The Cosmic Coincidence

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After Einstein inserted a cosmological constant into his field equations for a repulsive force that would prevent a finite universe from collapsing by gravity, Alexander Friedmann concluded an infinite number of models were possible [1]. A model now established is that of big bang theory (BBT) whereby the universe has expanded from a miniature volume of space and somehow the rate of expansion has increased, in theory, by some mysterious presence of dark energy. However, what complicates this model is the Cosmic Coincidence whereby the present rate of expansion equates to the ratio of gravitational and electrostatic forces. Another model of the universe is thus proposed whereby general relativity theory (GRT) is to be modified to somehow comply with the Cosmic Coincidence.

1. Introduction

The Cosmic Coincidence had previously been noted by Paul Dirac in using the Hubble Constant to construct such atomic particles as electrons and muons [2]. The accuracy of the Hubble Constant at the time was determined only within the range of about 100 kilometers per second. It has now been calculated from data collected by the Wilkinson Microwave Anisotropy Probe (WMAP) probe in deep space as H=70.5±1.3 km/sec/Mpc [3].

Dirac had accepted the cause of the Hubble Constant as a recession between the observer and the light source, as according to an expanding universe. Since in an expanding universe the distance between galaxies is increasing, and because the Hubble Constant is a change in light spectrum per distance, the Hubble Constant is only constant for distances of a particular time. It decreases thereafter. However, the other parameters of the Cosmic Coincidence are constants as well. This meant for Dirac that not all of them could be truly constant, as indications are that at least one of them needs to vary with the Hubble Constant. He chose the gravitational constant as decreasing in time along with the expansion of the universe.

The consequence of varying the gravitational constant as a solution to the Cosmic Coincidence is that BBT, GRT and Newton's universal law of gravity are in need of modification. It is contrary to BBT because it is too extraordinary that H is what it is at this specific time. It is also contrary to Newton's and Einstein's theories of gravity in contradiction that gravitational mass and inertial mass are the same according to either collision or weight anywhere in the universe.

Despite the implications of the inverse square law of gravity as universal, Newton was reluctant to assume that inertial mass and gravitational mass are the same everywhere in the universe. Even though it was nonetheless subsequently interpreted as applying throughout the cosmos, its validity has been questioned. Ernst Mach, for instance, proposed an alternative, the principle that the inertia of mass depends on the relative distribution of mass at large.

The principle of equivalence has locally been confirmed to an accuracy of at least one part in 10^{13}. However, this is not to say mass is determined the same everywhere in the universe. If it differs, then what is determined by observers in one galaxy as inertial mass and gravitational mass might not be the same as what observers in another galaxy might determine them to be.

Newton assumed absolute space and absolute time as intrinsic properties of nature for the formulation of laws of motion and a theory of gravity. Einstein confronted this assumption with the theory of relativity whereby space and time are considered relative instead. He then postulated the principle of equivalence as the foundation of GRT.

For the most part Einstein only modified Newtonian Mechanics by way of describing phenomena according to relative spacetime instead of absolute space and absolute time. Such laws as conservation of momentum and conservation of energy are maintained. How they are maintained by GRT, however, differs somewhat from how they are maintained by quantum physics and the special theory of relativity (SRT).

According to SRT total momentum and total mass-energy are conserved of collisions either between masses or between mass and light. This conservation is of collision as seen by observers in an inertial state of motion. It does not include other mass in view of the observer's changed state of inertial motion. By SRT and by Newtonian Mechanics the total momentum of all other mass is shifted in the opposite direction of the observer's acceleration. Furthermore, according to SRT whether the total mass-energy increases decreases or stays the same depends on how relative motion of the observer independently changes. Mass-energy is thus conserved with regard to its own interaction, but it is not conserved in view of an observer's changed state of relative motion.

Conservation of mass-energy and momentum similarly apply to GRT, but how they are conserved is more complicated in view of Einstein's interpretation of the principle of equivalence. By it observers in free fall feel no internal effect of their acceleration insofar as all mass-energy of observation gravitates in the same direction at the same rate.

In contradistinction to non-awareness of free fall are tidal effects. Earth, for instance, is in free fall towards its moon. Ocean tides occur because parts of Earth closer to the moon gravitate more towards it. Gravity is thus inhomogeneous by nature. Aspects of its non-awareness are nonetheless interpreted as curved space due to the presence of mass. Instead of accelerating by the force of gravity, mass-energy simply follows the path of space-time curvature. Moreover, with no force of gravity to reckon with, conservation laws appear to be inconsequential as well. However, this interpretation of gravity with regard to conservation laws is more entailed.

Besides tidal effects observers standing on Earth's surface resist free fall. Do conservation laws with regard to gravity apply to this resisting force instead of free fall itself? It is here assumed conservation of momentum and conservation of energy apply regardless of the nature of the action, but their empirical validity is conditional to the probability nature of quantum physics.

Space-time curvature somehow results from the presence of mass. Insofar as there is no explanation given as to how a stress condition of space results from the presence of mass it could refer to an unobservable phenomenon not subject to scientific scrutiny, as with regard to causality, and as in being consistent with the probability conditions of quantum physics resulting in vacuum effects. For black holes to be in compliance with the laws of thermodynamics, for instance, Stephen Hawking proposed that a particle existing inside a black hole has a probability of existing outside it [4]. Black holes are thus only black with regard to their cause and effect determination.

To elaborate according to the contiguous process of action as described by SRT, perhaps particles escape black holes by converting to a less detectable form of energy, thus creating a vacuum effect in their wake.

Gravity is likely a vacuum effect that results in the warping of space-time, but this vacuum effect must have a cause. Even if the cause is not observable it is still explainable according to conservation laws of momentum and mass-energy.

An overview of Newtonian Mechanics, the Mach principle, SRT, and the equivalence principle is therefore undertaken with regard to how conservation of momentum and conservation of mass-energy are maintained. The derivation of relative mass in accordance with these laws is first reviewed and further verified by example with regard to interaction of matter with light. The Schwartzschild Metric is next shown to indicate space contains inertia apart from matter. Gravity is then explained in manner consistent with both the Mach principle and general covariance of GRT. General covariance or the principle of equivalence, however, is here only valid as a local condition.

As for the Cosmic Coincidence, the Hubble Constant multiplied by the diameter of the hydrogen atom and then divided by light speed equals the ratio of gravitational and electrostatic forces between two hydrogen masses (which is to be mathematically shown). Since the Cosmic Coincidence is contrary to BBT an interpretation of gravity as a particular electrical effect is offered instead for a modification of GRT.

2. Conserving Relative Mass-Energy

According to SRT a mass m in relative motion at velocity v in ratio to light speed c is relatively greater than the same mass m_0 relatively at rest, as according to the equation

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{1}$$

Also according to SRT mass-energy is conserved after a collision between two or more masses. If the collision is inelastic, and if the total mass is observed from the same reference frame of motion, then the total mass-energy is unchanged.

The total mass-energy is also conserved for an elastic collision, but if there is a change in relative speed of the masses, then there is an exchange of relative mass between masses.

Note: Other mass-energy of the universe changing in view of an observer's changed state of relative motion (acceleration) is not conserved, as conservation of mass-energy does not apply to the observation of a change that is caused by an observer's acceleration that is independent of the action.

Despite this paradox an increase in relative mass along with an increase in relative motion is verifiable according to both conservation of mass-energy and conservation of momentum. Constant light speed and covariance also apply, as does the addition of velocities theorem.

Relative mass is first distinguished from rest mass. Let m_0 be a quantity of mass relatively at rest with either observer A or observer B. Let m be the same mass moving with observer B at velocity v_1 relative to the positive direction of observer A. Mass m in relative motion and mass m_0 relatively at rest becomes one, as M, relative to observer A by way of inelastic collision.

Both conservation of relative mass and conservation of total momentum apply according to Eqs. (2) and (3) below:

$$m + m_0 = M \tag{2}$$

$$mv_1 + m_0(0) = mv_1 = Mv_2 \tag{3}$$

Eq. (2) simply shows the total mass of two separate masses m and m_0 relative to observer A before the inelastic collision are the same as the total mass M relative to observer A after the collision. Eq. (3) is somewhat more complex inasmuch as $m_0(0)$ is at rest with observer A before the collision. Total momentum relative to observer A before collision is thus only mv_1. Moreover, because both masses move at velocity v_2 after inelastic collision, the total momentum relative to observer A is Mv_2.

The next step is substituting m and m_0 in Eq. (2) for M in Eq. (3) to obtain:

$$mv_1 = (m + m_0)v_2$$

$$mv_1 = mv_2 + m_0 v_2$$

$$mv_1 - mv_2 = m_0 v_2$$

$$m(v_1 - v_2) = m_0 v_2$$

$$m = \frac{m_0 v_2}{v_1 - v_2} \tag{4}$$

The objective now is to show:

$$m = \frac{m_0 v_1}{v_1 - v_2} = \frac{m_0}{\sqrt{1-\frac{v_1^2}{c^2}}} \tag{5}$$

This objective is achieved by converting v_2 in terms of v_1 in order to show the resulting form of the middle part of Eq. (5) is the same as that on its far right side. In so doing the principle of covariance and the addition of velocities theorem apply.

The addition of velocities theorem, as for velocities in either the same or opposite direction, is of the form

$$v_{ab} = \frac{v_a + v_b}{1 + \beta_a \beta_b} \tag{6}$$

In Eq. (6), $\beta_a = v_a/c$ and $\beta_b = v_b/c$. The velocity v_a is that of a second observer as measured by a first observer, v_b is another velocity of something else as measured by the second observer, and v_{ab} is the other velocity as measured by the first observer.

In view of an inelastic collision let observer B represent the first observer observing observer A as moving at velocity v_1. Let observer A then be the second observer observing the result of the inelastic collision moving at velocity $-v_2$. Since the principle of covariance requires the masses are the same relative to each other's point of view, as for comparing corresponding values with Eq. (6), the velocity $-v_2$ as perceived by observer A is v_2 as perceived by observer B. By substitution, Eq. (6) becomes

$$v_2 = \frac{v_1 - v_2}{1 - \beta_1 \beta_2} \tag{7}$$

$$v_2\left(1 - \beta_1\beta_2\right) = v_1 - v_2$$

$$v_2 - v_2\beta_1\beta_2 = v_2 - \frac{v_1}{c}\beta_2 = v_2 - v_1\frac{v_2}{c}\beta_2 = v_1 - v_2$$

$$v_2 - v_1\beta_2^2 = v_1 - v_2$$

$$2v_2 = v_1 + v_1\beta_2^2$$

$$2v_2 = v_1\left(1 + \beta_2^2\right)$$

$$v_1 = \frac{2v_2}{1 + \beta_2^2} \tag{8}$$

Substituting the solution for v_1 into the conservation of momentum formula (3) gets

$$m = \frac{m_0 v_2}{v_1 - v_2} = \frac{m_0 v_2}{\dfrac{2v_2}{1+\beta_2^2} - v_2} \tag{9}$$

$$\frac{m}{m_0} = \frac{v_2}{\dfrac{2v_2}{1+\beta_2^2} - v_2} \tag{10}$$

$$\frac{v_2}{\dfrac{2v_2}{1+\beta_2^2} - v_2} = \frac{1}{\dfrac{2}{1+\beta_2^2} - 1} = \frac{1+\beta_2^2}{2 - \left(1+\beta_2^2\right)} = \frac{1+\beta_2^2}{1-\beta_2^2} \tag{11}$$

The denominator on the far right of Eq. (11) further equates as

$$\sqrt{\left(1-\beta_2^2\right)^2} = \sqrt{1 - 2\beta_2 + \beta_2^2}$$

$$= \sqrt{1 + 2\beta_2 + \beta_2^2 - 4\beta_2} = \sqrt{\left(1+\beta_2^2\right) - 4\beta_2} \qquad (12$$

From the result of Eq. (12), Eq. (11) becomes

$$\frac{1+\beta_2^2}{1-\beta_2^2} = \left[\frac{\left(1-\beta_2^2\right)^2}{\left(1+\beta_2^2\right)^2}\right]^{-\frac{1}{2}} = \left[\frac{\left(1+\beta_2^2\right)^2 - 4\beta_2^2}{\left(1+\beta_2^2\right)^2}\right]^{-\frac{1}{2}}$$

$$= \left[1 - \frac{4\beta_2^2}{\left(1+\beta_2^2\right)^2}\right]^{-\frac{1}{2}} \tag{13}$$

In view of Eq. (8) the fraction or last term in the bracket on the far right side of Eq. (13) equates as

$$\frac{4\beta_2^2}{\left(1+\beta_2^2\right)^2} = \left[\frac{2\beta_2}{1+\beta_2^2}\right]^2 = \frac{1}{c^2}\left[\frac{2v_2}{1+\beta_2^2}\right]^2 = \frac{v_1^2}{c^2} = \beta_1^2 \tag{14}$$

Hence, by substituting $\beta_1{}^2$ of Eq. (14) for $4\beta_2{}^2/\left[1+\beta_2{}^2\right]$ of Eq. (13), Eq. (10) becomes

$$\frac{m}{m_0} = \frac{v_1}{v_1 - v_2} = \left[1 - \frac{4\beta_2^2}{\left(1+\beta_2^2\right)^2}\right]^{1/2} = \frac{1}{\sqrt{1-\beta_1^2}} \tag{15}$$

Hence

$$m = \frac{m_0}{\sqrt{1-\beta^2}} \tag{1}$$

3. Conserving Mass-Energy of Light

Verification of Eq. (1) was only for an inelastic collision between two equal rest masses. A more complete verification entails two unequal rest masses for both inelastic and elastic collision. Elastic collision is an inelastic collision plus the reverse of an inelastic collision, but it also involves a transfer of relative mass whereas the mass merely remains intact with regard to inelastic collision.

A more complete verification further entails the absorption and emission of light, as for showing a transfer of relative mass during elastic collision applies to light as well as to ordinary matter. The verification of two unequal rest masses is thus with regard to either reflection or absorption and emission of light energy. For simplicity the verification is only given here by example.

Let unit rest mass $m_0 = 1$ of zero momentum $m_0(0) = 0$ relative to observer A absorbing a photon of momentum $m_x c$ for $m_0 + m_x$ to move away from observer A at velocity $.6c$ relative to observer A. The total mass before inelastic collision was $m_c c + m_0(0)$. After inelastic collision it became $(m_c + m_0)(.6c)$. Given these results, total momentum is to be shown conserved, first, in view of conservation of total mass.

Since the total mass is conserved it equates in the manner

$$m_c c + m_0(0) = (m_c + m_0)(.6c)$$

$$.4m_c = .6m_0$$

$$m_c = 1.5m_0$$

Total momentum before the collision was thus $(1.5)(1)=1.5$ units. After the collision it became $(1.5+1)(.6)=(2.5)(.6)=1.5$ units. Total momentum of inelastic collision is therefore conserved along with conservation of mass.

Note: Total mass before and after the collision is simply $m_c+m_0=1.5+1=2.5$ units, as conditional to inelastic collision.

For the reverse process of elastic collision a photon is emitted from masses m_x+m_0 in view of observer B relatively at rest with equal energy in the opposite direction it was absorbed from. Relative to observer B the change in rest mass m_0 and its change in velocity and momentum is thus the same emitting the photon as absorbing it. Relative to observer A, however, the new velocity of observer B calculates according to the addition of velocities formula, where $v = v_1 = v_2$

$$v_{12}=\frac{2v}{1+\frac{v^2}{c^2}}=\frac{2(.6)}{1+.36}=\frac{15}{17}c$$

The relative mass becoming of m_0 relative to observer A is

$$m_2=\frac{m_0}{\sqrt{1-\left(15/17\right)^2}}=\frac{17}{8}m_0$$

The units of momentum becoming of m_0 relative to observer A are $(17/8)(15/17)=15/8$.

Conservation of momentum requires these units of momentum to be equal in opposite direction. They are thus calculated according to the Doppler formula in relation to the recessional velocity between observer A and the emitting source of light:

$$m_{xb}=m_x\left|\frac{1-v_{12}}{1+v_{12}}\right|^{1/2}=\frac{3}{2}\left|\frac{1-15/17}{1+15/17}\right|^{1/2}=\left(\frac{3}{2}\right)\left(\frac{1}{4}\right)=\frac{3}{8}$$

The total units of mass relative to Observer A are $17/8+3/8=20/8=5/2$, which is the same as they were for inelastic collision. Total units of momentum relative to observer A also remain as

$$\left(\frac{17}{8}\right)\left(\frac{15}{17}\right)-\left(\frac{3}{8}\right)(1)=\frac{15}{8}-\frac{3}{8}=\frac{3}{2}$$

Relative mass and momentum are therefore conserved with regard to the elastic collision between light and matter by way of a transfer of mass-energy between light and matter.

4. Inertial Space

Light is defined as having zero rest mass, but is light ever at rest? When it is reflected or absorbed and emitted by matter there is, in view of conservation laws of SRT, an exchange of relative mass. It therefore has mass.

How about gravity? Does it have mass? It can be shown that the space of a gravitational field also possesses the property of inertia.

According to GRT light moves slower in a gravitational field even though light speed is constant according to SRT. It therefore interacts with space-time as well as with matter, as to exchange relative mass with the field itself.

A condition of inertial space-time is evident with the retardation of light speed and all other events in a gravitational field. This retardation principle was derived in accordance with the Schwarzschild metric:

$$ds^2=\left(1-\frac{2GM}{rc^2}\right)c^2dt^2-\frac{dr^2}{1-\frac{2GM}{rc^2}}-r^2d\theta^2-r^2\sin^2\theta\, d\varphi^2 \tag{16}$$

The increment ds is with regard to invariance of the increments dt and dr of time and distance where the gravitational field of mass M is homogeneous, as within an infinitesimal volume of space where Newton's gravitational potential applies. The square root of $2GM/r$ in the relativistic factor $1-2GM/rc^2$ is the Newtonian escape velocity of the field.

If the event in question is a photon, then the difference between its actual change in position and its observed change in position, as in view of the principle of simultaneity, is zero, such that $ds=0$. By omitting polar coordinates $-r^2d\theta^2-r^2\sin^2\theta\, d\varphi$, the metric becomes

$$0=\left(1-\frac{2GM}{rc^2}\right)c^2dt^2-\frac{dr^2}{1-\frac{2GM}{rc^2}}$$

$$\frac{dr^2}{dt^2}=\left(1-\frac{2GM}{rc^2}\right)^2c^2$$

$$\frac{dr}{dt}=\left(1-\frac{2GM}{rc^2}\right)c=c' \tag{17}$$

The relative speed of light in a gravitational field is thus less than unity.

5. Equivalence and Mach Principles

The real significance here considered of the Schwarzschild metric is that it indicates the inertia of space. As to how ordinary matter can move freely through such a medium of space, except for its relative retardation effect, is because of the wave-like properties of matter that Louis de Broglie discovered. Wave equations essentially describe periodic effects, as cycles of rotation. Particles can thus create waves. Conversely, waves can carry momentum, as to possess particle effects. It is thus possible that mass propagates through space as waves of energy.

Consider matter as an anomalous condition of the space-time continuum in direct relation to gravity such that there would be no gravity if all mass were distributed evenly throughout space. There is, for instance, zero Earth gravity at Earth's center, as the influence of Earth's gravity in one direction is negated by its equal influence in the opposite direction. Similarly, if mass density was the same everywhere in space, then its equal influence everywhere in all directions would cancel. Gravity thus occurs as an anomalous condition of mass superposing on inertial space.

These conditions allow for an explanation of gravity as a contiguous action of inertial space. Mass as an anomalous condition of space and a medium for the propagation of mass-energy is also an equilibrium state of existence for gravity. Indeed, if the anomaly of inertial space is maintained by reflection of radiation, if more reflections occur in proportion to the anomaly of mass in the gravitational field, and if particles of mass move by superposition through the inertial space of the field, then the gravitational effect is thereby explained as a contiguous action of reflecting, or absorbing and emitting, radiation.

The anomalous and inhomogeneous condition of space as being conserved further provides an interpretation of the Mach principle according to principles of equivalence and general covariance of GRT. By the Mach principle the inertial property of mass is determined according to the relative distribution of mass as a whole. By general covariance this unevenness in the distribution of mass has the same effect regardless of where it occurs in the universe. General covariance thus merely conditions the Mach principle according to conservation of mass-energy and Einstein's interpretation of the principle of equivalence. The compatibility of these two principles, however, depends on how each actually applies to the real world.

Still in question here is the principle of equivalence. Atoms and subatomic particles, for instance, are predictable energy quanta, but how they are contained as such could be by the existence of a field structure of some kind. Is this field structure such that the mass and size of an atom is the same in all galaxies?

Field structure theory is essential in view of quantum physics insofar as a local measure of atoms or subatomic particles is determined by them having the same values. Moreover, in accordance with relativity theory the mass and size of an atom is the same whether it is measured either on Earth by an Earth observer or on Mars by a Mars observer.

It is evident that an exact form of the atomic structure somehow maintains throughout space. However, besides the successful predictions of quantum measurements, curious geometrical discoveries reveal unique relations between mass and mass volume. Carl Littmann, for example, discovered the volume of one of three large spheres enclosing one small sphere has a ratio of 270.10 to 1 to the volume of the small sphere, as in comparison to the average charged and non-charged mass of the pion, as in ratio to the mass electron, which is 270.13 to 1 [5]. Other mass ratios equaling volume ratios are with regard to the proton and electron, the kaon and electron, and the muon and electron.

Contrary to these mass-volume ratios the proton is about 1836.15 times the electron mass and the radius of the hydrogen atom is about 1836.15 times that of the nucleus of the hydrogen atom, which contains the proton. The density of the nucleus to the atom is thus to the fourth power, as being more mass per smaller volume, as is also consistent with the Stefan-Boltzmann fourth power law. As to explain why the mass-volume ratios equal the reverse of the radii ratios, fractals of field structure theory proposed by Charles Briddell and others is considered [6]. The geometrical layout of the kaon, for example, is of 3 outer circles each having a radius 9.89898 times that of a radius of 3 inner circles. Let that be the first step. The next step is 3 more outer circles with radii 9.89898 times the radius of a circle circumscribing the three previous outer circles. One more step renders an outer circle with a radius 9.89898 cubed times the most inner radius, which is the same as the ratio of volume between the most and second most inner circle.

A field structure is thus evident inasmuch as it is required for maintaining the proportionality of atomic particles. However, although the proportionality of say an electron mass in ratio to a proton mass is the same everywhere in space, as in view of a local observer, it is still possible for an electron mass in one galaxy to differ in size to say an electron mass in another galaxy.

These ratios could be relative to allow the squeezing of ubiquitous spheres of mass-energy into a smaller universe that stays proportionally the same, which has relativistic implications. Analysis of GRT, however, indicates there is no relativistic contraction of mass in relation to its position in a gravitational field. By the Schwartzschild metric both relative motion of ordinary matter and light speed are slow by the square of the relativistic factor in relation to the escape velocity of gravity. Relative motion of a body of mass in rotation is also constitutive of a clock, which in the field is also slow as to nullify the slowness of light speed and other relative motion. Assuming a relativistic contraction also occurs seems to confound this null result.

There is thus only a relativistic contraction of length in the direction of relative motion, as according to SRT. Postulating a contraction as such would at least constitute a modification of GRT. The modification here proposed is with regard to relating the curvature of space-time of GRT as a particular aspect of and subject to the conditions of a more general theory of electromagnetism.

6. Cosmic Coincidence Implications

The Dirac proposal of G varying with H constitutes a modification of GRT. Moreover, an expanding universe is complicated itself inasmuch as the observance of more distant stars is of the past, as the value of H should be greater if the expansion of the universe began at a common origin for the recession to continue at the same constant rate. However, BBT now interprets the astronomical data as indicating an increased rate of expansion due to the addition of dark energy in the universe. In contradistinction, it would be another remarkable coincidence if this increased rate of expansion is the same for a value of H interpreted according to a tired light theory. Since by it the shift in the light spectrum toward the red end occurs because of a partial absorption of light energy by intergalactic space, no increase of H is expected with regard to the more distant past.

The distinction between theories is analytically obvious, but interpretation of observational data is controversial in itself. The controversy is allowed by the difficulty of comparing minute differences of effects at astronomical distances. A variance in H, as according to the interpretation of WMAP data, is comparable to an increase in recessional speed occurring only at about 70 kilometers per second for every one hundred million parsecs increase in distance. One million parsecs equals 3.26 million light years, or 3.09×10^{19} kilometers.

Measurement of H has also varied extensively over the years. The range of values is from about 45 km/sec/Mpc to about 95 km/sec/Mpc depending on the nature of the group of stars studied along with the means of determining values. Nonetheless, these different means of determination could all relate to a mean as was determined by WMAP according to theory. However, a different interpretation of theory is now given.

The value of the Hubble Constant, as calculated from the data collected by WMAP, is 70.5 ± 1.3 km/sec/Mpc. This value of H multiplied by the diameter $2r_a$ of the hydrogen atom and divided by light speed c equals the ratio between the gravitational and electrostatic potentials Gm_a/r_a and $k_e e^2/m_a r_a$ for the mass of the hydrogen atom.

The proton and electron are the two fundamental masses of the smallest atom. The electron has about 1836.15 times less mass than does the proton as the nucleus of the hydrogen atom. The nuclear radius also approximates as 1836.15 times shorter than the radius of the hydrogen atom. Since the mass of the proton is about one part in 1836.15 equal to the mass of the hydrogen atom, the Cosmic Coincidence approximates as an equality between the Hubble Constant H times the diameter $2r_n$ of the hydrogen nucleus divided by light speed and the ratio of the gravitational and electromagnetic forces or potentials between of the proton and electron of the hydrogen atom. By substituting $m_e c^2 r_e$ as electron mass, light speed squared and electron radius parameters in place of the electrostatic charge unit squared, as in cgs units of centimeters, grams and seconds, the ratio of forces takes the form

$$\frac{Gm_p m_e}{k_e e^2} = \frac{Gm_p m_e}{m_e c^2 r_e} = \frac{Gm_p}{r_e c^2} = 4.4\times10^{-40} \tag{18}$$

where

$$\begin{aligned} m_e &= 9.10938215(45)\times10^{-28}\ \text{g} \\ c &= 2.99792458\times10^{10}\ \text{cm/sec} \\ r_e &= 2.8179402894\times10^{-13}\ \text{cm} \\ k_e e^2 &= 23.07\times10^{-20}\ \text{g-cm}^3/\text{sec}^2 \\ G &= 6.67428(27)\times10^{-8}\ \text{cm}^3/\text{g-sec}^2 \end{aligned}$$

The value of Eq. (18) also approximates in relation to the Hubble Constant with regard to the nuclear radius r_n and light speed:

$$\frac{2H_1 r_n}{c} \approx \frac{Gm_p}{r_e c^2} \tag{19}$$

The left side of Eq. (19) is linear whereas the right side is quadratic, but by multiplying both sides by $2r_e c$ and dividing them by $4r_n$ the approximation on the right further transforms into a form whereby the quadratic part is interpreted as a relativistic factor:

$$Hr_e \approx \frac{2Gm_p c}{4r_n c^2} = \frac{c - \left(1 - \frac{2Gm_p}{r_n c^2}\right)c}{4} \tag{20}$$

Eq. (20) relates to the difference in light energy after its spectrum has been gravitationally Doppler shifted. Although the dimensions of Hr_e are the same as those of a velocity, the relativistic factor is a general application such that a mass or some other kind of entity could be added to all equalities. Eq. (20), then, is open to further interpretation with various applications.

If the observable part of the universe is limited to a radius of $R = c/H$, then Eq. (19) further relates in the manner

$$\frac{k_e e^2}{R} \approx \frac{Gm_p m_e}{2r_n} = \frac{1}{2}m_e v_e^2 = \frac{1}{2}m_p v_p^2 \tag{21}$$

The electric charge of the electron, as spread throughout the observable universe, thus appears related to the kinetic energies of the proton and electron in relation to a gravitational Doppler shift of light spectrum. Eqs. (20) and (21) thus indicate that light moving through the observable universe is proportionally decreased by the relativistic factor of its gravitational field for every diameter $2r_e$ of the electron, with $2H$ as the constant of proportionality.

Further implications are with regard to the use of the inverse-square-law for describing both gravitational and electrical forces. Newton's inverse-square-law for gravity in further relation to centripetal force is of the form

$$F_g = \frac{Gm_1 m_2}{r^2} = \frac{m_1 v_1^2}{r} = \frac{m_2 v_2^2}{r} \tag{22}$$

Coulomb's inverse-square-law for the electrostatic force between two charges of q_1 and q_2 is of the form

$$F_e = k_e \frac{q_1 q_2}{r^2} \tag{23}$$

A centripetal force in relation to Ampere's law of induction of a magnetic field **B** for a moving charge, as currents of electricity through wires, is of the form

$$\vec{\mathbf{F}}_B = \frac{q\vec{\mathbf{v}}\times\vec{\mathbf{B}}}{c} = \frac{mv^2}{r}\hat{\mathbf{r}} \tag{24}$$

The arrows signify the velocity is perpendicular to the magnetic attraction such that the resulting direction of motion is circular or radial. The force of an electric field $\mathbf{F}_L$ is **E** times charge q. It combined with Eq. (24) renders the Lorentz force law

$$\vec{\mathbf{F}}_L = q\vec{\mathbf{E}} + q\frac{\vec{\mathbf{v}}}{c}\times\vec{\mathbf{B}}_L \tag{25}$$

Along with Ampere's Law of Induction for a moving charge Charles W. Lucas Jr. relates the magnetic field **B** to the electric field **E** in the manner $B \approx qE(v/c)$ [7]. As a consequence, Eq. (24) becomes

$$\vec{\mathbf{F}}_L \approx q\vec{\mathbf{E}} + q\vec{\mathbf{E}}\left(\frac{\vec{\mathbf{v}}^2}{c^2}\right) \tag{26}$$

Since the motion of electrons is involved in the process of induction, a relativistic modification is in order. The last term in Eq. (25) becomes

$$\frac{q\vec{\mathbf{E}}\left(\frac{\vec{\mathbf{v}}^2}{c^2}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \approx q\vec{\mathbf{E}}\left(\frac{\vec{\mathbf{v}}^2}{c^2}\right) + \frac{1}{2}q\vec{\mathbf{E}}\left(\frac{\vec{\mathbf{v}}^4}{c^4}\right) \tag{27}$$

Lucas further relates v as a free electron drift velocity that is generally detected in conductors to be about 3 cm/sec, or about $10^{-10}c$. Since the ratio of gravity to electrostatic forces is about 10^{-40}, Lucas identifies gravity as a residual effect of the order v^4/c^4, which he derived as a "universal electro-dynamic contact force" as an extension of Eq. (27).

The advantage of equating gravity as an electrical effect is gravity is then one of many different results of electrical phenomena that gravitational formula cannot itself explain. In addition to explaining gravity, for instance, Lucas claims his generalized equation explains "(1) the extra energy of the spiral arms of spiral galaxies which required dark matter and dark energy to be invented to rescue General Relativity Theory, (2) the quantization of gravity as codified in a modern version of Bodes Law which is totally missing from GRT, (3) the electrodynamic origin of the force of gravity as the force between vibrating neutral dipoles which have to radiate continuously producing the cosmic background radiation at 2.7 degrees Kelvin, (4) the electrodynamic definition of gravitation and inertial mass, (5) the force of gravity is a constant force due to the electric and magnetic fields of the vibrating neutral dipoles extending to infinity, remaining attached to the charges, and having tensile strength, etc.— the force of gravity slowly decays over time due to the decay of mass. The universal constant is not decaying. Evidence for the mass decay is an observed expansion of the earth, its moon, the other planets, and their moons. A gravitational red-shift was measured at Princeton University. A decay of the gravitational red-shift causes the Hubble red-shift with distance law on the average with deviations of Doppler shifts of distant stars moving towards and away from the earth."[8]

7. Conclusion

Challenge to established theory continues. Alternative theory providing explanation for the Cosmic Coincidence and other cosmic phenomena is offered whereby GRT could be applicable in modified form similar to how Newtonian Mechanics is modified to apply to the relativity of space, time, and motion. The true nature of the physical world, however, is still open to possibilities. The development of theory could still be in its infancy in need of countless contributors and worthwhile contributions.

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