Experimental and Theoretical Progress on the GEM Theory

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Abstract

This paper reports experimental and theoretical progress on the GEM unification theory. In theoretical progress, the derivation of the GEM theory using it in a fully covariant form is achieved based on the principle of self-cancellation of the ZPF EM stress-momentum tensor. This derivation reveals that the final Gravity-EM system obeys a Helmholtz-like equation resembling that governing sound propagation. Finally an improved derivation of the formula for the Newton Gravitation constant is shown, resulting in the formula:

\[ G = \frac{e^2}{4\pi \alpha_0 m_e m_p} \exp\left(-2 \frac{\sigma - 0.86}{\sigma^2}\right) = 6.673443 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2 \]

that agrees with experimental values to 3 parts per 100,000. Experiments have found parity violating weight reductions in gyroscopes driven by rotating EM fields. These experiments appear to confirm gravity modification using electromagnetism predicted by the GEM theory through the Vacuum Bernoulli Equation.

1. Introduction

The GEM theory [1-3] has advanced over the years and provided a reasonable model for both gravitational fields in terms of EM fields, and the ratio of coupling constants between EM and gravity. It has achieved this by combining the model of Sahkarov [4] for gravitational fields, and the formalism of Kaluza-Klein theory [5]. Using these two theories, it is possible to derive both Maxwell’s and Einstein’s equations for a hydrogen plasma as a coupled set, with the appearance of a hidden fifth dimension. In this article, we briefly describe two theoretical advances: the derivation of the GEM equations from the principle of the vanishing of the ZPF EM stress-energy tensor, with the approximate form of the final equation, plus a brief discussion of an improved derivation and formula for the Newton Gravitation constant.
Constant, yielding a theoretical value within experimental error of that measured, which is 1 part in ten thousand. Experimental progress will also be briefly discussed.

**Nomenclature**

\[
\begin{align*}
c & = \text{speed of light (cm/sec)} \\
G & = \text{gravitation constant} \\
r & = \text{distance (cm)} \\
r & = \text{radius (cm)} \\
M & = \text{mass (g)}
\end{align*}
\]

2. Derivation And Meaning Of The Gem Theory Based On The Vanishing Of The Zpf

GEM is an alloy of the theoretical concepts of Sahkarov [4] and (Kaluza-) Klein [5]. To see this we begin with the Hilbert action principle in 4 spacetime dimensions with a zero cosmological constant.

\[
W = (16\pi G)^{-1} \int g^{\mu \nu} R_{\mu \nu} \sqrt{-g} d^4 x,
\]

where \( g^{\mu \nu} \) is the metric tensor and \( R_{\mu \nu} \) is the Ricci tensor. Finding the extremum of this action leads to the vacuum gravity equations with no fields.

\[
R_{\mu \nu} - \frac{1}{2} g_{\mu \nu} R = 0.
\]

Sakharov showed blatant disregard for conventional wisdom and interpreted the integrand as a real energy density, despite the fact gravity energy density is not supposed to exist. He equated this energy density to a perturbed quantum EM ground state spectrum of ZPF (Zero Point Fluctuation) due to the Heisenberg Uncertainty principle applied to the vacuum EM field. The zeroth-order ZPF is assumed to vanish due to a canceling cosmological constant term proposed by Zel’dovich [6], a colleague of Sakharov’s. This “Zeldovich Cancelation” ensures that only the perturbations due to curved space cause the ZPF to appear. Sakharov calculated the perturbed part of the ZPF due to spacetime curvature. He then derived a formula for \( G \) in terms of an integral over the perturbed ZPF:

\[
G^{-1} \approx \frac{\hbar}{2c^2} \int_0^{\omega_p} \omega d\omega = \frac{\hbar \omega_p}{c^5};
\]

\[
G = \frac{c^3 r_p^2}{\hbar} = \frac{c^4}{r_p^2 T_o},
\]

where \( \omega_p \) is the Planck frequency \( c/r_p \), where \( r_p = (Gh/c^4)^{1/2} \) and the energy density \( T_o = \hbar c/r_p^4 \) is the Planck scale energy density. This is consistent with a physical model of gravity forces due to imbalances of the EM Poynting vector, or a radiation pressure. This can be seen from two physical examples: the E×B drift of plasma physics (see: Figure 1 and Figure 2) which gives all particles a velocity \( V = E \times Bc/B^2 \) in the left of Figure 1, the uniform \( B \) field coming out of the page, acting in combination with the uniform \( E \) field between the plates, causes a uniform motion at velocity \( V = E \times Bc/B^2 \) of all charged particles. In the right figure the electric field is made non-uniform leading to identical acceleration of all charged particles.
The second example of radiation pressure acting on particles in a box whose wall absorb and emit radiation is shown in Figure 2. In Figure 2, the left figure shows hot-bright particles in a dark-cold enclosure, the right figure shows cold–dark particles in a hot–bright enclosure. Block arrows show mutual radiation pressure forces.

As was shown in the first GEM article [1], an E×B or Poynting drift field, with constant B and E growing stronger in the direction of the drift, can produce gravitational-like acceleration of charged particles of all charges and masses, as shown in Figure 1. The Sakharov model for the gravitational force is basically that of a radiation pressure Poynting field produced by non-uniformities in the ZPF and is successful in the sense that is self-consistent (see Figure 2). It is understandable that Sakharov would arrive at this physical model for gravity, since he worked on the Soviet Hydrogen Bomb where radiation pressure is crucial. We can derive the same idea, in relativistic-covariant form, from the expressions in the first GEM article, where the zeroth-order ZPF stress energy was caused to vanish. That is we will explain the Zeldovich Cancelation as EM-gravity unification physics.

The following equations show this theory in covariant form. It can be seen that if the metric tensor for gravity is written as a normalized first part of the EM momentum-stress tensor:

$$ g_{\alpha \beta} = \frac{4 F^\gamma \gamma_{\alpha \beta}}{F_{\mu \nu} F^{\mu \nu}} $$

Then it will follow that the full EM momentum stress tensor vanishes everywhere
We can expand this first part of the momentum-stress tensor:

\[ T_{\alpha\beta} = F^\mu_\alpha F^\nu_\beta - g_{\alpha\beta} \frac{F^{\mu\nu}}{4} = 0 \]  

(6)

We can expand this first part of the momentum-stress tensor:

\[
g_{\alpha\beta} = \frac{4F^\mu_\alpha F^\nu_\beta}{F^{\mu\nu}} = \left[ B^2 - E^2 \right]^{-1} \begin{pmatrix}
-E^2 & S_x & S_y & S_z \\
S_x & E_x^2 - B_y^2 - B_z^2 & E_x E_y + B_y B_z & E_x E_z - B_y B_z \\
S_y & E_y E_x + B_x B_y & E_y^2 - B_z^2 & E_y E_z + B_y B_z \\
S_z & E_z E_x + B_x B_z & E_z E_y + B_y B_z & E_z^2 - B_x^2 - B_y^2
\end{pmatrix}
\]

(7)

When this metric is averaged over large scale, such as in an isotropic Planckian field, we obtain a Lorentz flat space metric since all off-diagonal elements average to zero.

We find that we must apply the condition that the ZPF, when averaged over a region of spacetime, is isotropic, uniform, where \( E \cdot B = 0 \) locally, and is dominated by magnetic flux:

\[ E^2 = \frac{B^2}{2} \]

(8)

in order that a flat Minkowski space arises when averaged at large scale.

\[
g_{\alpha\beta} = \begin{pmatrix}
-1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{pmatrix}
\]

(9)

What have we achieved by saying that the gravitational field is an \( E \times B \) drift vector field? What we did is this: we have solved one of the greatest problems of physics, the vanishing of the ZPF stress energy tensor, and also, by this relationship, have said that we can control the metric tensor of gravity \( g_{ab} \) by EM fields. The correspondence of the \( E \times B \) drift vector field: \( V/c = E \times B / B^2 \) to the metric tensor defined in equation (7) can be seen by understanding the Poynting vector \( S = E \times B \). We have formally explained the Zeldovich Cancellation by saying that ultra-strong EM fields, such as the ZPF, cancel themselves. In doing this we have not changed the Einstein Gravity Equations, for zero Cosmological Constant, which are equations of the space-time metric tensor \( g_{ab} \). We can understand the physical meaning of \( g_{ab} \) by recognizing, in the limit of weak terrestrial gravitational fields the dominant term is \( g_{tt} = 1 + 2 \phi \) where \( \phi \) is the Newtonian gravity potential. The full Einstein relativistic equations for the metric tensor \( g_{ab} \) are not changed

\[
R_{ab} - \frac{g_{ab}}{2} R = 8\pi G T_{ab} \quad \text{where} \quad T_{ab} = F_{\mu}^a F_{\nu}^b - \frac{g_{ab}}{4} F^{\mu\nu}
\]

(10)

Nor are the Maxwell EM equations changed, which depend in relativistic formalism on the Faraday Tensor \( F_{ab} \).

\[
F^c_{\mu,\nu} = J_\mu \quad \text{where} \quad F_{\mu\nu} = A_{\mu,\nu} - A_{\nu,\mu}
\]

(11)

Both Einstein’s and Maxwell’s equations are well verified and come from the Kaluza-Klein theory. This theory does not change them. Instead, we have illuminated a new relationship within them, which is the requirement that the stress energy tensor of the ZPF vanishes. This means the metric tensor of gravity is actually electromagnetic, and must be of the form that makes the EM stress tensor in equation (10)
vanish. The fully relativistic form of this EM-metric tensor is seen in equation (7). When written in non-relativistic terms, the diagonal term $g_{tt}$ of the tensor is equivalent to a scalar gravity potential: 

$$g_{tt} \approx 1 + \frac{S^2}{T_{zp}^2 c^2}$$  \hspace{1cm} \text{which means } T_{ab}(ZPF) = 0 \tag{12}$$

Where $S$ is a net Poynting energy flow in curved space. This relationship means approximately that the Einstein equations [equation (10)] can be written as a wave equation for the propagation of EM pressure, that can be written using the Planck Length $r_p = (Gc^2/\hbar)^{1/2}$ and then $G = c^4/(T_{zp}r_p^2)$ where $T_{zp} = (\hbar c)/r_p^4$ is the radiation pressure of the ZPF.

$$R_{ab} - \frac{g_{ab} R}{2} = \frac{8\pi G}{c^4} T_{ab} \approx (\nabla^2 \left( \frac{S^2}{T_{zp}} \right) - \frac{\partial}{\partial t} \left( \frac{S^2}{T_{zp}} \right) ) = \frac{S^2}{r_p^2 T_{zp}} \tag{13}$$

So that Einstein’s equations, with the GEM formulation of the metric tensor, are basically an EM stress wave propagation equation, similar to a sound wave propagation equation. However, this equation can also have a source term on the right side, which is the same EM energy concentration. This form of equation occurs commonly in physics and is called the Helmholtz Equation. Note that the gravitation constant $G$ plays the role of a normalization constant and carries within it the background pressure $T_{zp}$. Progress was made in calculating this constant.

### 2.1 Improved Accuracy Of The Newton Gravitation Constant

Let us assume the Big Bang was triggered by a cosmic event, such as the appearance of the Kaluza-Klein 5th dimension. Let us model the effect of the compact fifth dimension by allowing angle $\phi$ in equation (6) to become an imaginary rotation angle to give two real particle masses corresponding to an "up" quantum state and "down" quantum state from the U(1) symmetry. Let us therefore assume a model of a “broken vacuum”, where a new “out of plane” imaginary angle exists that changes the U(1) symmetry from complex to real valued:

$$m = m_o \exp(\pm \frac{q}{e} \varphi_o) \tag{14}$$

So a proton is an “up” angle $\varphi_o$ and an electron is a “down” angle $\varphi_o$, so that even though mass symmetry is broken in terms of the new 5 space we experience, it is actually preserved in terms of geometry involving the imaginary angles in the original U(1) symmetry. The sign of the angle is most simply associated with a normalized charge, $q/e \equiv 1$, positive being “upness” for the heavy particle and negative being “downness” for the light particle. That is, the new particle dimension looks symmetric in the space of an imaginary angle. We assume here that even if the “bare charge” value of $e$ varies near the Planck scale, the normalized charge $q/e$ condition will still be valid.

We write then approximately, following previous derivations [3]

$$\ln(r_e(\xi)/r_p) \approx \sigma = \exp\left(\frac{q}{e} \varphi_o(\xi)\right) \tag{15}$$

so that $\varphi_o = 0$ and lepton and baryon numbers disappear within approximately a tunneling length of the Event Horizon radius for two Planck masses $\sim 2 r_p$. In the limit of $\sigma = 1 + \gamma$ where $\gamma << 1$ and $r_e/r_p = C_o + \epsilon$, where we define near the Planck scale $\epsilon = \xi r_e/r_p$ if $\epsilon << 1$, then we have then the series expansions for equation (16).
So that we have for a generalized normalized charge near the Planck scale:

\[
\frac{d\varepsilon}{d\gamma} = C_o \frac{q}{e}
\]  

(17)

At \( r_c/r_p \) and \( \sigma >> 1 \) it is known that we can use \( C_o = 1 \) and \( C_o q/e = 1 \) and get accurate formulas [2], so these are zeroth-order values, however this does not work near the Planck scale since \( \sigma = 1 \) outside the event horizon at \( r_c/r_p = 2 \). In this model the conditions near the Planck must allow normalized charge states of greater than one representing exotic quark-electron associations. The Planck scale must be studied to determine the limiting normalized charge. To obtain a reasonable value for \( C_o q/e \) at the Planck scale in our model we must turn to Standard Model Physics. In the Standard Model quark confinement fails at the Planck scale and so does the principle of integral electron charges, accordingly, we would expect to find exotic associations of quarks and electrons not seen under normal cosmic conditions. Recent experiments may have found evidence of such exotic particles as tetra-quarks [7]. In the GEM model the exotic proto-lepton and proto-protons are approximately 22 MeV in intrinsic mass. These can be formed simply by a penta-quark of a proton-like association and two up quarks for a normalized positive charge of \( 7/3 \) and a bare mass of approximately 24 MeV and a tetra-quark plus an electron that consists of an antiproton association plus down quark for a bare mass of 24 MeV and balancing charge of \(-7/3\). The Baryon number then begins as “upness” in this model even before the proton appears. The next simplest arrangement in the plasma will be the same arrangement of free quarks in association with a neutron and antineutron for masses of approximately 26 MeV and charges of \( \pm 4/3 \). Given the Sakharov model of CPT invariance and the inferred freeze-out neutron to proton ratio \( \mu \approx 1/6 \) [8] the normalized charge of the proto-protons and proto-electrons is approximately

\[
C_o \frac{q}{e} = \frac{7/3 + 4/3 \mu}{1 + \mu} \approx 2.2
\]  

(18)

This relationship changes the effective dimensionality from the Planck scale to the mesoscale. We then write the transcendental relationship that satisfies equation (16) for \( \sigma >> 1 \):

\[
\left(1 + \frac{C_o}{\sigma}\right) \ln \left( \frac{r_c}{r_p} \right) = \sigma
\]  

(19)

In the limit of \( \sigma = 1 + \gamma \) where \( \gamma << 1 \) and \( r_c/r_p = C_o + \varepsilon \), where \( \varepsilon << 1 \) we have then have the relationship between \( \varepsilon \) and \( \gamma \) for equation (19). By choosing \( \ln C_o = 1/(1 + C_2) \) we obtain a system where \( \sigma = 1 \) where \( r_c/r_p = C_o < 2 \), which is inside the surface of the black hole at \( r_c/r_p = 2 \). Expanding in series we solve for the derivative \( d\varepsilon/d\gamma \), which is our generalized normalized charge near \( \sigma = 1 \)

\[
\frac{d\varepsilon}{d\gamma} = C_o (1 + 3C_2/1 + C_2)/(1 + C_2)...
\]  

(20)

Using our approximate value of the normalized charge in the Big Bang from equation (18), we can solve for \( C_2 \) and obtain the value \( C_2 = 0.86 \) to two significant figures. Therefore, in this model, the value of \( C_2 \) is constrained by conditions near the Planck scale, which can be inferred from BBN.
2.1 The Newton Gravitation Constant

If we examine the physical meaning of the ratio of the mesoscale radius to the Planck radius \( r_o/r_P \) in equation (19), we discover it is a quantum-normalized ratio of coupling constants between gravity and EM, in addition to being a ratio of lengths:

\[
\frac{r_o}{r_P} = \sqrt{\frac{\alpha}{Gm_e}}
\]  

(21)

So that the size ratio of the Planck to the mesoscale length is actually a ratio of the strengths of interaction of gravity and electromagnetism between an electron and proton with a normalization factor of \( \alpha \). This also means the formula of equation (17) can be inverted to find an accurate expression for the gravitation constant.

We thus obtain for the gravity constant, using the measured value of the proton electron mass ratio, to second order:

\[
G = \left( \frac{e^2}{m_p m_e} \right) \alpha \exp \left( -2 \left[ \left( \frac{m_p}{m_e} \right)^{1/2} - 0.86 \frac{m_p}{m_e} \ldots \right] \right) = 6.67424 \times 10^{-8} \text{dyne cm}^2 \text{gm}^{-2}
\]  

(22)

this expression is within roughly a part per \( 10^5 \) of the measured value of 6.67428 \( \times 10^{-8} \) dyne-cm\(^2\) gm\(^{-2}\). With this progress theoretically, we now can look for evidence of experimental gravity modification based on the GEM theory.

3 Parity Violation in Gem Experiments

It is one thing to believe EM and gravity can be unified mathematically, it is quite another to believe that the EM fields required to change local gravity fields are in the range of strengths that can be achieved by present technology. Support for the theory that EM fields can locally modify gravity exists from the results of Haysaka and Takeuchi [9] (see Figure 3.) and an earlier report by Kozyrev [10]. They found that gyroscopes spun with Tesla three-phase power, would lose a small amount of weight. This effect occurred only for rotation in the clockwise direction, or spin vector down. A null result was obtained using a compressed air driven gyroscope [11], with no weight loss for either rotation sense, suggesting that any weight loss is an EM effect. The idea of rotating 3-phase power was first invented by Nicholia Tesla, and is the basis for the induction motor.

Reasons exist to look upon reports of weight loss in spinning gyroscopes with caution: It is well known that the vibration from bearings in rotating systems can effect complicated mechanical systems with damping to produce cumulative unidirectional “creep” or “rectification” effects; the use of “lock-washers” for nut and bolt fastener systems to prevent becoming unscrewed in vibrating environments is an example. However, such “rectification” effects from vibration are usually independent of rotation sense and have instead to do with “creep” to lower energy states for the system. If such an effect were in operation in the Kosyrev, Haysaka, and Takeuchi experiments, one would expect it to be seen in the Faller experiment, instead Faller reported no weight change at all [11]. Therefore, it was decided to duplicate the original gyro experiments to see if the result was reproducible.

The author was able to duplicate the Kozyrev, Haysaka and Takeuchi experiments to a high degree of fidelity, and reproduce the reported weight loss effect in the laboratory, and thus the author concluded that the Kozyrev, Haysaka, and Takeuchi results were a real EM effect. (See Figure 4.) These experiments were reported in 1998 [12]
Figure 3. The loss of weight observed by Hasagawa and Tacheuchi [9] for metal rotors spun by 3-Phase EM fields. Note that weight loss occurs only for right-rotation (clockwise) and is null for left-rotation (counter clockwise).

Figure 4. The loss of weight observed by Br andenburg and Kline [12] for metal rotors spun by 3-Phase EM fields. Note that weight loss occurs only for spin vector down (clockwise) and is null for spin vector up (counter clockwise) in agreement with that reported for Haysaka and Takeuchi [9] and Kozyrev [10].

The effect of rotation sense, in the GEM theory, is explained by constructive or destructive interference with a pre-existing rotating GEM component of the ZPF that leads to gravity [12]. Why one rotation sense would be preferred in gravity associated EM fields is not understood at this time, but may be linked to parity violation and the cosmic preference for ordinary matter, rather than anti-matter [2]. This same preference for gravity-EM effects to field rotation direction, possibly related to the rotation of the Earth, is now seen in superconductor experiments reported by Tajmar et al. [13].
4 Summary And Discussion

Using the principle of the vanishing of the EM ZPF stress-energy tensor a fundamental connection can be made with the form of the normalized EM stress energy tensor and the metric tensor. In retrospect, this relationship is physically and mathematically straightforward. Both tensors must be symmetric and both tensors must have well defined traces. Using this relationship, the Einstein-Maxwell equations can be collapsed into one set of Helmholtz-like equations. This concept is entirely consistent with the Kaluza-Klein concept that both EM and gravity fields are a result of the curvature of a generalized 5 dimensional manifold. In particular the Kaluza-Klein action can be understood as a relationship between stress-energy scalars with the curvature scalar becoming a stress energy when divided by G. Alternatively, both the EM field stress can be understood as a geometric curvature when divided by G. An ultimate understanding of spacetime as made of EM potentials in a harmonic relationship may be possible.

In other progress the value of G can now be found to within experimental accuracy by rationalizing the behavior of the mass ratio between protons and electrons near the Planck scale.

Finally and perhaps most important, the Kozyrev-Haysaka-Takeuchi effect: the apparent parity-violating loss of weight by rotors spun by 3-phase EM fields, has been reproduced and is now seen by Tajmar. This confirmation suggests that the GEM unification theory can yield useful technology in the near term. Therefore, there is reason for optimism regarding both a deeper understanding of EM gravity unification and prospects for future technology derived from it.

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