and molecules present in both the Solar System and interstellar space has to be sought elsewhere.

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Recoil Between Photons and Electrons Leading to the Hubble Constant and CMB

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This paper proposes a recoil interaction between photons and electrons in the plasma of intergalactic space as a mechanism that could lead to the observed Hubble constant and cosmic background radiation. It begins from the Hubble diagram for type Ia Supernovae, which gives the value of the Hubble constant, H as 64±3 km/s Mpc^{-1}. In SI units, H is 2.1×10^{-18} s^{-1}, equal to 'hr_e/m_e per cubic meter of space', where h is Planck's constant, r_e is radius of the electron and m_e is the mass of the electron. This coincidence suggests a possible relationship between H and the electrons in the plasma of intergalactic space. Electrons act collectively and oscillate if displaced. The possibility that light from distant galaxies is absorbed and re-emitted by the electrons, with recoil on both occasions, is considered. A double Mössbauer effect leads to a red-shift in the transmitted light. Introduction of the photo-absorption cross-section $2r_e\lambda$ leads to the relationship $H = 2n_e hr_e/m_e$, giving $H = 12$ km/s Mpc^{-1} when n_e has the reported value of $n_e = 10^{-7}$ cm^{-3}. The small amount of energy transferred to the electron by recoil is radiated as bremsstrahlung with a wavelength in the microwave region.

Key Words: Hubble constant, Intergalactic Plasma, CMB, Redshift; **Subject headings**: Cosmic microwave background --- Cosmology: Galaxies: distances and redshifts ---Intergalactic medium

1. Hubble Constant *vs*. Electron Paradox

Whilst the conventional interpretation of observed cosmological red-shifts is an Expanding Universe, some researchers have expressed doubts that the red-shifts are caused by expansion alone [1-6]. Marmet [7] proposed a recoil interaction between photons of light and the hydrogen atoms in Inter-Galactic (IG) space, but this idea would seem to have problems when one considers the discrete nature with which atoms absorb and re-emit photons. However, no researchers have previously reported the remarkable coincidence between the Hubble constant and the parameters of the electron ($H = hr_e/m_e$ per cubic meter of space). Nor, until now, has anyone derived a possible relationship between the two.

The Hubble diagram for type Ia Supernovae gives the value of the Hubble constant, H as 64±3 km/s Mpc^{-1} or $(2.07\pm0.1)\times10^{-18}$ s^{-1} [8]. The quantity 'hr_e/m_e' where h is the Planck constant (6.626×10^{-34} Js), r_e is the classical electron radius (2.818×10^{-15} m) and m_e is the electron rest mass (9.109×10^{-31} kg) is equal to (2.05×10^{-18} m^{3}s^{-1}) and so 'hr_e/m_e per cubic meter of space' has the same magnitude and dimensions as the Hubble constant. The HST key Project result for H of 72+/- 8 km/s per Mpc [9] gives a range of $(2.1\text{–}2.6)\times10^{-18}$ s^{-1} is remarkably close to hr_e/m_e 'per cubic meter of space' when one considers that, if we are to believe in an Expanding Universe, H could have had any value from zero up to the speed of light, and is not supposed to be related to the electron. We must ask the question, "why is the measured value of H so close to a simple combination of the parameters of the electron if they are not related?"

These are not isolated results. Table 1 shows recent experimental values of the Hubble constant, H as selected by the ADS database. To select an unbiased sample the words 'Hubble' and 'constant' and 'measurements" were fed into the database, and 'return 100 items' chosen. Of these, all the papers giving an actual value for H were selected and should include the most recent results. The results for H are given in terms of hr_e/m_e per cubic meter of space. To do this the symbol k was assigned to represent the constant 'hr_e/m_e per cubic meter of space'.

The average of all the results was then taken. It should be noted that uncertainties were not taken into account, and for those papers giving a range of values for H the middle value was taken. The average of all these values for H, found by several different techniques, is equal to 1.0k *i.e.* hr_e/m_e per cubic meter of space. It is therefore proposed that this relationship between the Hubble constant and the electron is not a chance event.

2. The Medium with which Light Interacts

This coincidence could suggest a relationship between H and the electrons in the plasma of IG space, $n_e \approx 10^{-7}$cm^{-3} [10]. Electrons in the plasma interact simultaneously with other electrons by means of long-range Coulomb forces giving rise to a collective behavior. Significantly, a displaced electron in the plasma of IG space will perform Simple Harmonic Motion [12] and a system of electrons that is able to oscillate is able to absorb and emit electromagnetic radiation. It is possible that photons from distant galaxies could interact with these electrons.

Author	Date	Bib. Code	Method Used	Value of H in units of hr_e / m_e
Cardone *et al*.	00/2003	2003acfp.conf..423C	Grav. Lens	0.91k
Freedman *et al*.	00/2003	2003dhst.symp..214F	HST – Cepheids	1.1k
Tikhonov *et al*.	07/2002	2002Ap…45…253T	HST – Stars	1.2k
Garinge *et al.*	06/2002	2002MNRAS.333..318G	Xray emission	0.89k
Tutui *et al*.	10/2001	2001PASJ..53..701T	CO line T-F	0.94k
Freedman *et al*.	05/2001	2001ApJ..553..47F	HST Cepheids	1.1k
Itoh *et al.*	05/2001	2001AstHe.94.214I	Xray emission	0.94k
Jensen *et al*.	04/2001	2001ApJ.550..503J	SBF	1.2k
Willick *et al*.	02/2001	2001ApJ.548..564W	HST Cepheids	1.3k
Koopmans *et al*.	00/2001	2001PASA..18..179K	Grav. lens	(0.94 – 1.1)k
Mauskopf *et al*.	08/2000	2000ApJ..538..505M	Xray emission	0.92k
Sakai *et al*.	02/2000	2000ApJ..529..698S	HST Cepheids	1.1k
Tanvir *et al*.	11/1999	1999MNRAS.310..175T	HST Cepheids	1.0k
Tripp *et al*.	11/1999	1999ApJ..525..209T	Ia Supernovae	0.97k
Jha *et al*.	11/1999	1999ApJS..125..73J	Ia Supernovae	1.0k
Suntzeff *et al*	03/1999	1999AJ..117.1175S	Ia Supernova	1.0k
Iwamoto *et al*.	00/1999	1999IAUS..183..681	Ia Supernovae	1.0k
Mason *et al*.	00/1999	1999PhDT…29M	Xray emission	1.1k
Schaefer *et al*.	12/1998	1998ApJ..509..80S	Ia Supernovae	0.86k
Jha *et al*.	12/1998	1998AAS..19310604J	Ia Supernovae	1.0k
Patural *et al*.	11/1998	1998A&A..339..671P	HIPPARCOS	0.94k
Wantanabe *et al.*	08/1998	1998ApJ..503..553W	Galaxies T-F	1.0k
Salaris *et al*.	07/1998	1998MNRAS..298..166S	TRGB	0.94k
Hughes *et al*.	07/1998	1998ApJ..501..1H	Xray emission	(0.66 – 0.95)k
Cen *et al*.	05/1998	1998ApJ..498L..99C	Xray emission	(0.94 – 1.3)k
Lauer *et al*.	05/1998	1998ApJ..449..577L	HST SBF	1.4k
Average of all the values				1.0k

3. Proposed Red-Shift Mechanism

When photons travel through any transparent medium they are continually absorbed and re-emitted by the electrons in the medium. French [13] states "the propagation of light through a medium (even a transparent one) involves a continual process of absorption of the incident light and its reemission as secondary radiation by the medium." Feynman [14] describes the transmission of light through a transparent medium simply as "photons do nothing but go from one electron to another, and reflection and transmission are really the result of an electron picking up a photon, "scratching its head", so to speak, and emitting a *new* photon."

The plasma of Intergalactic space acts as a transparent medium and photons of light, as they travel through space, will be absorbed and re-emitted by the electrons in this plasma. At each interaction where the momentum of the photon is transferred to the electrons, there will be a delay. So the electron will recoil both on absorption and reemission - resulting in inelastic collisions [15].

A double Mössbauer effect will occur during each interaction between photon and electron. Some of the energy of the photon will be transferred to the electron, and since the energy of the photon has been reduced, the frequency will reduce and the wavelength will increase. It will have 'undergone a red-shift'.

Energy lost to an electron [16] during emission or absorption is equal to $Q^2 / 2m_e c^2$, where Q is the energy of the incoming photon (hc / λ), m_e is the rest mass of the electron and c is the speed of light.

This energy calculation must be applied twice for absorption and re-emission. Hence, total energy lost by a photon is $Q^2 / m_e c^2 = h^2 / \lambda 2 m_e$ (energy before interaction) – (energy after) = $h^2 / \lambda^2 m_e$

$$hc / \lambda - hc / \lambda' = h^2 / \lambda^2 m_e$$

where λ is the initial wavelength of the photon and λ' is the wavelength of the re-emitted photon. Multiplying through by $\lambda^2 \lambda' m_e$ and dividing by h gives:

$$\lambda\lambda' m_e c - \lambda^2 m_e c = h\lambda'$$

Increase in wavelength is $\delta\lambda = \lambda' - \lambda$, so:

$$\lambda(\delta\lambda + \lambda) m_e c - \lambda^2 m_e c = h(\delta\lambda + \lambda)$$
$$\Rightarrow \lambda m_e c \delta\lambda + \lambda^2 m_e c - \lambda^2 m_e c = h\delta\lambda + h\lambda$$
$$\Rightarrow \delta\lambda(\lambda m_e c - h) = h\lambda$$

Then since $h << \lambda m_e c$,

$$\delta\lambda = h / m_e c$$

On their journey through IG space, the photons will make many such collisions and undergo an increase in wavelength of $h / m_e c$ each time. On this basis red shift becomes a distance indicator and the distance - red shift relation becomes: photons of light from galaxies twice as far away will travel twice as far through the IG medium, make twice as many collisions, and thus undergo twice the red shift.

Conservation of linear momentum will ensure the linear propagation of light.

4. The Hubble Law

The process whereby a photon interacts with an electron and gives all its energy to the electron is known as photo-absorption and the photo-absorption cross section σ is known from the interaction of low-energy X-rays with matter [17, 18, 19].

$$\sigma = 2 r_e \lambda f_2$$

where f_2 is one of two semi-empirical atomic scattering factors depending, amongst other things, on the number of electrons in the atom. For 10 keV to 30 keV X-rays interacting with Hydrogen, f_2 has values approximately between 0 and 1, '0' meaning that the photon was absorbed and an identical photon re-emitted, and '1' meaning that the photon has been absorbed and the electron remains in an excited state [13].

Since the photon frequency of light from distant galaxies is far removed from the resonant frequency of the electrons in the plasma of IG space, the photons will always be re-emitted. The collision cross section for the recoil interaction considered here is, therefore, $2r_e\lambda$ since f_2 only 'modulates' $2r_e\lambda$ for the atom.

On their journey through the IG medium, photons of radiation at the red end of the spectrum will encounter more collisions than photons at the blue end of the spectrum and thus undergo a greater total shift in wavelength. For a particular source, the ratio $\Delta\lambda / \lambda$ will be constant. The collision cross section for a particular photon will not be constant, but will increase every time it interacts with an electron. The photon travels shorter and shorter distances between collisions as it travels further and further, and it is this phenomenon that makes the red shift relation go nonlinear for large red shifts. If the initial wavelength is λ, then it will be ($\lambda + h / m_e c$) after one collision, ($\lambda + 2h / m_e c$) after two collisions, ($\lambda + 3h / m_e c$) after three collisions and so on.

The mean free path of a photon in the plasma of IG space is given by $(n_e\sigma)^{-1}$ or $(2n_e r_e \lambda)^{-1}$ since $\sigma = 2r_e\lambda$. If the photon makes a total of N collisions in traveling a distance d , the sum of all mean free paths is d , or

$$\begin{aligned}&(2n_e r_e \lambda)^{-1} + [2n_e r_e(\lambda + h / m_e c)]^{-1} + [2n_e r_e(\lambda + 2h / m_e c)]^{-1} \\ &+[2n_e r_e(\lambda + 3h / m_e c)]^{-1} + \ldots + \{2n_e r_e[\lambda + (N-1)h / m_e c]\}^{-1} \\ &= d\end{aligned}$$

or

$$\begin{aligned}&\lambda^{-1} + (\lambda + h / m_e c)^{-1} + (\lambda + 2h / m_e c)^{-1} \\ &+(\lambda + 3h / m_e c)^{-1} + \ldots + [\lambda + (N-1)h / m_e c]^{-1} \\ &= 2n_e r_e d\end{aligned}$$

or

$$\sum_{x=0}^{N-1} \left[\lambda + x(h / m_e c)\right]^{-1} = 2n_e r_e d$$

Since N is large and $h / m_e c$ is small (2.43×10^{-12}m), this approximates to:

$$\int_0^{N-1} \left[\lambda + x(h / m_e c)\right]^{-1} dx = 2n_e r_e d$$

or
$$1 + h(N-1) / m_e c\lambda = \exp(2n_e h r_e d / m_e c)$$

$$N = \lambda \exp(2n_e h r_e d / m_e c)(h / m_e c)^{-1} + 1 - \lambda(h / m_e c)^{-1} \quad (1)$$

The total increase in wavelength, $\Delta\lambda = N\delta\lambda$, or $Nh / m_e c$.

$$\Delta\lambda = \lambda \exp(2n_e h r_e d / m_e c) + h / m_e c - \lambda$$

The red shift, z is defined as $\Delta z = \Delta\lambda / \lambda$, which implies

$$z = \exp(2n_e h r_e d / m_e c) + h / m_e c\lambda - 1$$

Since $h / m_e c\lambda$ is small for all wavelengths longer than X-ray wavelengths,

$$z = \exp(2n_e h r_e d / m_e c) - 1$$

Using the power expansion of the exponential, *i.e.*

$$e^x = 1 + x / 1! + x^2 / 2! + x^3 / 3! + \ldots$$

gives:

$$\begin{aligned}z &= (2n_e h r_e / m_e c)d / 1! + (2n_e h r_e / m_e c)^2 d^2 / 2! \\ &+(2n_e h r_e / m_e c)^3 d^3 / 3! + (2n_e h r_e / m_e c)^4 d^4 / 4! + \ldots\end{aligned}$$

In Hubble's Law, the radial speed, v , is given as

$$\begin{aligned}v = cz &= c(2n_e h r_e / m_e c)d + c(2n_e h r_e / m_e c)^2 d^2 / 2 \\ &+c(2n_e h r_e / m_e c)^3 d^3 / 3! + c(2n_e h r_e / m_e c)^4 d^4 / 4! + \ldots\end{aligned}$$

Since $2n_e hr_e / m_e c$ is very small, the terms involving powers of two and above can be ignored until d becomes very large. That is, for nearby galaxies, the expression approximates to

$$v = (2n_e hr_e / m_e)d$$

and, as $v = Hd$ (H being the Hubble constant), comparing the two equations gives

$$\boxed{H = 2n_e hr_e / m_e} \tag{2}$$

Consequently we have:

$$v = Hd / 1! + H^2 d^2 / 2!c + H^3 d^3 / 3!c^2 + H^4 d^4 / 4!c^3$$

or

$$\boxed{v = c[\exp(Hd / c) - 1]} \tag{3}$$

and

$$\boxed{z = \exp(Hd / c) - 1} \tag{4}$$

It should be noted that this relationship between redshift, z and distance, d is identical to that first proposed by Zwicky in 1929 [20].

5. Comparison with Experimental Results

This theory predicts by Eq. (2) that $H = 2n_e hr_e / m_e$, or $H = 4.10 \times 10^{-18} n_e$ s^{-1}.

As cited earlier, $n_e \approx 10^{-7}$cm^{-3} [10,11], and using this value to predict H gives:

$$H \approx 0.41 \times 10^{-18} \text{ s}^{-1} \ (H \approx 12 \text{ km/s Mpc}^{-1})$$

This is in good agreement with the experimental values ([8] *i.e.*, $H = (2.1 \pm 0.1) \times 10^{-18}$ s^{-1}.

To match the experimentally derived H of 2.1×10^{-18}s^{-1} (64±3 km/s Mpc) requires $n_e \approx 5 \times 10^{-7}$ cm^{-3} compared to the cited value of $n_e \approx 10^{-7}$cm^{-3}. Light of wavelength 5x10^{-7} m would have a collision cross-section of 2.8×10^{-21} m^2, and each photon would, on average, make one collision with an electron in the plasma of IG space every 75,000 light years.

Published statistical tests on redshift data show that the Hubble diagram is straight up to z ≈ 0.1, goes nonlinear at $z \approx 0.8$, is quadratic at $z \approx 2.8 - 3.6$ and for redshifts above this, follows a non simple power law ([8, 21, 22, 23]. However, it has recently been shown [24] that data from the Calan/Tololo Supernova survey can verify this exponential law with a value of H of 72 km/s per Mpc, *i.e.* 1.13 hr_e / m_e per m^3 ($n_e = 5.7 \times 10^{-7}$ cm^{-3}) if the data is not 'corrected' for the relativistic effects of expansion first. That is the data fits this theory's predicted exponential Hubble law provided that we do not assume that the Universe is expanding and manipulate the data accordingly. This theory's predicted exponential Hubble curve is shown in Fig 1 for comparison.

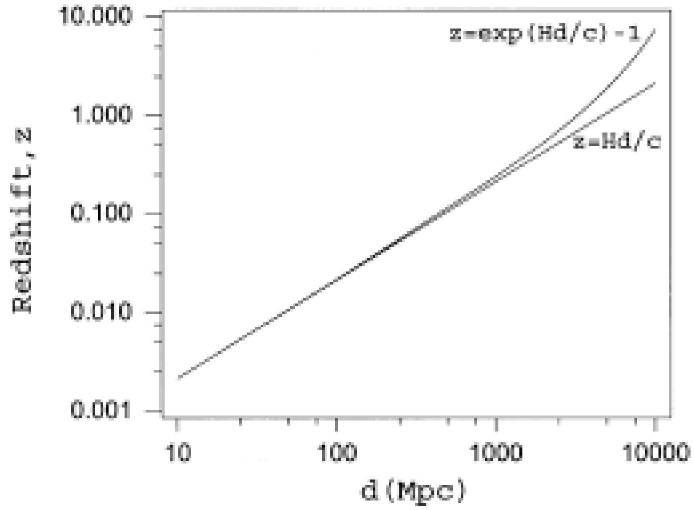

Figure 1.

6. Cosmic Microwave Background (CMB)

The recoiling electron will be brought to rest by Coulomb interactions with all the electrons contained within a Debye sphere of radius λ_D. The decelerating electron will emit transmission radiation (TR) *i.e.* bremsstrahlung. There are two emission channels of the system, 'intrinsic emission' by the decelerating electron, and 'emission by the medium', where the background electrons radiate energy.

Intrinsic radiation arises when the recoiling electron exchanges a virtual photon with the external field (set up by the large number of coulomb centers) with momentum $\mathbf{q}$ and emits a quantum with momentum $\mathbf{k}$. The medium or external field in which the recoiling electron is moving radiates when the virtual photon of momentum $\mathbf{q}$ results in the production of radiation by background electrons contained within the Debye sphere [25].

The interactions between light and the electrons are non-relativistic and the initial and final states of the electron belong to the continuous spectrum. The photon frequency of the transmission radiation f_{CMB} is given by:

$$hf_{CMB} = \frac{1}{2}(p^2 - p'^2) / m_e$$

where $p = m_e v$ and $p' = m_e v'$ are the initial and final momentum of the electron [26].

The electron returns to rest after absorption and reemission and so the wavelength of the transmission radiation λ_{CMB} is given by:

$$\lambda_{CMB} = 2m_e \lambda^2 c / h$$

Light of wavelength 5×10^{-7}m gives rise to TR of wavelength 0.21m. In IG space, the dominant background photons are microwaves, having peak energy of 6×10^{-4}eV and a photon density of about 400 per cm^{-3} [27,28]. In this theory, these background photons ($\lambda = 2.1 \times 10^{-3}$ m) would be given off as TR by a photon of wavelength 5x10^{-8} m (*i.e.* ultra violet radiation) interacting with an electron.

7. Discussion

This proposed theory has successes in predicting values of H and λ_{CMB} that have the same magnitude as experimental values. As to whether this proposed interaction makes up the whole of the red-shift or just a part of it will not be known until n_e has been determined to a greater accuracy. The theory also shows a relationship between H and 'hr_e / m_e per cubic meter' which could explain the remarkable coincidence between their magnitudes. As scientists, we must always be suspicious of quantities that are equal but do not appear to be related. The theory still has to explain the 'surface brightness test' [29] and the time dilation in supernova light curves [30-34].

However, the value of H quoted here (64±3 km/s Mpc^{-1}) is only one value, and other techniques and other workers give differing values. A value of 70±7 km/s Mpc^{-1} can be said to represent present data from all areas [35], and thus all agree that values of H lie in the range 1.0 to 1.2 times 'hr_e / m_e per cubic meter of space'. With the 'Big Bang' theory, H could have had any initial value (as far as we know) and the effects of gravity and 'vacuum energy' make H time dependent, changing in magnitude from this original value. How probable is it that the first time we measure H with some accuracy it has the same value as 'hr_e / m_e per cubic meter of space' (especially when these constants carry such importance in the scattering of light). To complicate matters further, the age of the Universe is often quoted as H^{-1}, which we now realize to be equal to between 0.8 and 1.0 times m_e / hr_e - this is a test that the Expanding Universe 'fails' and now has to explain.

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E.A. Milne and the Universes of Newton and Relativistic Cosmology

This note reviews the 1930's work of Milne on the relationship between the universes of relativistic cosmology and those that follow from Newtonian theory. The extension to the case of non-zero pressure is considered also. In each case, any assumptions made are noted, and the thermodynamic implications of these are explored in the final Section.

Introduction

In the 1930's, Milne [1] initiated an investigation into the relationship between the universes of relativistic cosmology and those that may be considered using only Newtonian theory. McCrea [2] later joined in this work. Milne then gathered together all the results in his book on relativity, gravitation and world structure [3]. It seems somewhat surprising that this work does not appear well known today. One reason for this may be that Milne and McCrea concentrated on the zero-pressure situation. The present note reviews the approach of Milne and McCrea and examines the situation obtaining when the pressure is not zero. This latter case appeared in works by Peebles [4] and Harrison [5]. In addition, Harrison pointed out that Newtonian cosmology provides an excellent description of a universe in which the pressure is small. Further, it might be noted that Callen, Dicke, & Peebles [6] claimed the Newtonian treatment to be a perfectly correct method. Here more detail will be presented to make the assumptions made, particularly the thermodynamic assumptions, more obvious, and allow the implications of these to be discussed.

Resumé of Milne's Approach

Following an earlier paper by Milne in which the velocity v was assumed equal to the escape velocity [1], McCrea and Milne [2] investigated the case when the velocity does not necessarily have this value. The v was assumed to be the velocity of a particle at a distance r from the observer at time t. This velocity was assumed to be radial in nature, and a function of r and t. Under these circumstances, the equation of motion is

$$D\mathbf{v} / Dt = \mathbf{F} \quad \text{or} \quad \partial \mathbf{v} / \partial t + \mathbf{v} \bullet \partial \mathbf{v} / \partial r = \mathbf{F} \tag{2.1}$$

where $\mathbf{F}$ is the force due to gravity, given by Poisson's equation

$$\nabla \bullet \mathbf{F} = -4\pi G\rho$$

where ρ is a function of t only. The equation of continuity may be written

$$\frac{1}{\rho}\frac{d\rho}{dt} + \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v) = 0 \quad .$$

It follows that the second term in this equation must be a function of t only. Hence, put

$$\frac{1}{\rho}\frac{d\rho}{dt} = -3f(t) \quad , \text{ so that } \quad \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v) = 3f(t) \quad ,$$

which may be integrated to give $r^2 v = r^3 f(t) + g(t)$ where $g(t)$ is a constant of integration. This result may be rewritten

$$v = rf(t) + r^{-2}g(t) \quad . \tag{2.2}$$

If this expression is inserted into (2.1), then, since ρ is a function of t only,

$$\frac{1}{r}\left\{rf'(t) + r^{-2}g'(t) + [rf(t) + r^{-2}g(t)] \times [f(t) - 2r^{-3}g(t)]\right\}$$

must be a function only of t also. Hence, $g(t) = 0$ and (2.2) becomes

$$v = rf(t) \tag{2.3}$$

which may be integrated to give $r = \alpha R(t)$, where α is a constant arising from the integration and $R(t)$ is a function of t satisfying

$$\frac{1}{R}\frac{dR}{dt} = f(t) = -\frac{1}{3\rho}\frac{d\rho}{dt} \quad . \tag{2.4}$$

Hence
$$\rho = \beta / R^3 \tag{2.5}$$

where β is a constant. Taking the divergence of (2.1), substituting for v from (2.3) and using Poisson's equation gives

$$3\left(df / dt + f^2\right) = -4\pi G\rho \tag{2.6}$$

Using (2.4) and (2.5) in (2.6) then leads to

$$\frac{1}{R}d^2R / dt^2 = -4\pi G\beta / 3R^3 \quad ,$$

which may be integrated to give

$$\left(dR / dt\right)^2 = \frac{8}{3}\pi G\beta / R - \gamma \quad ,$$

where γ is a constant. By using (2.5), these latter two equations may be written

$$\frac{1}{R}d^2R / dt^2 = -\frac{4}{3}\pi G\rho \tag{2.7}$$

and
$$\frac{1}{R^2}\left(dR / dt\right)^2 + \frac{\gamma}{R^2} = \frac{8}{3}\pi G\rho \tag{2.8}$$

respectively. These final two equations are seen to be formally identical with the equations usually associated with relativistic cosmology for an expanding universe with zero pressure. [4]

The above is the quite standard procedure adopted by McCrea and Milne, and which appears also in Milne's book [3]. However, it is worth noting that it applies solely to the case of zero pressure and, frequently these days, the equations used in relativistic cosmology involve non-zero pressure.

A Modification to Involve Pressure

If the pressure is to be taken into account, Eq. (2.1) must become

$$D\mathbf{v} / Dt + \frac{1}{\rho}\nabla p = \mathbf{F} \quad ,$$

where p is the pressure and $\mathbf{F}$ is the force due to gravity. However, if, as is usually assumed, the pressure is a function only of time t, then ∇p will be zero. The pressure will actually enter the problem via the modified Poisson equation applicable in this case. As has been pointed out by Peebles, the generalization to the case where the pressure is not negligible requires changing the source for gravity from the mass density ρ to the sum $\rho + 3p$. Here, equilibrium between matter and radiation is assumed, and the $3p$ term takes account of the radiation pressure. Thus, for this case, Poisson's equation becomes

$$\nabla \bullet \mathbf{F} = -4\pi G(\rho + 3p) \quad .$$

The only effect of this modification would be to alter (2.7) to

$$\frac{1}{R}d^2R/dt^2 = -\frac{4}{3}\pi G(\rho + 3p) \quad . \tag{3.1}$$

Again following Peebles, it might be noted that, since ρ is the mass per unit volume, the net energy within the sphere is $\boldsymbol{U} = \rho\boldsymbol{V}$. When the material moves so that the radius of the sphere changes, the energy $\boldsymbol{U}$ changes also because of the work due to pressure on the surface:

$$dU = -pdV = \rho dV + Vd\rho$$

Hence,

$$\dot{\rho} = -(\rho + p)\dot{V}/V = -3(\rho + p)\dot{R}/R$$

where the volume $V \propto R^3$. Substituting for p in (3.1) gives

$$\ddot{R} = -\frac{4}{3}\pi G\left\{\rho - R\dot{\rho}/\dot{R} - 3\rho\right\}R = \frac{8}{3}\pi G\rho R + \frac{4}{3}\pi G R^2\dot{\rho}/\dot{R} \quad ,$$

where the dot refers to differentiation with respect to t. This latter equation may be integrated to give

$$\dot{R}^2 = \frac{8}{3}\pi G\rho R^2 + \text{const.}$$

Following the approach of McCrea and Milne once more, this latter equation is seen to be of exactly the same form as (2.8). Hence, a slight modification of the approach of McCrea and Milne is seen to lead to equations of the same form as those of relativistic cosmology in the case of a non-zero pressure.

Discussion

In the above, it is immediately obvious that the final equations, derived by utilizing purely Newtonian methods, are identical in form with those resulting from the more modern relativistic techniques. In the Section dealing with the case of non-zero pressure, it is instructive to look more closely at the various assumptions made. In noting that the energy U changes because of work due to pressure, the equation

$$dU = -pdV$$

emerges. This is a special case of

$$TdS = dU + pdV - \mu dN \quad ,$$

which applies, for example, when both TdS and μdN equal zero; that is, when the process under consideration is adiabatic and the total number of particles remains unaltered. Hence, once again it is seen that the equations used for cosmological discussions imply adiabaticity. This was the conclusion reached by looking directly at the Einstein equations used to introduce the idea of inflation and, at that time, it was pointed out that these equations could not be used to describe non-adiabatic situations. [7]. Here it is made clear that the equations apply also only to situations in which particle number is conserved. The importance of these observations lies in the fact that they place very clear limitations on the use of the said Einstein equations and on the equations of identical form derived by Newtonian methods.

It might be noted, however, that an alternative explanation for the use of the equation $dU = -pdV$ in place of $TdS = dU + pdV - \mu dN$ does exist; that is that any entropy change is brought about purely by a change in particle number. This, and this alone, would enable non-adiabaticity to be allowable within the models and here the plural is used because this argument applies equally well to the use of the equations of both Newton and Einstein.

Further, while the methods employed here to derive these basic equations differ greatly from those normally used in general relativity and the meanings of some of the symbols may vary, the two sets of equations are formally identical and the situations they are supposed to describe are the same. Therefore, the question concerning the place and importance of the accepted equations of general relativity must be raised. In their paper, McCrea and Milne, having derived the equations in the case of zero pressure, go on to discuss the curvature of space and make the point that 'the local properties of the universes in expanding spaces of positive, zero or negative curvatures are observationally the same as in Newtonian universes with velocities respectively less than, equal to, or greater than the parabolic velocity of escape.' This is further claimed to give 'great insight into the physical significance of expanding curved space.' It is of immediate interest to note that they always talk of 'space' not 'space-time', thus keeping the three-dimensional world in which we live and time as two separate concepts firmly at the forefront of any considerations. This has the effect of making it immediately clear what is claimed to be happening in our surroundings.

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From the Editor: An Agenda Concerning Gravity

Introduction

Progress in the twentieth century was accompanied by the loss of many concepts previously cherished. Some of the losses are to be lamented. For me, they include **1) Galileo's kinematics**, which has been replaced by Einstein's Special Relativity Theory (SRT); **2) Newton's gravity**, which has been replaced by Einstein's General Relativity Theory (GRT); **3) Classical potentials**, which have been replaced by potentials that cause physical effects, not via forces, but directly; see GRT & quantum mechanics (QM); **4) Unification of disparate theories,** which was exemplified by the achievement of classical electromagnetic theory, remains a goal but is rarely an accomplishment.

I dealt with loss no. 1 in SI 3 of 2005. The present SI 3 of 2006 shows where we have come to on account of loss no. 2. This little addendum comments as well on losses no. 3 & 4. I hope to elicit reader response in addressing all these points further.

On Galileo's Kinematics *vs*. SRT

In Galileo's kinematics, all scenarios play out in well-understood Euclidean three-dimensional space, with universal time. Velocity vectors combine by simple **vector addition**. But SRT replaces vector addition with **matrix multiplication**, which leads to mysterious results: **1)** Light speed c seems to be a universal speed limit; **2)** Thomas rotation occurs because combining non-collinear velocities produces not just velocity, but also rotation. **3)** The 'Twins Paradox' implies that every clock 'runs slower' than every other clock. SRT was perhaps a bad starting point from which to develop GRT.

On Newton's Gravity *vs*. GRT

Newton's gravity theory is computationally straightforward, although mysterious for its 'instantaneous action at a distance'. It can solve 'two-body' problems in closed form, although not three-or-more-body problems. But GRT is even *more* mysterious, with '**curved spacetime**', and even *less* powerful: GRT seems limited to situations where one big body is the 'source', and another much smaller body is the 'test particle' – a '**one-body**' problem. Have we regressed here?

The problem shows up most conspicuously in regard to the precession of the perihelion of Mercury. There are two contributors to that. One part of it, 43"/century per century, is understandable in terms of GRT with the Sun being the source and Mercury being the test particle. But the greater part of it, 532" per century, is due to the other planets, and since the other planets take the problem beyond the 'one body' limit, that part has to be computed with Newtonian theory.

Whenever possible, physicist like to get a 'seamless' theory that covers all aspects of a problem. Otherwise, they must cobble together a **patchwork** of different theories for different aspects of the problem. Such a patchwork of theories is considered inelegant, and potentially risky: it may leave gaps of reality uncovered, or have overlaps, duplications, and double-countings, or it may require conflicting assumptions. But alas, for this most important problem, GRT is simply *not* the seamless theory.

On Classical *vs*. Modern Potentials

In classical physics, a potential is an entity whose **physical effects** are revealed only by its **derivatives**. For example, the gradient of Newtonian gravitational potential is gravitational force per unit mass responding, the gradient of Coulomb potential is an electric field, and the time derivative of Ampere vector potential augments that electric field, and the curl of that vector potential is the magnetic field.

In quantum physics, the vector potential is said to produce a physical effect directly, without any differentiation being required. The phase shift in the Aharonov-Bohm effect is said to arise this way. Likewise in GRT, the gravitational potential is said to produce physical effects directly: it is said to slow clocks, redden light emitted, or bend light passing by, and contribute to orbit precessions.

All of this is very confounding. In classical physics, the **integration constants** that go with the potentials have no physical meaning. But in quantum and/or gravitational situations, integration constants can apparently produce physical effects, and so must have some kind of physical meaning. But *what* meaning?

I believe we may have given two different meanings to just the one word: 'potential'. That is the kind of corruption of language that can lead to deep confusion. We might, perhaps, be well advised to create a different word for 'potentials' that require no differentiation to cause a physical effect.

My own opinion is that the physical effects observed and attributed to potentials ought to be attributed instead to appropriate second derivatives of potentials.

On Needed Unifications

Classical electromagnetic theory unified electrostatics and magnetism, and that unification was celebrated in its day. More unification is still being sought today: for GRT & QM. I believe this effort is premature. In fact, there is a more pressing need for better unification between GRT and its own *parent* theory, SRT.

Consider the GPS system. The data processing for GPS involves the ever-risky use of a **patchwork** of theories. The clocks aloft do slow in comparison to clocks on Earth. To account for that, the GPS system uses GRT for a contribution dependent on **gravitational potential**; and then for a contribution dependent on **squared velocity**, SRT and Lorentz Transformations (LT's), or maybe Lorentz Ether Theory (LET) and Mansouri-Sexl Transformations. The GPS clock situation is no better than the perihelion precession situation, where one needs to use the supposedly-replaced Newtonian theory along with GRT to get the full result.

I believe that we started off the twentieth century on the wrong foot, with SRT. First and foremost, we have to overcome that bad start. Only then can we achieve a next level of unification in physics.

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