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# Application of the GEM theory of Gravity-Electro-Magnetism Unification to the problem of Controlled Gravity : Theory and Experiment

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Abstract

The GEM theory is applied to the problem of controlled gravity by deriving a "Vacuum Bernoulli Equation" showing Gravitational energy density to be equated to an EM dynamic pressure that is quadratic in the local Poynting Flux: $G^2/(2\pi G_c) - S^2/(c^2 u_0) =$ Constant where G and S are the local Gravity and Poynting vector magnitudes, respectively, $G_c$ is the Newton-Cavandish constant and $u_0$ is a local magnetic energy density. This relation satisfies the Equivalance Principle. It is shown that this equation predicts that gravity modification can occur through a Vacuum Bernoulli Effect or VBE by creating a perturbing Poynting flux by a rotating EM field, a "Poynting Vortex", and that this effect can lead to a lifting force for human flight applications. The theory is then applied to experiments involving EM driven gyroscopes with and without metal rotors.

## I Introduction: The GEM theory, the Equivalence Principle, and Negative Mass

According to Sakharov (1968) Gravity results from the imbalance of radiation pressure from the ZPF (Zero Point Fluctuation) EM fields which are required by Quantum Mechanics to fill the vacuum. This idea was inspired by the work of Zeldovich, (1967) who had studied the ZPF and concluded that it canceled itself at each point except when matter was present and that the presence of matter interfered with the self cancelation process .

Zeldovich proposed the canceling term to the ZPF to overcome one of the great paradoxes of Quantum Physics: the fact that vacuum has no mass. The ZPF is required by Quantum Mechanics and being EM energy, should give the vacuum mass, assuming gravity is itself not a manifestation of the ZPF. However, if gravity is due to ZPF then the concept of mass for EM fields becomes more complex. Since ZPF is observed directly only as a tiny stochastic fluctuation of EM fields in otherwise field free region , we can imagine that at each point ZPF radiation confronts a resonant quantum of radiation that cancels the impact of the initial radiation, resulting in only a small residual fluctuation due to slight imperfections in cancellation . This can be conceptualized by assuming that just as the ground state of the electron field in vacuum consists of particle-antiparticle pairs, producing a net electron wave function of zero for any region of space, so the EM field or photon field vacuum groundstate consists of photon-antiphoton pairs with canceling EM fields. The photon being its own anitparticle, the vacuum can be thought of as being full of canceling photon pairs. Looked at differently, we can consider that the photons have mass, but that the canceling fields due to antiphotons have negative mass, so that the net vacuum state has zero mass.

The GEM theory is a model for field unification that neglects strong and weak nuclear forces and combines the Sakharov-Zeldovich approach of Gravity being a vacuum EM ground state effect with the Kaluza-Klein (1921) concept of a new dimension appearing that allows EM and Gravity to separate. The new dimension , or new degree of freedom, allows excited vacuum states to occur. That is, the appearance of a new dimension, a charge to mass energy ratio-radius dimension, simutaneously allows both the EM-Gravity pair to appear as a distinct fields and the electron-proton pair to appear as charged particles.



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The GEM theory codifies the concepts of Sakharov and Zeldovich by saying gravity arises from a background of powerful EM energy, that is self canceling, but which loses complete cancellation in the presence of matter and thus gives rise to an imbalanced radiation force. thus the problem of zero mass for the vacuum is also confronted by the GEM theory. The GEM theory requires a portion of the vacuum ZPF to have negative mass. Thus when the radiation imbalance occurs in the ZPF leading to gravity, a negative mass must also appear in the vacuum. In Newtonian gravity theory, the negative mass density that occurs in space is due to gravity fields themselves. This term has the form

$$negative \quad mass \quad density = -\frac{G^2}{8\pi G_c} \qquad (1)$$

where G is the gravity vector and $G_c$ is the Newton-Cavendish constant. This term allows the "mass at distance" the mass contained within a Gaussian surface around a compact mass such as star, to remain constant as the star collapses, its internal kinetic energy thus increasing. The increase of mass-energy within the star due to kinetic energy of collapse is balanced locally by the increase in gravity field strength and thus negative mass density. This negative mass balances the mass energy derived from the gravity energy driven collapse and allows the mass a distance to remain constant. Thus, if gravity fields have negative mass and yet are some form of ZPF EM effect, then it is possible for EM fields to have a negative mass density.

Negative mass, if it could be produced in compact volume, would be repelled by ordinary masses, since its force is opposed to the gravity vector. If it could be created in a controlled way, its repulsion from a nearby planet would create a lifting force that would boost a craft containing negative mass from the planets surface and into space. Negative mass in a layer above a planetary surface also would have the property of weakening the gravity field immediately above it. This can be seen from Figure 1.

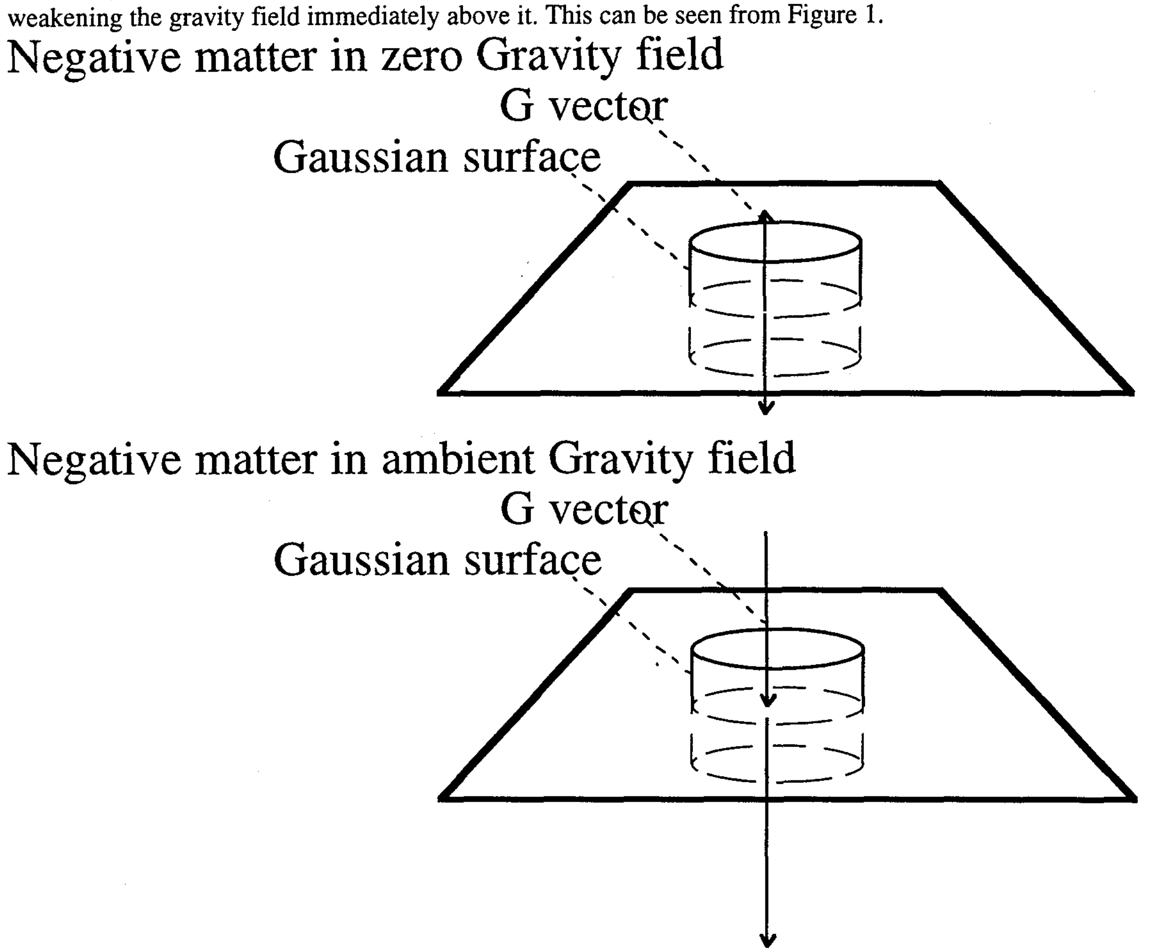


Figure 1. Negative mass, and its effect on ambient gravity. Negative mass will weaken the gravity above it .

Thus, seemingly inherent in the ZPF theories of gravity, is the suggestion of possible lifting forces and practical flight by controlled gravity. However, a practical theory that unifies EM and gravity must satisfy several constraints.

The idea that gravity fields arise from a radiation pressure, and thus is a force on individual particles, must be reconciled with the Equivalence Principle, which says that gravity mass and inertial mass are always equal. That is, all masses fall at the same rate and gravity effectively vanishes in a free falling frame of reference, such as in an orbiting space shuttle. This also means that negative mass must also have negative inertia, so that any craft using negative mass to create a lifting force must also have near zero total mass and be able to "stop on dime". This constraint means that any definition of a gravity field or gravitational energy density in the GEM theory must vanish in the frame in which the particles move in free fall.

In the GEM theory , it is possible the photons responsible for the ZPF radiation pressure are all spin polarized in one direction, like the neutrino. That is, gravity may have a parity violating aspect; this comes about from the requirement that GEM allow the appearance of electron-proton pairs from the vacuum, where they have a virtual existence as unified "union" particle-antiparticle pairs at the Planck length (Brandenburg 1995). These pairs then split into a proton and electron , rather than the antiproton and positron, like the decay of a neutron into a proton and electron. Like neutron decay, this vacuum decay must give rise to matter as opposed to anti-matter, so that charge and mass must be correlated: positive charge is heavy-negative charge is light. This can be written as the requirement that $G\Sigma E < 0$ during vacuum decay. Like neutron decay this requires that the quanta carry away energy and have only one spin state relative to its motion. Therefore like the anti-neutrino that accompanies neutron decay, the photons involved in GEM processes that give rise to the appearance of a separate gravity and EM force and a separate proton and electron must also be spin correlated with motion so that $s\Sigma p > 0$ for the photon. This means that gravity fields have a "twist" in them, that we see in gyroscope experiment, where a spinning EM field couples with gravity field for one spin direction, but not for the other. In our concept of the vacuum EM field as a collection of canceling pairs of photons, the presence of gravity means that the photons of one spin only are imbalanced, or incompletely canceling.

In our gyro experiment we confirmed that a rotating EM field appeared to create a negative mass density and thus weaken local gravity. In the GEM theory (Brandenburg 1992, 1995)it does so by strengthening the local gravity vector to create a region of increased negative energy density as given in Eq. 1. If it does so in a sealed container, such as gyro housing, the net result is that the gyro assembly should weigh less.

We can consider that the gravity field energy represents , not the full ZPF, but only the residual imbalance higher in energy density than the gravity field energy density by a factor of $1/\alpha$. This should be approximately true since the interactions of EM fields with charged particles occurs in orders of $\alpha$, with higher orders being those interactions that entail repeated EM field-charged particle exchanges of energy and momentum. The gravity field energy density is thus be of a EM field that has "scattered" off matter once already. Thus we should have

$$\alpha\left[\frac{E_a^{\ 2}}{8\pi}+\frac{B_a^{\ 2}}{8\pi}\right]\approx\frac{G^2}{8\pi G_c} \qquad (2)$$

where the first term represents the energy density in the unscattered ZPF EM field and the second term is the energy density in the scattered or gravitational field, where $E_a$ is the ZPF electric field and $B_a$ is the corresponding magnetic field.

II The GEM theory and the Vacuum Bernoulli Equation

We begin with the definition of gravity fields within GEM as ExB drifts in the special case of constant background B field $B_o$ where $E \perp B_o$ everywhere:

$$G = \dot{E} x B_o c / B_o^2 + ExB_o c / B_o^2 \bullet \nabla \left[ ExB_o c / B_o^2 \right] \qquad (3)$$

where the dot signifies a time derivative, we can write with the definitions

$$S = \frac{ExB_o c}{4\pi} \qquad (4)$$

where S is the Poynting vector
and we define the basis stress

$$u_o = B_o^2 / 8\pi \qquad (5)$$

$$G = \frac{1}{2u_o} \dot{S} + S / 2u_o \bullet \nabla \left[ S / 2u_o \right] \qquad (6)$$

It should be noted that this expression is merely the Euler equation with the ExB drift velocity substituted for the fluid velocity. A very similar expression was first derived by R.L. Valle'(1970), who appears to have arrived at a theory very similar to the GEM theory independently of the author. The interpretation could be made that the ExB drift velocity is in fact the "drift velocity of the fluid vacuum" or "drift velocity of the ether". This interpretation would mean that charged particles caught up in an ExB drift field are like particles of dust caught in a flow of gas or liquid. The GEM expression for gravity satisfies the equivalence principle because S vanishes in the frame of the moving particle, this is because E =vxB in this frame, and even in a case where E increases with time $E_{,t}$ $=v_{,t}$ xB so that the particles will experience no local electric field.

$$G = \dot{V}_D + V_D \bullet \nabla V_D \qquad (7)$$

We now write Newtons Law of Gravitation

$$\nabla \bullet G = -4\pi G_c \rho_m \qquad (8)$$

where $\rho_m$ is the mass density and assuming the Einstein relation $E=Mc^2$ for fields we obtain

$$\nabla \bullet G = -\frac{4\pi G_c}{c^2}\left(\frac{E^2}{8\pi}+\frac{B^2}{8\pi}\right) \qquad (9)$$

We then differentiate with respect to time

$$\nabla \bullet \dot{G} = -\frac{4\pi G_c}{c^2}\dot{\left(\frac{E^2}{8\pi}+\frac{B^2}{8\pi}\right)} \qquad (10)$$

and apply Poyntings theorem from standard EM theory

$$\nabla \bullet S = -\dot{\left(\frac{E^2}{8\pi}+\frac{B^2}{8\pi}\right)} = \frac{c^2}{4\pi G_c}\nabla \bullet \dot{G} \qquad (11)$$

and from this obtain another expression relating S and G

$$\frac{S}{c^2} = \frac{\dot{G}}{4\pi G_c} + \nabla \times Z \qquad (12)$$

where Z is a vector potential of rotational component in the Poynting field, that must be considered to exist in order to make Eq. 8 mathematically complete.

We will assume for now that Z=0 everywhere .
We can combine Eq. 11 for Z=0 with Eq. 5, our GEM expression, for the case $S\sum\nabla S \cong 0$ and obtain

$$\frac{G \bullet \dot{G}}{2\pi G_c} = \frac{S \bullet \dot{S}}{u_o c^2} \qquad (13)$$

Integrating in time , with the condition $u_o$ = Constant we obtain the "Vacuum Bernoulli Equation" and we should expect by analogy a "Vacuum Bernoulli Effect "or VBE. We call this the VBE because allows flight in vacuum as the conventional Bernoullii effect allows flight in air. We have then

$$\frac{G^2}{2\pi G_c} - \frac{S^2}{u_o c^2} = K \qquad (14)$$

where K is a constant in time, though it can vary in space. Again a similar expression was derived by R.L. Valle'(1970). The VBE says that energy stored in a gravity field is actually an EM energy from a Poynting flux due to ZPF. Note that this expression obeys the Equivalence principle because in the frame of reference of a free falling particle G=0 and also S= 0 because the particle sees $E=vxB_o$ where $v= 4\pi S/u_o$. It must also be remembered that because of the Zeldovich Cancellation the ZPF in a region of space far away from any localized masses has both G=0 and S=0, however, this means that in the region near a localized mass, Zelodovich cancellation fails, and neither G or S is zero. This means the when G π 0 that we must have an S ' which represents the missing Zeldovich canceling flux.

III Gravity Control Via the VBE: the Poynting Vortex

We can use the VBE to find the change in local gravity field due to a change in Poynting field.

$$\frac{dG \bullet G}{2\pi G_c} = \frac{dS \bullet S}{u_o c^2} \qquad (15)$$

This expression says that where we create a Poynting flux parallel to the Poynting flux created by Zeldovich cancellation and thus leading to gravity, we can perturb gravity. The perturbation in this case will be positive, that is local gravity will increase. Because the ZPF fields should be rotationally polarized, perhaps favoring one spin polarization over another, a rotating EM field or Poynting Vortex will be one method of perturbing gravity. Another idea that may be successful is the creation of a Poynting Vortex using static E and B fields, however a rotating EM field is more easily made. The idea of a rotating EM field was first proposed by Tesla and is the basis for almost all commercial electric motor technology. A rotating EM field creates a vortex pattern of Poynting flux, hence the description Poynting Vortex.

We can create a region of enhanced gravity leading to a lifting force by creating a Poynting Vortex in a superconducting cavity which we will term an "areole". The superconducting cavity we will call an "emfoil" because it shapes the EM fields and leads to a lifting force as an airfoil leads to aerodynamic lifting force. The whole arrangement we will call a Poynting Vortex Areole or PVA. This is shown in Figure 2.

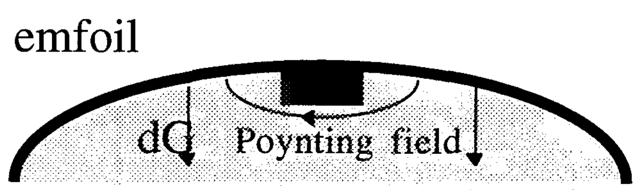


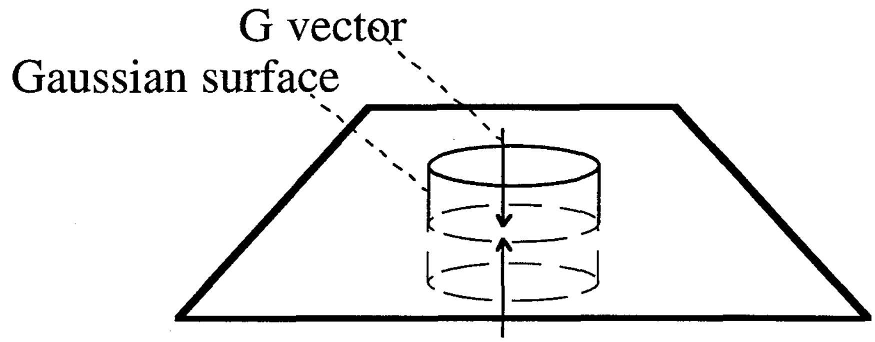

Figure 2. A Poynting Vortex Areole. The perturbed gravity field, dG ,below the emfoil leads to a negative mass layer on the emfoil and thus a lifting force.

The PVA leads to a lifting force because the region of Poynting vortex below the emfoil couples to the rotating component of the ZPF that causes gravity and by Eq. leads to an enhanced gravity field by an amount dG below the emfoil. This enhance dG disappears above the emfoil however, and creates an imbalance of gravity energy density or pressure above and below the emfoil, since this pressure is stronger below the emfoil the increased gravity pressure leads to a lifting force. This is very similar to the action of an airplane wing or helicopter rotor, which creates an increase of air pressure below the wing or rotor.

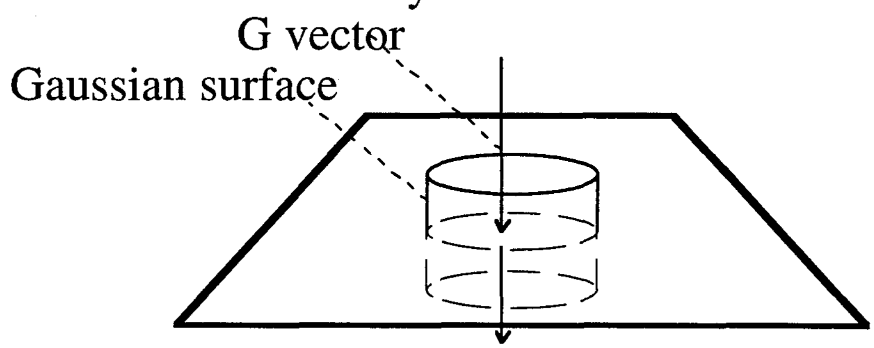
We can understand and calculate the lifting force by the following formalism. When a plate of ordinary matter, which is attracted by gravity, is placed in an ambient gravity field the gravity vector immediately above the plate is stronger than the gravity vector immediately below it. This can be seen from applying Gausses theorem on the plates surface within the context of Newtons gravity theory, as seen in Fig 3.

However, when a plate of negative matter, which is repelled by gravity, is placed in an ambient gravity field the gravity vector immediately above the plate is weaker than the gravity vector immediately below it. this can also be seen by Gausses theorem, Fig. 1.

Ordinary matter in isolation




Ordinary matter in ambient Gravity field




Gravity weaker below mass layer

Figure 3. Ordinary matter in zero gravity and in an ambient gravity field. Note that gravity is stronger above the mass layer.

The repulsion of the negative mass layer by gravity is a lifting force, lifting away from the attracting mass and has a magnitude, per unit area

$$Lifting\ \ Force\ \ per\ \ unit\ \ area = \frac{dG \bullet G}{4\pi G_c} = \frac{dS \bullet S}{2u_o c^2} \qquad (15)$$

where the factor of two is due to Gausses theorem. It is apparent that if this lifting force per unit area can exceed the gravity force due to the mass per unit area of the emfoil, then the entire emfoil would experience a net lifting force, and could rise in the earth's gravity field and flight could be achieved.

Application to gyro experiments

To attempt to interpret the gyro experiment results we return to our expression for change in gravity which can be written

$$\frac{|dG|}{|G|} = \frac{dS \sum S}{u_o c^{\ 2}} \frac{2\pi G_c}{G^2} \qquad (16)$$

It is apparent that two types of perturbation can exist for this system, one which perturbs only S and one which perturbs both S and $u_0$. In the case of a gyroscope with a metal rotor, the $u_0$ due to a time constant portion of the ZPF cannot exist, because the ZPF field would have to spin with the rotor, and thus not be constant. Therefore, in the case of the gyro with a spinning rotor, dS and $u_0$ are both due to the perturbing field. However, in the case of a gyro with no metal rotor, so that only the magnetic field spins, the $u_0$ is due to the ZPF and the perturbation is only due to dS.

We now consider that in an existing gravity field an S must exist due to the ZPF field of the vacuum. However we will not use the portion of the ZPF that directly leads to gravity but the portion of the ZPF that is part of the Zeldovich cancellation field. In other words, gravity fields exist , according to Zeldovich, because of an imbalance or imperfect cancellation of fields due to the presence of matter. However, this means that in the vacuum , a large canceling field exists to the S field giving rise to gravity. This field for the most part cancels the Poynting fields that give rise to gravity fields except for a small portion has an energy density of $\alpha^{-1}$ times the energy density of unconcealed portion, making up the gravity field. This factor of $\alpha^{-1}$ is due to the fact that this unperturbed field has undergone no scattering from the electronic charges making up matter. We will assume that this field is constant and of the form.

$$S = \hat{v} \frac{G^2 c}{2\pi G_c \alpha} \qquad (17)$$

In the case of a gyro with a metal rotor, we will also assume this field undergoes a Bose Condensation into a resonant state with the perturbing , artificial field, dS, which at every point is the rotating magnetic field rotating with velocity dv.

$$u_o dv = dS \qquad (18)$$

and where we assume a velocity field v that rotates due to the preferred rotation of the Poynting field S due to gravity. That is, we must assume that gravity has a preference for one rotation sense of the field over another. This means that the resulting gravity effect will not depend on field strength directly, but only on the velocity of the spinning rotor.

We then obtain for our VBE for a perturbed gravity field for the case of a gyro with a rotor

$$\frac{|dG|}{|G|}=\frac{dv\bullet\hat{v}}{\alpha c} \qquad (19)$$

We assume an x and y component for the rotating fields of the form

$$dS=\hat{x}\cos\omega t+\hat{y}\sin\omega t \qquad (20)$$

where the x and y unit vectors have carats superscripts.

Since we assume the field is in resonance with the rotating field the x and y components of the field will couple together through a dot product of components as in Eq. 16 and we will have

$$dv\bullet\hat{v}=r\omega[\cos^2\omega t+\cos\varphi\sin^2\omega t] \qquad (21)$$

where we will choose our x axis to be the axis of tilting of the plane of rotation of dS relative to the vertical flow of S parallel to the gravity vector (See Figure 1)

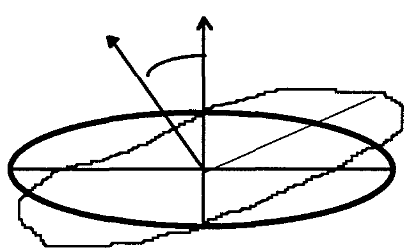


Figure 4. Tilted coordinate systems. Note that one axis remains invariant between the two coordinate systems.

The time average of these contributions is found to be

$$<dv\bullet\hat{v}>=\frac{\int_0^{t'}\cos^2\omega t+\cos\varphi\sin^2\omega t dt}{t'}=\frac{1}{2}+\frac{1}{2}\cos\varphi \qquad (22)$$

Because with tilting of the plane of rotation of dS ,with respect to vertical, uses the x axis as its axis of rotation, no change occurs in x component dot product while y component changes its projection via the cosine law. Thus we have

$$\frac{1}{2}+\frac{1}{2}\cos\varphi = \cos^2\frac{\varphi}{2} \qquad (23)$$

This is the famous "half angle " expression that is seen in the spinor formalism of rotations, and arises from the same effect: the fact that components of a field along the axis of coordinate rotation are invariant, whereas others go as the cosine. In the case of the GEM theory it results from the interference pattern of two rotating fields whose spin axes are at angle φ relative to each other.

We have then for our perturbed gravity field for a gyro with a metal rotor

$$\frac{|dG|}{|G|}=\frac{dv\bullet\hat{v}}{\alpha c}=\frac{|dv|}{\alpha c}\cos^2\frac{\varphi}{2} \qquad (24)$$

It should be noted that the expression for perturbed gravity does not depend on the field strength, this is because of the spinning metal rotor, which requires that uo in Eq.   be that due to the perturbing rotating field which causes dS. This means that once the pattern of fields has been determined by the spinning rotor, the field s can be turned off and only the ZPF fields are necesarry. However, it must also be noted that the field strength must be sufficient to initially spin up the metal rotor, so that this field strength cannot be arbitrarily small.

From this expression we can predict a "half angle" dependence for gravity perturbations, induced by rotating EM fields. This effect is proportional to the magnitude of rotational velocity dv where the velocity is normalized to the speed αc or 1/137 the speed of light. This speed is a EM field rotation speed and thus does not need to be the speed of a spinning material rotor. This speed of αc found in the denominator was first proposed by Kozyrev (1968) based on this velocity being a fundamental quantity, $2\pi e^2/h$.

In the case of no metal rotor Eq. determined in a different way. In this case the ZPF determines the uo and so the dS is the sole source of perturbation. Since dS is not canceled by uo in the rotorless case we can have a situation where the perturbation of gravity depends on applied field strength. The perturbation of the existing ZPF , whose fields are much stronger than the artificial fields, is not perturbed by the applied S, since this would be quadratic in the applied field strength, that is , as $dB^2$ which would be overwhelmed by the uo of the ZPF in the denominator of Eq. . Instead, dS arises to first order in the fields, that is proportional to applied dB, so that we have

$$dS=\frac{E\times dBc}{4\pi}+\frac{dE\times Bc}{4\pi} \qquad (25)$$

Since the expression for perturbed gravity depends on $dS/u_o$ and in the GEM theory E<< B since the escape velocity for a planet such as Earth determines $v_{esc}/c = E/B <<<1$ we can write

$$\frac{dS}{u_o} = \frac{2E \times dBc}{B^2} + \frac{2dE \times Bc}{B^2} \cong \frac{2dE \times Bc}{B^2} \qquad (26)$$

Therefore, it is the expression that is linear in dE = v/c x dB = (ωxr) /c x dB , that should give the strongest contribution. From this we can predict that perturbed gravity effects should be linear in applied field strength, and when skin depth effects are neglected, should be linear in frequency- linear velocity, of the fields. That is, in the rotorless case the local perturbed gravity should depend linearly on applied field, frequency of the fields, and linearly upon the radius of rotation of the fields. Thus we should have

$$\frac{|dG|}{|G|} = \frac{dv \bullet \hat{v}}{\alpha c}\frac{dB}{B} \qquad (27)$$

In the case of the spinning metal rotor, only one rotation sense of the ZPF fields seemed to be involved, however in the case of the rotorless gyro, or pure Poynting Vortex, it is observed experimentally, that two rotation senses appear involved, this means that dvΣv has two terms, one for clockwise rotation of v and the other for the opposite sense. In the case of two rotation senses, Eq.    becomes

$$< dv \bullet \hat{v} > = \omega r \left( \frac{\int_0^{t'} \cos^2 \omega t + \cos\varphi \sin^2 \omega t dt}{t'} + \frac{\int_0^{t'} \cos^2 \omega t - \cos\varphi \sin^2 \omega t dt}{t'} \right) = \omega r \qquad (28)$$

The terms due to the Cos φ dependence cancel and thus the interaction becomes isotropic in angle. Therefore the expression for perturbation of gravity should become

$$\frac{|dG|}{|G|} = \frac{dv \bullet \hat{v}}{\alpha c}\frac{dB}{B} \qquad (30)$$

It must be noted that this theoretical framework predicts that effects will be most visible when the Poynting Vortex fields are well confined, that is : the rotating EM fields are present in some areas of the experiment and completely absent from others. This sharp exclusion of the Poynting Vortex fields creates negative mass layers that can be studied as isolated and compact objects. In theoretical discussions this is easily accomplished by using em-foils to shape the fields that are made of perfect conductor. In actual practice however, the emfoils will have to be made of metal several skin-depths thick for the frequency of Poynting Vortex field used, or else they must be made of superconductor. The skin depth for ordinary metals is dependent upon their conductivity and the frequency of the fields. We have then for the skin depth

$$\delta = \sqrt{\frac{\omega\sigma}{c^2}} \qquad (31)$$

where the formula is in cgs units. The skin depth gives the exponential decay of fields into metal. For aluminum metal at ω =2π 400Hz , δ=1cm . Thus for experiments at that frequency, rather heavy experiments will have to be used with emfoils of several cm thick to achieve compact negative mass layers, unless superconductors are employed.

## IV Application to Gyro Experiments

### Summary of previous experiments

In both Kozyrev and Hayasaka and Takeuchi experiments small 3-phase gyros were enclosed in sealed vessels ( a vacuum vessel in the case of Hayasaka and Takeuchi but merely a hermetical sealed vessel in the case of Kozyrev) and spun up to 400 revolutions a second using 400Hz three phase power. In both experiments the gyros were weighed on balance type chemical scales. In both experiments weight loss was observed in the spin vector (determined by the right hand rule) parallel to the gravity vector and no weight loss was seen in the case of spin vector anti-parallel to the gravity vector. Kozyrev also reported 1/2 the weight loss seen in the spin-gravity parallel case for the case of spin vector at right angles to the gravity vector. In both experiments the weight losses were found for several different types of rotor material and different speeds. The results of the Japanese and Russian experiments agreed and their results can be summarized as

$$\frac{|dG|}{|G|} = \frac{v}{v_o}\cos^2\frac{\varphi}{2} \qquad (32)$$

where dG is the change in weight of the rotor , is the mass of the rotor, v is the mean rotational velocity of the rotor, where $v_o = 7 \times 10^5$ m/sec, and $\varphi$ is the angle between the spin vector of the rotor and the gravity vector. Thus mass loss occurs for spin vector parallel to the gravity vector, $\varphi$=0 , but no mass loss occurs for spin vector opposite the gravity vector, $\varphi = \pi$.

The close agreement between the results of the two experiments and their nearly identical apparatus and procedure suggested the effect was real. In both experiments weight loss was observed even after all three phase power was ended. However, an attempt to repeat experiment using a compressed air the driven gyro found null results. This suggested that 3-phase power was an important factor in the experiment even if it was not present during actual measurement. Therefore it was decided, in the spirit of classical scientific inquiry, that a duplication of the experiment, to as great a degree of fidelity as possible, was necessary to see if it was truly reproducible.

Another factor leading to a desire to reproduce the experiment was the existence of the GEM theory (Brandenburg 1992), which predicted that gravity fields were closely related to electromagnetic fields, being related through the Poynting field, and that control of one by the other might be possible. The GEM theory also predicted that the quanta carrying momentum and energy in gravity fields was of single spin, being parity violating (Brandenburg 1995), and would have spin parallel to its direction of propagation like the antineutrino. Thus, veiled in terms of the GEM theory, the possibility that objects might exhibit spin specific, anomalous gravity effects in rotating EM fields was not unexpected. In fact a theoretical analysis in terms of the GEM theory of the experiments has revealed that the GEM theory predicts the observed results to within a factor of order unity.

Therefore it was decided that a high fidelity reproduction of the Kozyrev, and Hayasaka and Takeuchi experiment might be undertaken to see if the results were truly reproducible.

## Apparatus

The central apparatus of the experiment were as follows, **1.** a three phase aviation gyroscope, **2.** a plastic housing capable of being hermetical sealed to enclose the gyro **3.** a source of three phase power of variable frequency, **4.** a set of balance type chemical scales, **5.** a stroboscopic apparatus for determining the rotation frequency of the gyro rotor.

1. The Gyroscope was obtained through a local repair shop specializing in aviation electronics for $160, it was a Sperry Flight Systems Gyro-Horizon Indicator model # P/N-608588-28, manufactured in 1970 and ran on 3-phase power at 115V and 400Hz.

The gyro rotor was well balanced and ran with little vibration. The mass of the gyro rotor was found to be 289.6g composed of a steel cylinder with an aluminum inner cylinder as an insert. The outer radius of the steel ring was 2.55cm and its inner radius 2.05 cm. The inner radius of the aluminum portion of the rotor 1.65cm in radius and 2.05cm in outer radius. Since the steel portion of the rotor was larger in radius and much more massive than the aluminum portion, the rotor could be approximated, in these preliminary analyses, as being a mass of 289.6g rotating as a ring of radius 2.25cm. For a rotation frequency of 400Hz this would give a predicted mass loss , based on the Japanese and Russian experiments, of 32mg.

2. The stroboscopic monitor of revolutions of the gyroscope consisted of a small Cadmium Sulfide (CdS )cell mounted on a piece of electronic breadboard in front of a small hole in the gyroscope housing a twisted pair of wires consisting of #30 kynar insulated wire connected the CdS cell to a small operational amplifier circuit assembled from a breadboard electronics kit. Because of the desire to use lightweight wires and to mount the cell near the gyrorotor the gyroscope was subject to electrical interference from the gyro and hence could not give an accurate optical reading until 3 phase power was off and gyro rotor was coasting. The lightsource for the stroboscope consisted of a ordinary household flashlight.

3. A hermetically sealed housing for the gyroscope was made using a circular plexiglass baseplate with a circular raised ridge 1 mm thick and 1 cm high concentric with the center of the baseplate, 4 holes admitting the 3 phase power wires and a twisted pair for the photocell readout passed through the holes and were sealed with thermoplastic resin. A tuperware cap with a small plastic plug was pressed down over the ridge to form a tension fit around the plexiglass base with the plug removed so as not to trap air. Once the cap was in place the plug was replaced so that a near zero differential pressure condition between the outside air and inner air would prevail. The tension fit around the base was sealed with vacuum grease. The gyro was mounted on a small aluminum bracket that could be itself mounted in two positions to give the gyro spin vector either an up-down direction (spin vector parallel or antiparallel to the gravity vector) or horizontally (spin vector at right angles to the gravity vector).

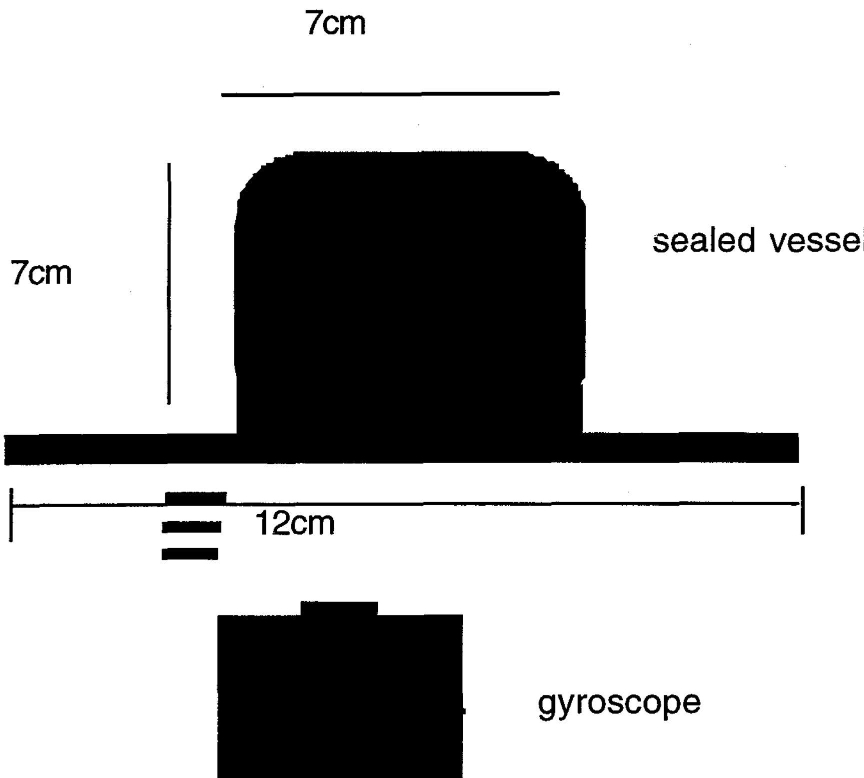



Figure 1. dim[redacted]yro and its sealed vessel

The whole assembly of gyroscope, photocell rotation speed monitor, and hermetically sealed housing, had a mass of 595g.

4. Three phase power supply consisted of a Jack and Hientz inverter model F20-5 rated to supply up to 400Hz 3 phase power at 115V. The inverter consisted of a D.C. motor connected to 3 phase AC generator with associated voltage and current regulators. The DC motor had maximum ratings of voltage at 27.5V at 10A. The motor was engaged by supplying a controll voltage at 27.5V which in turn tripped a relay connecting the main current to the motor. Main power for the motor was supplied by a Hewlett Packard Model 6032A power supply which could be preset for fixed voltage. Because the small gyro presented such a small load the DC motor was never run at full voltage but was operated at between 7V and 15V and drew a maximum of 14A.

In the gyro experiments we create a spinning EM field that in turn spins a conducting metal rotor imbedded in the field. Based on the VBE analysis we would expect a rotor imbedded in such a spinning field to feel less gravity field and thus lose weight. In the experiments performed at RSI the geometry is very simple. We can assume the spinning EM field fills the enclosed gyro casing homogeneously and induces a reduction of gravity in the enclosure that is felt by the rotor (See Figure 2)

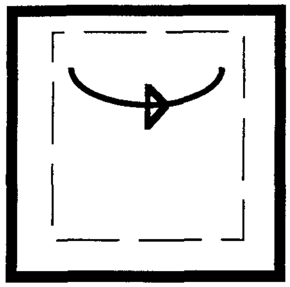


Figure 6. An enclosure holds a spinning EM field in which a rotor is imbedded.

The rotor will then experience a loss of weight ΔW that is proportional to velocity of the spinning EM field, which is also the speed of the rotor.

$$\frac{\Delta W}{W} = \frac{V_{rotation}}{2.2 \times 10^6 m/\sec} \cos^2 \frac{\varphi}{2} \qquad (33)$$

where W is its normal weight and we have assumed only the rotor and not the case is affected by the spinning EM field. This compares well to the results of our experiments, which used an enclosed rotor design.

$$\frac{\Delta W}{W} \cong \frac{V_{rotation}}{2 \times 10^6 m/\sec} \cos^2 \frac{\varphi}{2} \qquad (34)$$

Note that no geometric factors appear necessary to give reasonable agreement between theory and experiment. This appears to occur because of the physically simple case of having a totally enclosed region of rotation field, in which the rotor turns.
We also have the published results of (Kozyrev, 1968, Hayasaka and Takeuchi 1989), where the gyroscopes did not use an enclosed rotor but allowed field to leak out and surround the gyroscope yoke structure, which held the spinning rotor.

$$\frac{\Delta W}{W} = \frac{V_{rotation}}{7 \times 10^5 m/\sec} \cos^2 \frac{\varphi}{2} \qquad (36)$$

These experiments obtained three times the weight reduction seen in our experiment. The interpretation, within this analysis, being that the gyroscope yoke structure also experience weight loss due to the spinning EM field around it.
Further experiments were done with a new gyroscope of the same model and manufacturer, in these experiments the gyro was run exclusively on the Mettler scale at Goddard space flight center. The gyro was run with only the gyro case around it but with holes in sealed with aluminum tape to create a hermetically sealed vessel, except for one hole to allow for light entrance for photocell readout of the rotor speed. As the gyro was run with the variable frequency power supply, data on both its weight and rotor speed was taken at each step using the scale and the photocell readout. The data is presented in Figure 7.

As can be seen the angular dependence of the earlier experiments and the effects linear increase with frequency are reproduced by the data, however, the magnitude of the effect is less than that measured previously for gyroscopes of similar type by a factor of 1/5. We have no explanation for this discrepancy, except to note that theoretically, in this limit of metal cases being much thinner than a skin depth, fields from the gyroscope spill out to surround the device and involve other objects in the Poynting vortex effect. The major difference in apparatus appears to be the plastic case, which was omitted because it seemed unnecessary and interfered with passage of light from the outside to the rotor readout cell. If our interpretation of the difference in magnitude between the effects observed by Kozyrev, Hayasaka and Tacheuchi are correct, then the geometry of the apparatus and its case are important and account for the difference.



V Rotorless Experiments

Because of the GEM theory our interpretation of the gyro experiments has been that the rotating fields cause the weight loss, not the spinning of the rotor itself. Therefore, an experiment was done to see if the weight loss would occur without the rotor. This was actually an easier experiment to perform than with the rotor since no torque's or vibration occurred. It was found that the effect was amplified and now resulted in a 100-1000 fold increase in weight loss over that measured on the gyroscopes with rotors. In these experiments the rotation direction dependence disappeared , so that weight loss occurred for either rotation, also weight loss was linear in applied current or voltage. This is equivalent to the mathematical change of weight loss having a new term due to the counter rotating component of the Gravity induced Poynting flow

$$\Delta W == K[\cos^2\frac{\varphi}{2}+\cos^2\frac{\varphi+180}{2}K[\cos^2\frac{\varphi}{2}+\sin^2\frac{\varphi}{2}]=K \qquad (22)$$

which results in the weight loss being made isotropic.

The weight loss was measured by placing the apparatus directly on a Sartorius 1000 scale. the weight loss would appear when the device was turned on and disappear when the device was turned off. The weight loss was linear in the applied voltage or current, but with a threshold as shown below (Figure 8). The weight loss varied depending on how the device was supported, becoming less as the distance between the scale and the device was increased. Use of a 1 cm thick aluminum disk to support the device instead of a 1cm thick plastic piece made no difference in recorded weight loss, and suspension of the device by wire directly over the scales caused no effect on the scale when it was turned on an off. Weight loss measured on the Mettler scale at Goddard, which is entirely mechanical in operation was roughly half that measured on the Sartorius. For these reasons , it is believed that this weight loss effect was not the result of electrical interference with the scale operation. However, the variation of the observed weight loss with the means of support remains the most confusing aspect of the rotorless gyro experiments and will be thoroughly investigated at a later date.

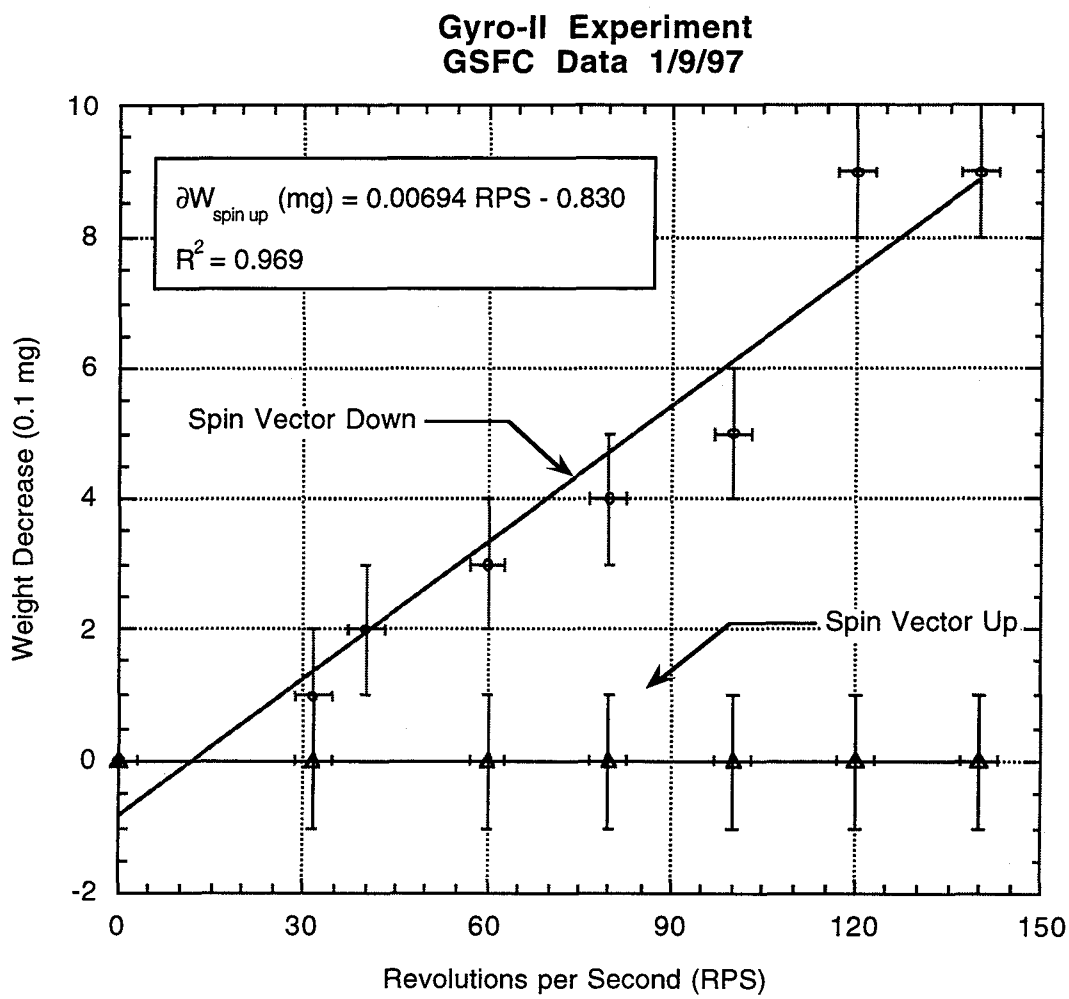



Figure 7. Weight loss measured on a Mettler scale as a function of rotation frequency of a gyroscope driven by three phase power. Sensitivity of the scale is 0.1mg.

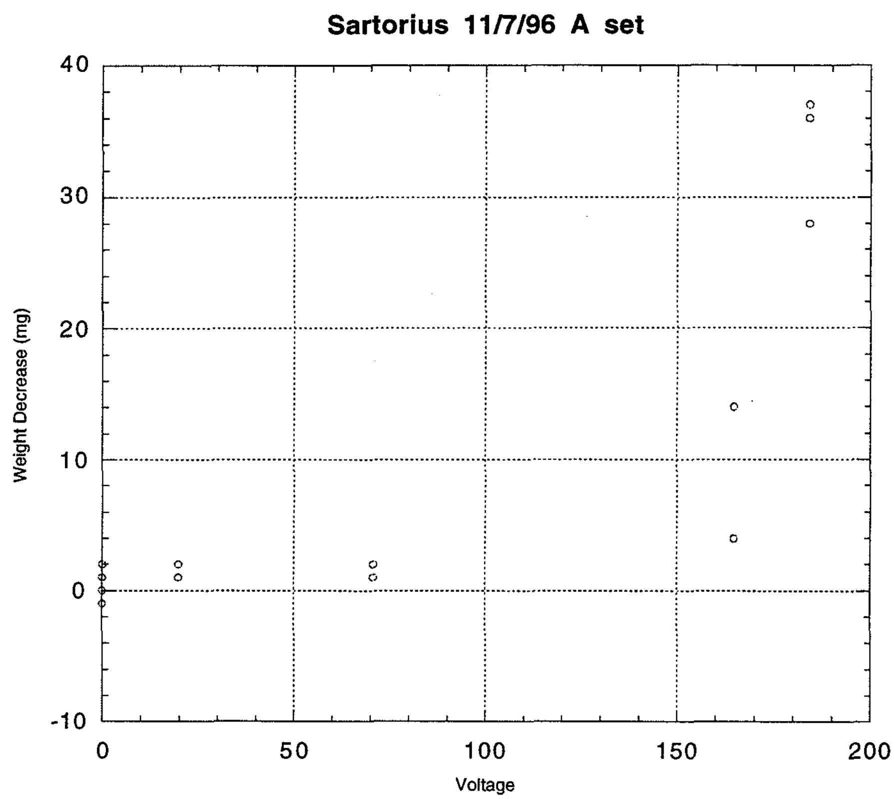



Figure 8. Weight loss of a rotorless gyroscope measured on a Sartorius scale as a function of applied voltage.

V Discussion

At this stage of our investigations, we have a theory which predicts modification of gravity via a Poynting Vortex, a theory very similar to that proposed earlier by DeValle, and we have experiments with gyroscopes, both with rotors and without that appear to show the predicted modified gravity effects. Their is therefore great reason for encouragement , in that the theory appears to basically describe much of the phenomena seen in the experiments. The fact hat the major prediction of the theory, that rotorless experiments would give similar if not larger effects than solid rotor experiments, must be regarded as a major advance. However, the experiments are done in a problematical limit of the theory, the limit of unconfined fields. In addition, much of what is observed in the experiments remains anomalous , particularly the variation of weight loss depending of thickness of support above the scale, and the presence of angular anisotropy of the effect seen in the case of the rotor, and its absence without the rotor. It must be said therefore that we have a theory which only roughly describes what is seen, and experiments that appear to give robust and reproducible effects, but whose effects remain mysterious in detail.

One explaination for these mysterious effects may be suggested by a close analog that seems to exist between the GEM equations for gravity and those of hydrodynamics. If this analogy is correct, the ZPF behaves more like a fluid or "aether" than empty space. This would mean that when a Poynnting vortex is formed unstable flows and turbulent eddys of Poynting flux can form and propagate. The full equations for gravity would thus resemble the full Navier Stokes equations with all the dynamics they allow. For the simple case of incompressible fluid aether this would be:

$$G = \dot{V}_D + V_D \bullet \nabla V_D - \frac{\nabla P}{u_o} - \mu \nabla^2 V_D \qquad (37)$$

where $V_D$ is $S/(2u_o)$ P is an aether pressure and $\mu$ is a aether viscosity. The viscosity term would arise from frame dragging found in General Relativity and the pressure term is of quantum mechanical "virtual particle "origin. This hydrodynamic analogy would simply suggest that some processes not involved in the original theory could be involved in these experiments.

Given the experimental observations, much further careful study appears required before unambiguous evidence of gravity modification can be claimed. In particular, methods for finding an unambiguous measure of gravity modification, such as an unambiguous demonstration of lifting force, or change in reading on a gravity meter must be found. It would also appear that the next experiments should employ superconducting emfoils, to confine the fields. In this way the experiments should operate in a regime where the Vacuum Bernoulli Effect theory can be tested in a clear fashion.

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