GR, QM, and Field Unification

Horace Heffner December 2004

OVERVIEW

Herein is described a minor advancement to the theory of gravimagnetism, especially as developed by Oleg D. Jefimenko in his book *Causality, Electromagnetic Induction and Gravitation.* This advancement, which essentially consists of creating an isomorphism between gravitational and electromagnetic theory by including the imaginary number i in mass, brings a rigorous consistency to Jefimenko's theory, answers a number of questions, and by symmetry implies some startling predictions.

This is not a formal scientific article. This is an informal discussion of questions which the author, as an uneducated amateur physicist, has been puzzled. The first part of the discussion here merely exposes some old problems and questions, rambles somewhat, and is highly conjectural. This article was cobbled together from various of the author's news list postings. It does, however, show the train of thought which led to the concept. Jefimenko's theory is discussed and the central isomorphism developed, and then some possible implications are explored. The isomorphism suggests a logical nomenclature which is defined. The issue of which particles have mass is explored. That virtual photons carry no mass charge is proven through a mass halo computation. The concept of graviphoton (vs graviton) is developed. More questions and imlications are then explored within this new framework.

Many things here are likely wrong. However, some things may be right, and if so, the questions raised may be worth a student keeping in the back of the mind when learning about gravity or quantum mechanics.

SOME BASIC ISSUES WITH RESPECT TO GRAVITONS

In a quantum mechanics (QM) approach to gravity it is assumed that gravity, like the other forces, is carried by a messenger particle. This messenger particle is commonly called a graviton. If gravitons carry the gravitational force then numerous questions and conflicts arise.

If gravitons can interact with gravitons, as is typically thought of messenger particles, i.e. carry the gravitational force between themselves, then black holes would not be detectable in any way, even by their gravitational mass, because gravity itself could not escape them.

If gravitons travel through space, then Einstein's General Relativity (GR) theory, which shows gravity to be a side effect of the warping of space-time in the vicinity of mass, implies gravitons can not escape black holes for the same reason that photons can not, because space-time is too warped for them to escape.

For these reasons, either GR is wrong or the QM approach to gravity is wrong,

or gravitons do not travel through space-time as we know it, but rather through some other dimension or dimensions unrelated to space and time, but yet connecting all particles in space-time. The existence of such dimensions outside of space-time yet connecting every point of space-time would additionally help explain quantum entanglement, whereby information can be exchanged across the universe seemingly instantaneously.

PHOTONS, ENERGY AND MASS

Photons are today not thought to carry mass. However, it seems there is good reason to question this view. Energy and mass are involved in all photon exchanges. The universe may or may not spontaneously create mass and therefore energy from the vacuum, but it seems reasonable that in a given reference frame in this universe mass and energy must remain in the balance

$$E/m = c^2.$$

That is because photons carry momentum, and momentum corresponds to energy. By Plank's law, photons carry energy E:

$$E = h*nu = h(c/lambda)$$

and momentum

$$p = h/lambda$$

so photons always carry momentum and energy in the ratio

$$E/p = h(c/lambda)/(h/lambda) = c$$

Assume a photon is created by a nuclear event, where mass (delta m) is converted to energy at the exchange rate of E = (delta m) c^2, thus there is a loss of mass:

$$(delta m) = E/c^2.$$

This photon is thought, by conventional theory, to carry no mass, only the momentum p = E/c. However, to conserve momentum, a photon absorbed by a target mass must impart to the target mass an additional kinetic energy (delta K) corresponding to the change in velocity of the target due to the momentum change of the impacted mass, and if energy is conserved then (delta K)=E. However, by the special theory of relativity, that results in a corresponding increase in apparent mass of the absorbing body by the ratio (delta K)/c^2 = (delta m). So we have the mass (delta m) back! The photon carried mass (delta m) from one body to another. Therefore, in our rest frame, *both* mass and energy are conserved in such a photon exchange, as is the ratio E/m = c^2.

GR, QM, and Field Unification

Horace Heffner December 2004

The strange thing is that photons clearly carry mass from one place to another, i.e. do mass exchange in the end result, yet are thought to have no mass. Further, it is well known (from the lensing effects of stars) that photons are bent by gravity in an amount exactly equal to the amount a mass carrying body would be bent. It is said this proves space is warped about gravitational bodies, in that the supposedly mass-free photon travels the same path as a high speed mass carrying particle.

It seems far more logical that the photon has mass, that gravitons act upon photons. Photons are trapped in a black hole by gravity. Strange that a photon traveling directly away from a black hole, a singularity, supposedly reverses course upon itself, retracing its path right back to the black hole! If this is because space is warped, how is it the photon has a path to retrace at all, and how is it that velocity c is maintained?

Photons are thought to have no mass because the magnitude of their relativistic "momenergy" is zero, and this can only happen if their mass is zero. However, this approach to relativity does not consider the possibility that gravitational mass and inertial mass are not one and the same. A possible resolution of the apparent paradox is that the photon carries gravitational mass, i.e. a gravitational charge, and yet carries zero inertial mass. The EM fields of the photon carry no net inertia. They do not self-interact because they travel at velocity C, thus virtual photons cannot achieve self-force exchange within the waveform required to resist acceleration to c. This does not mean the photon carries no mass or momentum.

Then there is the principle issue of quantum gravity - the notion that gravity is exchanged by gravitons. If gravity is force exchange by gravitons, then the notion of warped space (in addition) provides a double apparent force, thus things are out of kilter. Is it graviton exchange that pulls the photon back to the black hole? If so, then the photon is capable of graviton exchange, and thus has mass. If it is not capable of graviton exchange, how is it that the photons are trapped by gravity, especially those on a course directly away from a singularity?

It seems reasonable that some of the dark matter of the universe might be photons. They are only "dark" because they are not hitting our eyes. The kinetic pressure of photons should cause the universe to expand more rapidly, especially at the periphery, than predicted by mass gravitational and momentum considerations only. The effect in the center of the universe would be to create more apparent mass than expected, though the mass density of photons in the vacuum of the universe would be exceedingly small.

PHOTONS, GRAVITY, AND CONSERVATION OF ENERGY AND MOMENTUM

GR, QM, and Field Unification

Horace Heffner December 2004

To consider issues of conservation of energy and momentum we might engage in a thought experiment because a single inconsistency, a single violation of a law, invalidates the law. Suppose we are in a space ship near a black hole. Further suppose that, through very advanced technology, the space ship is able to skim a laser beam near the surface of the black hole in just such an orbit that it returns to the ship. Though the space-time metric does not allow such an orbit for matter, it does permit such an orbit for photons. We obtain thrust upon emitting the beam, and further by absorbing it upon its return. This thrust is due to the well known photon carried momentum. Further, due to our advanced technology, we can perfectly reflect or re-emit the beam, and continually repel ourselves from the black hole without the use of significant further energy.

What is strange about all this? It is the lack of effect upon the black hole itself. Since (if) the photons have no gravitational mass, there is no gravitational attraction to the black hole, no mechanism of force on the black hole itself. This violates conservation of momentum, and thus conservation of energy as well. The photons change direction without a counter-force, thus violating Newton's laws. The photons, having no gravitational mass, neither warp space in the vicinity of the black hole nor exchange gravitons with the black hole.

Let us assume for a moment that the photons merely bend about the black hole due to the warping of space, and that somehow space itself provides a mechanism for transmitting the counter-force to the black hole. If this is the case, then that force upon the black hole is indistinguishable from gravity itself, and thus *is* gravity. If the force between photons and mass precisely follows the gravitational rule, on both the photon and the mass, then how is it that force is distinguishable from gravity itself? Further, the photons carry and deliver mass. Is it not reasonable to assume they "have" mass?

If photons do have mass then there is a seeming paradox that they can accelerate in zero time to speed c. However, as the mysteries of quantum mechanics and messenger particles go, this is not much of a paradox. Other than the fact we can not apply the formula m' = m * gamma to the photon, there is no reason that the photon can not still have zero rest mass, as the mass carried from place to place is incremental to and embodied in the masses which exchange the photon, not in the photon itself except during its journey. Inertial mass may in fact be separate and distinct from gravitational mass, and the instantaneous acceleration of the photon may indeed provide proof of that fact. When the photon is at "rest" it has already transferred its mass-energy to the body which has absorbed it. When in motion it has only one velocity, namely c. Its mass and energy is determined by the rest frame from which it is observed.

Further, it may be questioned as to whether the photon actually has a journey,

since in its reference frame the journey takes zero time. The path of its journey is thus laid out fully in advance of or at least at the moment of departure, and exists for the photon as a singularity in time. For the photon there is no oscillation, no frequency, no Newtonian effects, no process, no wavelength, merely an event. If time dilation is real, then the effects of gravity and every other form of possible interaction on a photon's set path must thus be worked out in, exist in, an instant. Gravity exchanges with the photon must exist in a framework independent of space-time. Similar truths would have to exist for the graviton if relativistic effects apply to the graviton. These strange qualities it seems makes photons and gravitons more alike than not alike, though to some extent they may in part exist in separate universes. The graviton must be incapable of exchanging gravity with itself, and must, when considered in the context of general relativity, exist at least partly outside of space-time.

Despite the unfathomable nature of existence, in our limited framework of understanding, it seems more reasonable and consistent than not to assume that the photon has gravitational mass. However, assuming the contrary is also exciting, in that, as demonstrated by the above thought experiment, it opens the door to the possibilities of free energy and reaction mass free propulsion, since conservation of energy and momentum are no longer inviolable laws.

CAUSALITY AND JEFIMENKO'S GRAVITY

In establishing his correspondence between gravity and the electromagnetic field, based primarily on causality and the effects of retardation, Jefimenko, in *Causality, Electromagnetic Induction and Gravity*, creates the correspondence of G to -1/(4*Pi*epsilon_g_0) to -mu_g_0*c^2/(4*Pi). The term epsilon_g_0 here is the gravitational equivalent to the electrostatic permittivity of the vacuum epsilon_0, and mu_g_0 is the equivalent to the magnetic permeability of the vacuum mu_0, as will be explained below. Jefimenko's version of EM fully accounts for causality, i.e. the fact that a cause at a distance d can not precede the effect by time delta t which is less than d/c (or d/c_g in the case of gravity.) Jefimenko shows that causality justifies invention of the co-gravitational field K, analogous to B. This will be shown below to make a full gravitational-electromagnetic field isomorphism possible. Jefimenko demonstrates that B, and thus K, are merely computed quantities, secondary quantities that necessarily follow from the only true causes, the interaction of charge upon charge or mass upon mass. This provides strong evidence for the "real" existence of K, as "real" as B, i.e. that an (apparent) K can be observed experimentally to the same extent B can, though it is much more difficult to observe due to the extreme orders of magnitude involved. In other words, if causal electromagnetism is correct, then the causal gravity is also necessarily correct. The isomorphism holds by

necessity because the full set of postulates have already been experimentally verified. However, if it turns out that causal electromagnetism is incorrect, and B exists in a real sense, then it does not follow that K can (any longer) be assumed to exist on the basis that it is merely a computed quantity, like energy.

B and E are variable when the velocity of the observer is taken into account. This magnitude dependence on observer velocity is fully accounted for by causality treatment, because the relative velocity of the observer merely changes the apparent retardation. This aspect even more fully justifies Jefimenko's treatment of B as an artifact of charge motion.

In Jefimenko's text the world of gravity and electromagnetism are maintained as separate worlds, and merely corresponded to each other. Jefimenko thus uses epsilon_0 in the gravity context to mean -1/(4*Pi*G), and mu_0 to mean -4*Pi*G/c^2. He also uses c to mean the speed of propagation of gravity.

Here use the new notation epsilon_g_0 to mean the permittivity of space to gravity, mu_g_0 to mean permeability of space to co-gravity, and c_g to mean the speed of gravity propagation. So far there is really no change with the view of Jefimenko, only an extended notation. There are some immediate advantages to this notation, however. First it provides corresponding constants which could have been nicely used in the EM to gravity correspondences on page 104 of Jefimenko's book: *Causality, Electromagnetic Induction, and Gravity*. Namely we could have the new Table 1, shown below.

Electric	Gravitational
q	m
E	g
B	K
J	J_g
epsilon_0	epsilon_g_0
mu_0	mu_g_0

Table 1: Initial Gravity-electromagnetism Isomorphism Correspondence Table

However, this is still not ideal. We have a problem with signs, as it appears did Jefimenko, but which he remedies by placing minus signs in the corresponding formulae. The problem lies in the fact that, to maintain the convention that a positive force is repelling, we end up with sign problems between the force equations:

$$Fg = G*(m1*m2/r)$$

for gravity and

$$Fe = k*(q1*q2/r^2) = (1/(4*Pi*epsilon\_0))(q1*q2/r^2)$$

for the Coulomb force.

Jefimenko fixes this problem by making his epsilon_g_0 and mu_g_0 negative. Thus, in effect he has the gravitational equivalent to the above:

$$Fg = G*(m1*m2/r) = (-1/(4*Pi*epsilon\_g\_0))*(m1*m2/r^2)$$

His gravitational permittivity and co-gravitational permeability thus end up negative in order to preserve the correct sign on force. This eventually causes problems. An example is the Poynting vector correspondence:

$$S = (1/mu\_0)\ E \times B$$

vs the Jefimenko gravitational version:

$$P = (c^2/(4*Pi*G))\ K \times g = (1/mu\_g\_0)\ K \times g$$

Note that Jefimenko here reverses K and G instead of using an arbitrarily placed minus sign.

It appears that there is a handy way out of this lack of true isomorphism. That solution is to specify the sign of the mass charge in terms of i = (-1)^(1/2), the imaginary number i. Charge has sign, so why not mass? This then makes the isomorphism complete. We now have

$$epsilon\_g\_0 = 1/(4*Pi*G)$$

$$mu\_g\_0 = 4*Pi*G/(c\_g)^2$$

and all the formulae then exactly correspond, including signs. The disadvantage to this approach is that the imaginary number i must be carried throughout the gravitational field units. Perhaps this is really an unexpected advantage though. Gravitational fields are imaginary, electromagnetic are real. There is then some hidden meaning to this? One is that the two worlds ARE for the most part disconnected. We have in fact an indication of field *dis-unification*. Additionally we have that anti-gravitational matter, if it exists as implied by symmetry, would then carry sign (-i).

SPEED OF GRAVITY

Jefimenko adapts his theory to account for general relativistic effects by adjusting the speed of gravity. He notes (p. 135 ff.) that to account for the precession of the perihelion of Mercury, that the speed of propagation of

gravity must be about 0.3 c. We thus have

c_g = 0.3 * c

and we know that

(c_g)^2 * epsilon_g_0 * mu_0_1 = 1

thus

(0.09 c^2) * epsilon_g_0 * mu_0_1 = 1

and we also have

mu_0 = (4/0.9)*Pi*G/c^2

We now have the full correspondence shown in Table 2 below.

Electric	Gravitational
q	m * i
E	g
B	K
J	J_g
epsilon_0	epsilon_g_0 = 1.192602x10^9 kg s^2/m^3
mu_0	mu_g_0 = 1.037x10^-25 m/kg
c	c_g = = 8.99x10^7 m/s (Jefimenko's estimate)

Table 2: Gravity-electromagnetism Isomorphism Correspondence Table

where we now (roughly) know epsilon_g_0, mu_g_0, and c_g, and gravitational mass is expressed in terms of imaginary units i. J_g is mass current. Inertial mass everywhere in relativistic cases is the relativistic mass m0*gamma. We have a complete field isomorphism.

This isomorphism implies both a connection, as well as disconnection, between the electromagnetic and gravitational fields. We have achieved a form of "field dis-unification." The existence of i in some resulting equations distinctly and permanently isolates the purely gravitational fields and masses from electromagnetic components. We also now have computed fundamental constants: c_g, epsilon_g_0, and mu_g_0, as they must be according to Jefimenko's theory.

THE PROPOSED ISOMORPHISM IS NOT LIMITED TO JEFIMENKO'S VISION OF EM

Any complete theory of electromagnetism, including electromagnetism within the framework of relativity, can be used to create an isomorphism between electromagnetism and gravity, provided B in the theory is not real in the sense it is simply a byproduct of the other laws of the electromagnetic theory, and the electromagnetic vector potential function can be be derived from the (retarded) motion of charge. Jefimenko showed that the law of causality, if postulated, ensures that B meets this criteria. It is suggested here that the subject isomorphism can be established by first measuring or establishing the rate of propagation of gravity, c_g. We then can compute the permeability of space to co-gravity:

mu_g_0 = 4*Pi*G/(c_g)^2

and the permittivity of space to gravity:

epsilon_g_0 = 1/(4*Pi*G).

It is expected that c_g = c when full relativistic effects are applied, though, the ratio c/c_g is likely to change within close range to massive objects, due to the fact gravity and electromagnetism operate in separate spatial dimensions.

We now establish the isomorphism by applying the following rules to every electromagnetic law in order to obtain corresponding gravitational laws.

Replace c, mu_0 and epsilon_0 with corresponding terms c_g, mu_g_0, and epsilon_g_0 above. Co-gravity K is defined as the gravitational equivalent to (corresponds under the isomorphism to) B, the magnetic field intensity B. Gravity g is defined as the gravitational equivalent of the electrostatic field E. Wherever charge is used, gravitational mass (gravitational charge) is substituted, with the sign of the charge removed (if ordinary matter is involved, i.e. not anti-gravitational matter) and replaced by the imaginary number i. J_g is the mass current vector corresponding to current density vector J.

When special relativity is included, we then have the full correspondence shown in Table 3 below.

Electric	Gravitational
q	m * i
E	g
B	K
J	J_g
epsilon_0	epsilon_g_0 = 1.192602x10^9 kg s^2/m^3
mu_0	mu_g_0 = 9.329597x10^-27 m/kg
c	c_g = c

Table 3: Gravity-electromagnetism Isomorphism Correspondence Table

NOTATION AND NOMENCLATURE RELATED TO GRAVITATION

The EM-GK isomorphism provides analogs to a vast quantity of physical laws, formulae and terms. This can cause much confusion in the process of attempting to assign names and symbols the gravitational analog items. To be consistent, and end terminology confusion, when discussing or expanding the isomorphism proposed here between the electromagnetic (EM) and gravikinetic (GK) fields, when referring to a gravitational feature the analogous term borrowed from the EM universe should be prefixed with "gravi" to indicate that that analogous feature is in the GK universe. If it is not appropriate to prefix a term with "gravi" then it can be preceded with the adjective "gravitational".

Under the proposed EM-GK isomorphism every variable, every formula, every unit in EM has a corresponding value, a gravitational analog. The formulas and variables from the EM world should be used faithfully, and simply subscripted where necessary with a g to designate the GK analog.

The exceptions to these rules are the variables g, and G, and co-gravitational field K, which is hereby now called the gravimagnetic field K, which are symbols that already have specific meanings.

Based on the above principles, the following are sample correspondences:

electrostatic field E: gravitational field g
magnetic field B: gravimagnetic field K
electromagnetic (EM) : gravikinetic (GK) (a necessary rule exception)
charge: gravicharge (an imaginary quantity in units of +i kg, or possibly -i kg, not to be confused with mass)
current: gravicurrent (an imaginary quantity in units of +i kg/s)
magnet: gravimagnet
monopole: gravimonopole

```
Poynting vector P:    gravitational Poynting vector P_g
ohm (omega):         graviohm (omega_g)
permittivity (epsilon) :     gravipermittivity (epsilon_g)
permeability (mu) :          gravipermeability (mu_g)
lightspeed (c):              gravispeed (c_g)
impedance of the vacuum (nu):  graviimpedence of the vacuum (nu_g)
Maxwell's laws of electromagnetism:  Maxwell's laws of gravimagnetism
Gauss' Law of electric flux:  Gauss' Law of gravitational flux
Laplace's Law of Electrostatic potential:   Laplace's Law of Gravitational
Potential
```

Similar terminology should be used when applied to the laws of Lenz, Biot-Savart, Ampere, Ohm, etc. The theory itself, the EM-GK Isomorphic Theory, can thus simply be called a theory of gravimagnetism.

This approach to nomenclature puts an end to the need for all kinds of special terms and variables. Also, when the meaning is clear, one can simply dispense with the g subscripts, and thus incur no notation overhead whatsoever. Note that this approach would not work well if the isomorphism were not complete.

NEWTON'S LAWS

Equations involving a single mass term, like Newton's description of inertia:

$$F = m*a$$

would seem, under the rules of the isomorphism, to produce an imaginary force ... if the m were a gravitational mass. The m must therefore be an inertial mass component of the affected body, it must be "real" and thus associated with an electrostatic field. A mechanism for producing such a force has long been theorized. That mechanism is due to the need for charged particle, e.g. the electron, to have a finite radius. If the electron did not have a finite radius, its field would contain an infinite energy and mass. Given that the electron has a finite radius, it must be composed of multiple mass portions, a mass portion associated with charge, and a mass portion associated with maintaining the structural integrity of the electron. Further, since the electron has a finite size, movement of one portion of the electron is "sensed" by other portions only in a delayed or "retarded" fashion. This delay results in a net self-force on the electron during acceleration, and thus increased inertia. The electromagnetic self-force accounts for most of the inertia of the electron. Exactly what percentage depends on the distribution of charge in the electron waveform. There possibly can be an inertial component to the gravitational mass or there must be some other component of the electron with inertial mass, as well as the electromagnetic inertial mass, if the full inertia of the electron is to be explained. (see papers by Ibbotson.) This is especially true for heavier leptons.

MORE ON MASS COMPONENTS

To summarize the conceptualization presented here thus far in a variation of Jefimenko's vision of gravity and electromagnetism, called here the EM-GK Isomorphism Theory, or more simply the theory of "gravimagnetism", charged particles have both an electromagnetic mass and a gravitational mass component. It is not fully justified as to whether fields have or not have a gravitational mass component. Inertia, however, is in the electron principally a function of the electromagnetic component of mass, and is due to the self-force of a charged particle when it accelerates. That self-force is due to the finite size of the charge, and the delay of force from one part of the charge to other parts over a finite distance. Inertial mass and gravitational mass are differing things with differing causes. The causes are charge and gravitational charge respectively.

It is of interest that electromagnetic retarded self-forces in the electron were used to predict m=m0*gamma before relativity was even invented. It seems that the two kinds of mass are only correlated in our minds, and by their fixed proportion in the environments where we have done gravitational experiments.

If gravity and light exist in isomorphic yet partially independent worlds, and if inertia is primarily a result of an electromagnetic (and strong force or other field) self-force of matter upon its own waveform, then by that isomorphism the gravitational portion of mass may itself have an analogous inertia which exists purely in the dimensions occupied by gravitons. There are thus two components to mass, the inertial mass component and the gravitational charge component. The fact the photon carries no inertial mass, even though it carries momentum, seems to dispel the notion that gravitational charge carries inertial mass.

Gravity can not act upon the gravitational field carriers, but thus far might possibly be considered to act upon the electromagnetic field, i.e. upon virtual photons, and certainly upon photons. Otherwise, black holes could not exist. If gravitons affected gravitons, black holes would cease to exert gravitational forces. If gravitons did not affect electromagnetic fields, then it appears at fist consideration that photons would not be prevented from exiting black holes, and black holes would not exist. However, if gravitational charge exists entirely separate from electrostatic charge, then this may not be so. Much more on this below.

If this conceptualization, The EM-GK Isomorphism Theory, is even roughly correct, then attempts at artificial gravity and electrogravity and even a fully unified field theory are likely to fail. The exciting thing, though, is that inertial mass might be manipulated to some degree by electromagnetics,

and that has significant implications for both space travel and energy generation.

MASS HALOS

We will now dispel the possibility that electromagnetic fields carry a gravitational component, i.e. that gravitons act upon virtual photons or that electromagnetic fields carry gravitational mass. In other words, it will be shown that under the EM-GK Isomorphism, virtual photons can not carry a gravitational charge.

When a pair of nearby charged particles are viewed from a distant perspective, they form a dipole field that dissipates in a 1/r^3 manner. Their fields are said to "superposition" and thus cancel. However, if fields carry a mass component, an imaginary gravitational mass component that is, this component will not superposition. The gravitational component terms will add independently, irrespective of the polarity of charges generating a super positioned field, because they each are positive and contain the factor i. We thus end up with a mass flow about any neutral mass equivalent to the mass of the electrostatic field that would exist if all the charges in that neutral mass were of the same polarity. Electrostatic fields are said to consist of virtual photon flows. According to the theory being advanced here, these virtual photons must at all points have an electromagnetic inertial mass component, and thus carry momentum, but lacking any imaginary portion, they cannot carry any gravitational component.

Let us now assume for a while that electromagnetic fields have mass.

A difference in charge might be viewed as a difference in time's arrow. Positive charge might absorb virtual photons and negative charge emit virtual photons, or vice versa. If not, and virtual photons have polarity, then there is a mass flow away and only away from any mass. Otherwise, there are matching mass flows into and out of any neutral mass. In either case, any mass has a large mass halo. The virtual photons flowing from neutral matter carry the vibrational energy signature of the emitting sources in addition to the momenta and presently assumed mass of the virtual photons.

We will now attempt to quantify the size of the mass halo which must exist if electromagnetic fields carry gravitational mass, i.e. carry an imaginary portion under the proposed theory.

The majority of the ordinary matter of interest here is composed of charged particles, i.e. either quarks having -1/3 or +2/3 the charge of an electron, or electrons themselves. Up quarks carry +2/3 q_e, or 2/3 the charge of an electron but opposite in sign. Down quarks carry 1/3 q_e. Even neutrons carry charged quarks, so must be accounted for in the tabulation of components

of a mass halo. For purposes of computing the mass halo density, we are interested in knowing the density of absolute charge in matter, not net charge. Protons carry two up quarks and one down quark, thus carry a total of absolute charge of 4/3 q_e. Neutrons carry two down quarks and one up quark, and thus have no net charge, yet carry an absolute charge of 4/3 q_e. If we assume roughly 1.1 neutrons per proton in the matter of interest, then we have an average absolute charge density of:

rho_c = (1.1*(4/3 q_e) + (4/3 q_e) + q_e)/(1.1 m_n + m_p + m_e)

rho_c = 1.732x10^8 coul/kg

The mass of the earth is 5.975x10^24 kg, so the earth carries an absolute charge of about 1.0375x10^33 coulombs. The mass of the sun is about 1.98x10^30 kg, so it carries an absolute charge of 3.43x10^38 coulombs.

Given an electrostatic field E from charge q, at radius r we have:

E = q/(4 Pi e_0 r^2)

and thus the energy density rho_energy is given by:

rho_energy = (e_0/2) E^2 = q^2/(32 Pi^2 e_0 r^4)

and given that the energy is equal to m*c^2, we have

rho_mass = rho_energy/c^2

so:

rho_mass = q^2/(32 Pi e_0 c^2 r^4)

and thus the density of mass in the mass halo is proportional to 1/r^4.

Using 4 Pi r^2 dr as a volume element, we integrate to obtain total halo mass in a region:

m_halo = integral of q^2/(8 Pi e_0 r^2 c^2)

and the mass of the halo from r_1 to r_2 is given by:

m_halo = (q^2/(8 Pi e_0 c^2) (1/r1 - 1/r2)

and integrating from r1 to infinity we thus have total external halo mass m_t:

m_t = (q^2/(8 Pi e_0 c^2)) (1/r1)

Using 1.21x10^17 coulombs for the earth, and a radius of 3.185x10^6 m, and making the very imperfect assumption that all the charge is located at the center of the earth, we obtain a minimum external mass halo for the earth of:

$$m_{t\_earth} = (1.0375\times10^{33}\ C)^2/(8\ Pi\ e_0\ c^2)\ (1/(6.371\times10^6\ m))$$

$$m_{t\_earth} = 8.45\times10^{51}\ kg$$

$$m_{t\_earth} / m_{earth} = (8.45\times10^{51}\ kg)/(5.975\times10^{24}\ kg) = 1.41\times10^{27}$$

This is an enormous halo mass.

We have not considered yet the ratio of the inertial mass portion to the gravitational mass portion. If here is any validity to this theory at all, then it is clear that the gravitational portion of the mass of the electromagnetic field must be very small indeed, much much less than 10^-27 of the total inertial mass of the electromagnetic field. Otherwise orbital mechanics applied to earth satellites would very quickly show us some gravitational anomalies. The apparent mass of the earth would increase with radius, and this would cause precession of the perigee. The mass halo also has implications to the quantity of recession of the perihelion of Mercury, and thus to the velocity of gravity that Jefimenko selected.

It is further notable that the proportions of gravitational and inertial masses in electromagnetic fields need not be the same as that for ordinary matter. However, it would seem that the gravitational component of mass in an electromagnetic field can not be zero, else black holes can not exist. This seems to represent a crisis to the theory.

There is a possible resolution to this crisis. Our initial assumption that electromagnetic fields carry gravitational mass was wrong. Electromagnetic field forces are carried by "virtual photons" and if virtual photons do not interact with gravitons then the need for the huge mass of the mass halo disappears. The implications of this fact are significant. Even though light itself can not escape black holes, electromagnetic fields can! Back holes might carry signatures of the angular momentum of their mass constituents in the form of massive magnetic fields. They can carry a net electrostatic charge that affects neighboring space.

It is only when electromagnetic fields break free of inertial mass, i.e. are photons, that they carry the ability to interact with gravitons. Electromagnetic fields can only break free in the form of photons. Considering that quantum entanglement between the mass carrying particle and the photon it creates can exist, it is perfectly logical that such a space-time independent link exists via the graviton dimensions between the originating gravitational mass and the gravitational charge associated with an entangled photon.

GRAVITATIONAL ZPE

Gravitons may be assumed to be entities which isomorphically exist in a set of dimensions in part independent from their cousins the photons. Gravitons thus have their own independent but isomorphic constant speed c_g which is meaningful in the graviton-visible universe. The full extent of the isomorphism requires significant effort to reveal the full ramifications. However, when phenomena exist in the electromagnetic universe it is reasonable to expect analogous phenomena in the gravitational universe, and further for these phenomena to interact to some extent in the combined universe.

The thermal motions of small charge pieces of mater in the universe is said by some to create zero point energy (ZPE) which accounts for the Zitterbewegung of matter. There must then be a gravitational equivalent to ZPE, a gravity wave equivalent to the zero point field (ZPF), due to the thermal vibration of matter throughout the universe. It is therefore a logical conclusion that the ZPF, with its cubical energy distribution by frequency, has two components, an electromagnetic component, and a gravitational component, though the gravitational component may be so small as to be undetectable. However, it may be that there exists a 1/r^3 distribution dipole field, both electromagnetic and gravitational, which also has a 1/r^3 energy to frequency distribution, that is in fact detectable close to large masses.

EVIDENCE FOR EXISTENCE OF THE GRAVIMAGNETIC FIELD

The existence of the gravimagnetic field is demonstrated by the precession of the equinoxes, the precession of the earth itself. The direction of the local gravimagnetic field is in the direction of the mean axis of orientation of the earth. The precession of the earth is due to the fact that the earth's axis is not oriented in the direction of the local gravimagnetic field, which is principally generated by the moon, sun, local stars, and the galactic core. Since the spinning earth represents a gravi-dipole, it has a gravimagnetic field. The earth's gravimagnetic field is not oriented in the direction of the local gravimagnetic field, and thus there is torque upon the earth that causes it to precess. This precession results in, is, the precession of the equinoxes. Careful three body analysis of the earth-moon-sun system, accounting for retardation, provides the same results as that obtained by use of gravimagnetics concepts. However, there are minor anomalies in the precession of the equinoxes. Analysis of these anomalies from the gravimagnetics perspective may provide evidence for motions of black holes in the vicinity.

RATIO OF INERTIAL MASS TO GRAVITATIONAL MASS

It sometimes is noted as strange that inertial mass and gravitational mass are equal. The EM_GK Isomorphic Theory shows that this coincidence is one of our own making, and thus an illusion. The kg weight and kgf force unit are related so nicely only by the fact that we live on earth, and that earth is fairly spherical, so g_earth is fairly constant at the surface. If our physicist ancestors lived on a planet where g was 3 times that of earth, the kgf would be 3 times as large and after setting that standard, i.e a kg weight being 3 times ours, the G they would subsequently discover or determine would be larger by a factor of 9 (than the G we earthlings "discovered") in order to compensate for that choice of definition of units of weight, i.e. gravitational mass.

What is actually constant in our comparatively low gravity environment is the ratio of inertial mass to gravitational mass. Our perception that the two masses (actually mass and weight) are equal then is flawed, but our earthling determined value of G compensates for this.

Under the EM-GK isomorphic theory of gravity proposed, what is important is that some particles, like the photon, consist of quantized chunks of gravitational mass and quantized chunks of inertial mass which are bound together. If there is only one chunk of each, or a fixed ratio of such chunks, then the ratio of the two kinds of mass must always be constant, unless changed by relativistic effects involving differing messenger particle velocities. An increase in the ratio of inertial mass to gravitational mass would appear to be a slowing of time, because all physical clocks, having higher inertial mass, would appear to be slow.

ANTI-MASS RADIATING BLACK HOLES

If both positive charge mass (units of +i kg) and negative charge mass (units of -i kg), i.e. anti-mass, exist, and two particles carrying opposite mass charges are matter and antimatter to each other, then an amazing phenomenon can possibly happen if and when a black hole singularity becomes massive enough. The black hole can radiate mass having the opposite mass charge from that which the black holes has. In other words, when a black hole gets large enough it should spew forth at near light speed large amounts of matter that is anti-mass to the mass of which the black hole is made. As the gravitational field strength in a locality grows, so then does the probability that a mass-anti-mass pair fluctuating in and out of the vacuum can be permanently separated by that gravitational field. The particle having the same mass charge as the black hole quickly disappears into the singularity, or some approximation thereof. The anti-mass particle, however, is immediately blown out of the black hole with enormous energy. The event horizon for the anti-mass particle does not exist. Such an event does not just happen at an event horizon, but rather throughout a spherical volume about the singularity.

The larger the singularity, the more anti-mass flow that can be expected out of the black hole, because the flow grows as the 3/2 power of the mass of the black hole.

This is a fairly scary concept, because it means that once a critical mass is formed, a black hole can explode continuously in size without boundaries. It can suck up all the matter the vacuum can feed it. Its event horizon then grows at an exponential rate, as does its mass and rate of anti-mass radiation. Fortunately, this is not a likely possibility, because the gravicharge of the photon is very small, thus the quantum of gravitational charge must correspond to a small energy. Anti-gravitational matter it seems should be more commonplace.

One possibility (other than denial of the proposed EM-GK isomorphism) that precludes this scenario is that matter and antimatter particles must all have identical mass charge signs. This is a very reasonable possibility. If mass-anti-mass pairs formed from the vacuum, they would not need a black hole to proliferate. They would self-repel.

So, a more logical possibility then is that if anti-mass particle pairs exist, then, when they are created by vacuum fluctuations, their matter-anti-matter particles have differing electrostatic charges, but the same (negative) gravitational mass-charge sign. In this way such particles can quickly annihilate and return to the vacuum from which they spring with far less frequency than pairs having positive and negative mass charges. This also to some extent gets us around the problem of the expected cominality of an exponentially exploding event horizon radius. The black holes have to become large enough that tidal forces separate the pairs despite their enormous electrostatic attraction. It does not eliminate the possibility that black holes above *some* large limit in mass will radiate near light-speed anti-mass particles. The reason for this is that when a particle pair separates within a fixed radius shell, and thus separate in a direction along a tangent to that shell, both particles are accelerated outward away from the black hole, and indefinitely separate, provided the tidal force that separates them (they each lie on separate diverging radii) is large enough.

We thus see that the neighborhood in the locality of huge black holes could be filled with objects made of anti-mass, including anti-mass black holes (anti-mass attracts itself). Such a neighborhood would appear to gradually take on an increasingly weaker gravitational constant. Some visible (or even invisible) bodies consisting a mostly anti-mass would take on maverick motional characteristics.

All highly speculative, yet all a direct and immediate consequence of the EM-GK Isomorphism Theory. Various particles are suggested by the resulting symmetries, including gravimonopoles.

GRAVIMAGNETICS, DARK MATTER, AND DARK ENERGY

If the messenger particle of gravity, gravitons, had a speed c_g less than the speed of light c, and gravity began with the big bang, then objects exceeding c_g at the time of the big bang could outrun gravity itself. It seems reasonable that c_g >= c. Even if in all cases c_g >= c, objects near the speed of c or even just distant from the center of the universe, i.e. the origin of the big bang, would have a diminished gravitational attraction to the center of mass of the universe because of retardation.

Retardation is the delay of effect due to transit time, in this case the transit time of gravitons. For distant objects, created at the time of the big bang, the gravitons from much of the universe are in transit, while for objects nearer the center of the universe a higher proportion of gravitons have completed their force transfer. Then net result is an apparent force accelerating objects that are further away from the center of the universe. This is not a true force, but rather an effect producing a force less than the expected gravitational force. The diminution is proportional to the distance between bodies.

This means a quantum treatment of gravity provides a possibility other than either an ever expanding universe or an ultimately collapsing universe. That possibility is that matter sufficiently far away will not return to a big crunch, while other matter closer to the origin of the big bang may crunch.

Gravimagnetics also provides a similar and at least partial explanation for dark matter. The gravimagnetic force, a 1/r^4 force between gravimagnetic dipoles, is powerful for objects close together. Ordinary orbital mechanics applied to close objects with similar spin axes will overestimate the mass involved, as compared to distant interactions of the same bodies. These are two sides of the same coin, depending on which mass information is obtained and relied upon first. The result is either apparent dark energy or dark matter, depending on the initial basis for determining the mass.

GRAVIMAGNETICS AND QUANTUM GRAVITY

The EM-GK isomorphism of gravimagnetics is complete, thus it extends all the way to the quantum world. The mediator of the gravitational force, the messenger graviton, i.e. virtual graviton, is the analog of the vitual photon. Unlike the photon, and like the virtual photon, the **virtual graviton**, commonly just called a graviton, carries no gravitational charge. An interesting thing then is the possibility of a **real graviton**, the momentum carrying mass charge carrying analog to the photon itself. Gravity waves of a generally unexpected kind may indeed be generated and sensed then at much higher frequencies than anticipated.

Gravimagnetics is forced into the quantum world by the fact the smallest angular momentum is h/(4*pi) and the smallest increment of angular momentum is h/(2*P). In that gravimagnetics defines the electromagnetic force and gravimagnetic force as independent entities in separate dimensions, the unification of the two fields is only through the embodiment of both charge and gravitational charge within some individual particles. The Bohr magneton, (q_e/m)* h/(4*Pi), thus establishes the link between the two quantum universes.

POSSIBLE FUTURE RESEARCH

Under this theory, the proven lack of gravitational mass in electromagnetic fields, the lack of interaction between the messenger particles of gravity, the virtual graviton, and virtual photons, resolves long standing issues regarding the theory of the zero point field (ZPF). It has been a matter of controversy (see papers by Puthoff and Ibbotson referring the the SED theory) as to whether the ZPF is carried by virtual or real photons. Further, a long standing objection to the ZPF concept has been that, to maintain an energy/mass ratio of c^2 the density rho of the ZPF in the vacuum would be astronomical in size if the cutoff frequency of the cubic energy distribution occurs at a Plank wavelength. This theory clearly resolves these issues by showing that no such high rho is required provided the ZPF is carried by virtual photons. Further, if a means can be found to interact with the colossal ZPF virtual photon flow, enormous amounts of inertial reaction mass is available from the vacuum.

Also of immediate interest is that existing gravitational computations may be off due to a failure to consider the effects of the gravimagnetic field K, which is a dipole field and thus diminishes as 1/r^3. Rotating satellites in polar orbits, or in orbits contrary to the earth's rotation, though in exactly the same orbits altitude wise, should experience slightly differing apparent values of g, thus their orbital parameters should differ slightly. Rates of precession of rotating bodies can be used to directly compute the value of the co-gravitational field K. Precession of a spinning body in space, in varying orientations, can be used to compute the local gravimagnetic field K.

Also of possible interest is determination of the magnitude of the gravimagnetic field of the Milky Way galaxy, plus influence from the closest great attractor, etc. Since much of the mass of the galaxy is located at the center, much of it in black holes and neutron stars, it is not possible to estimate the gravimagnetic dipole moment of the galaxy center. This quantity must be directly measured. The ambient gravimagnetic field K may be of use in interstellar or even interplanetary journeys.

The gravimagnetic force could explain, to some extent, dark matter and dark

energy. Bodies in the solar system and in galaxies like our Milky way, tend to rotate in similar directions and in planes orthogonal to the rotation axes.

Adjacent magnets with parallel axes repel each other. Unlike the magnetic field, the gravimagnetic field proposed in the EM-GK theory has the imaginary term i, thus the direction of the gravimagnetic force is reversed from that of the magnetic field. Bodies located in a plane, which also have mutually aligned spin axes, and thus also similar spin directions, attract. The gravimagnetic force, a 1/r^4 force between such rotating bodies, thus adds to the ordinary gravitational force.

If we do not account for the gravimagnetic force, when examining the motions of near bodies, we will overestimate the mass of the bodies. As we then examine the motions of bodies far away from such mass, as the distance to those bodies increases, we will see an unexplained diminution of the expected force. We will see "dark energy". If we determine the mass of a collection of rotating bodies bodies from far away from each other, like the ends of the arms of a galaxy, then as we examine the motions of bodies in a dense mass center, like the center of the galaxy, we will see the increased effect of the gravimagnetic force, and thus assume there exists some unaccounted for "dark matter" in the vicinity.

Matter further away from the big bang should have a higher velocity away from the origin of the big bang than matter closer to the origin of the big bang. If gravity is not due to space warping, but rather due to (virtual) graviton exchange, then a high receding velocity produces a red shift of these gravitons, and thus matter farther away will experience less momentum exchange with the gravitons from nearby. This then creates the illusion of some form of "dark energy" pushing things apart.

Dark energy, at least in part, is the red shifting of gravitons. If two bodies are mutually departing then their gravitons are mutually seen as red shifted. Hubble found that as a general rule all distant objects are in receeding motion, with velocity proportional to their distance from us. Since the red shifting of gravitons (as well as photons) is proportional to the relative velocity of source and observer, there appears to be a repelling force that is proportional to distance, a kind of dark energy from the vacuum, which it is not. It is merely the diminution of gravity.

Failure to properly account for both gravimagnetics and red shifting in observations leads to inaccurate mass determinations, which lead to futher errors in expected accelerations, and thus "gravitational anomalies".

The gravimagnetic force may help to explain the arms of the galaxy, and the tendency for the unexplained nearly uniform rotation speed of the arms, and even the spiral shape of the Milky Way. The as a galaxy evolves, the gravimagnetic force helps to agglutinate the arms, to create them and hold

them together. An arm then, like some long molecular string, acting like a whip, would tend to rotate about a galaxy as an entity, bending backwards at the tip, which is dragged along at increased speed in its orbit by the gravimagnetic force.

Much work is needed to accomodate the three additional dismensions of space required to build a proper general relativistic theory including both gravity and electromagnetism.

CONCLUSION

There remains much work to do to consider the ramifications of the EM-GK isomorphism presented here, and its logical consequences. Inconsistencies with reality are likely. However, the mathematical nature of the isomorphism of fields that can be formed is provable based on various palatable premises, and a natural consequence of the nature of space and time, thus this gives some credence to deduced consequences. Innumerable electromagnetic equations can now be directly applied to gravitational calculations. Each of Maxwell's laws, for example, have a now precisely defined gravitational equivalent. The practical consequences of this could be significant. Also important is the fact that many attempts to fully unify gravity and electromagnetism may be in vain, as their domains do not fully intersect. The theory indicates the principle available paths to obtaining powerful space drives and heavy lifters via electromagnetic means is via the electromagnetic modification of inertial mass or (by some unknown means) gaining a purchase on the vacuum. The gravimagnetic field might be of practical use, but its use appears very limited as a primary locomotion means compared to possible uses of the vacuum, the zero point field.

The proposed isomorphism is indeed a very simple and minor advance, if that, and yet it seems strangely powerful. The proposed EM-GK isomorphic theory was built on the retardation theory published by Jefimenko. However, Jefimenko did not establish a true isomorphism, so had to manually tweak the signs of various formulae to get things right. Further, Jefimenko had no means from his theory to discover that virtual photons carry no gravitational charge, and that photons do carry gravitational charge, nor a means to recognize that additional unfolded dimensions are required to describe gravity. He had no means of discovering an answer to the old problem as to why the zero point field is not massive in a gravitational sense. Jefimenko had no means to instantly recognize that Newton's F = m*a describes something principally in the world of electromagnetism, that inertia is principally electromagnetic, or at least not gravity related. The symmetries provided by the proposed EM-GK isomorphism suggest the possibilities of many new particles, and possibly a great expansion to the field of relativity, which Jefimenko's work does not fully embrace. Further suggested are implications to the mechanics of black holes, the possible existence of negative gravitational charge matter spewing

forth from large black holes. The theory also suggests possible errors in our determination of celestial masses, and possible explanations for inconsistent results in some co-gravitation experiments. The theory may in part account for dark matter and dark energy observations. Possibly most importantly, theoretically speaking, if the subject theory has any veracity, it in large part *dis-unifies* electromagnetism and gravity. It demonstrates why true field unification may be so elusive.