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A PHYSICAL ANALYSIS OF THE KALUZA-KLEIN AND SAKHAROV-PUTHOFF MODELS OF GRAVITY IN THE CONTEXT OF THE GEM (GRANDIS ET MEDIANIS) FIELD UNIFICATION THEORY

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Abstract

Kaluza-Klein and Sakharov-Puthoff models of Gravity are analyzed in the context of the GEM (Grandis Et Medianis) Field Theory. The GEM Unification theory is briefly reviewed with its resulting formulas for *G* and the mass of the proton. The physical identification of 5th dimension of Kaluza-Klein theory as electric charge is derived. The Sahkarov-Puthoff model of Gravity is connected to the Dirac Large Numbers hypothesis. The proton-electron mass ratio is shown to reside within the Stefan Boltzmann constant.

Keywords and phrases: Kaluza-Klein theory, Sahkarov-Puthoff model of gravity, proton-electron mass ratio, Stefan Boltzmann constant.

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1. Introduction: The GEM (Gravity Electro-Magnetism) Unification Theory in the KKE (Kaluza-Klein-Einstein) 5-Dimensional and the Sahkarov-Puthoff Quantum Electrodynamic Models of Gravity

The GEM (Gravity-Electro-Magnetism or "Grandis Et Medianis", the Great and the Middle scales), that is, the great Planck and Cosmic scales of energy and the middle, or atomic scale, theory [1, 2], following in the footsteps of Einstein's great "Unified Field Theory" effort [3] is an attempt to explain, in the manner of a "Bohr Model" how the basic forces and particles of the universe are related. GEM theory is notable in its success in deriving, by simple models, the value of the Newton Gravitation Constant to high accuracy, as well as the mass of the proton, from Planck scale considerations, calculations that will be summarized shortly. In general the GEM begins with a cosmos with one force and one particle-antiparticle pair, in a Planck scale vacuum, and from this produces a cosmos with two long range forces Gravity and EM and two particles, electrons and protons. This latter concept being also followed by Einstein in his "two particle paradigm" [3]. We will then consider a physical analysis of the Kaluza-Klein approach [4, 5] as well as the Sakharov-Puthoff [6, 7] approach to unify Gravity and EM. It is the goal of this article to show that the GEM theory may not only be useful, but that it is completely compatible with both Kaluza-Klien theory and Sakharov-Puthoff theory of Gravity-EM unification. Accordingly, we will briefly discuss the major basic results of the GEM theory and its key physical results: simple but highly accurate expressions for the Newton Gravitation Constant G and the mass of the proton, and the equally important result that the GEM theory is deeply connected to the ubiquitous quantum phenomenon of the Planckian or Black Body distribution.

The stunning success of Kaluza-Klein theory in producing the coupled equations of Einstein's GR (General Relativity) of Gravity and Maxwell's equations of EM (Electro-Magnetism) and the Lorentz force by the introducing a constrained or "hidden" 5th dimension to the Hilbert Action Principle [8], has inspired the entire "String Theory" effort to further unify the short range Strong and Weak Forces with the long range forces of EM and GR. However, the success of Kaluza-Klein theory, endorsed, and tentatively embraced by Einstein in his Unified Field effort [3], has always been overshadowed by the mysterious physical nature of the new 5th dimension that is the basis for the theory. This problem continues to plague String Theory, which added additional hidden dimensions to the five dimensional KKE (Kaluza-Klein-Einstein) approach and produced even deeper questions concerning the physical meaning of the new dimensions being introduced in order to produce promising field equations. In this article, we will attempt to understand the physical meaning of the Kaluza-Klein hidden 5th dimension and the physical relationship it suggests between GR and EM fields.

We will be guided in this discussion by the fundamental physics assumption that hidden dimensions are part of the physical world and that they are connected to the concept of particle structures, even as the existence of molecules and atoms are considered part of reality, despite not being humanly sensed. The hidden dimension of Kaluza-Klein can be understood physically in this way.

In the body of this article, we will first address the physical meaning of the Kaluza-Klein hidden dimension found in the GEM theory the context of the Planck Scale. This is the place where GR and quantum uncertainty come together. We will then summarize the present results of the GEM unification theory, which attempts to bring EM and GR together in one physical model and the relationship of this model to the physical model of Gravity fields as quantum EM phenomenon as proposed by Sakharov and Puthoff. We will demonstrate that these two models unifying physically EM and GR are in agreement. We will conclude with a brief discussion of how this may indicate a pathway to quantization of

GR by exploiting its deep connection to the quantizable EM theory.

2. The Basic Results of the GEM Theory

The GEM theory is based on two postulates: A. that gravity fields are equivalent to an array of $E \times B$ drifts familiar from plasma physics. B. that the cosmos began with a Planckian vacuum with one force field and one particle-anti particle species of the Planck mass $M_P = (\hbar c/G)^{1/2}$ and split apart in a Big bang expansion, with the appearance and “inflationary” deployment [9] of a hidden 5th dimension from the Planck length $r_P = (G\hbar/c^3)^{1/2}$, into the coupled appearance of two long-range force fields Gravity and EM (Electro-Magnetism) and two stable particles, electrons and protons of masses m_e and m_p, respectively. These particles with electric charges $\pm e$, came to be in this process from the Planck charge $\pm(\hbar c)^{1/2}$.

We can explore the physical/mathematical models associated with each postulate. For the first postulate, it is easy to see that all charged particles will assume the same drift velocity of magnitude V_d in the same direction in crossed E and B fields. The velocity magnitude will be in (cgs) for uniform crossed E and B fields. Here we will assume the fields lie in the x and y directions, leading to motion in the z direction.

$$V_d = \frac{cE \times B}{B^2}. \tag{1}$$

For constant $B = B_0$ but varying E in the z direction we will have an acceleration affecting all charged particles identically (see Figure 1)

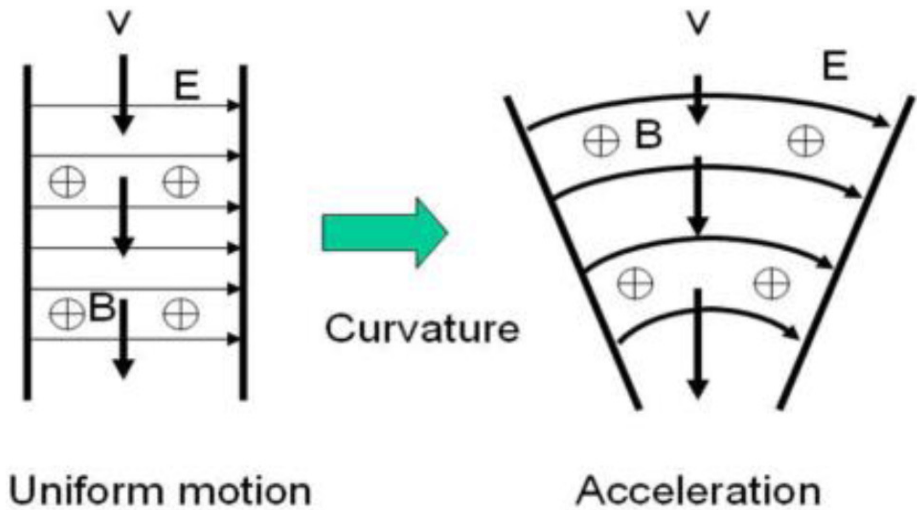

Figure 1. The $E \times B$ drift model of Gravity.

$$a = V_d \frac{dV_d}{dz} = \frac{c^2}{2B_0^2} \frac{dE^2}{dx}. \quad (2)$$

Following the form of the relativistic metric $g_{44} = (1 + 2\psi)$ where ψ is the Newtonian gravity potential, we obtain for g_{44}

$$g_{44} = \left(1 + \frac{E^2}{B_0^2}\right). \quad (3)$$

For $E/B << 1$, this can be generalized to the relativistic form, where we assume a nearly flat space metric $\eta_{\mu\nu}$ results, in a form of the metric tensor where the zero-point fields will be seen to "self censor."

$$g_{\alpha\beta} = \frac{4(F_\alpha^\gamma F_{\gamma\beta})}{(F^{\delta\varepsilon} F_{\delta\varepsilon})} \cong \eta_{\alpha\beta}. \quad (4)$$

The metric is ultimately measured by the Geodesic equation, and so must be effectively an average over the space in which a particle moves. Since particles are ultimately quantum wave packets, we must assume the metric is effectively a spacetime average. This means some local information is lost in the averaging process that must result in the metric tensor. Here we have defined the nearly flat space metric, $\eta_{\alpha\beta}$, which we will assume is entirely dominated by modes approaching the Planck Scale short wavelength modes, so that we have upon averaging nearly flat space metric over the spacetime accessed by quantum particles, including photons, which are by definition, are not localized. This form for the metric tensor of GR not only says that Gravity is a fundamentally EM phenomenon but also that very strong, high spatial frequency EM fields, ${F_0}^{\nu\mu}$, will "self censor" and not appear in the Maxwell stress tensor. That is, the vacuum zero-point fields do not appear in the stress tensor. However weak, large scale-length fields ${F_1}^{\nu\mu}$, coexisting with the strong, rapidly varying fields can appear in the stress tensor, these fields will appear in second order with the mixed zeroth and first order field terms averaging to zero.

The result for $F^{\nu\mu} = {F_0}^{\nu\mu} + {F_1}^{\nu\mu}$ is

$$\eta_{\alpha\beta} = \left\langle \frac{4F_\alpha^\gamma F_{\gamma\beta}}{F^{\delta\varepsilon}F_{\delta\varepsilon}} \right\rangle = \frac{4F_{0\alpha}^{\gamma}F_{0\gamma\beta}}{F_0^{\delta\varepsilon}F_{0\delta\varepsilon}}. \tag{5}$$

However, the form of the metric tensor then requires that $F_0^{\nu\mu}F_{0\nu\mu} = B_0^2 - E_0^2 > 0$, that is, a vacuum- dominated by strong, small regions of magnetic field.

$$\left\langle F_\alpha^\gamma F_{\gamma\beta} \right\rangle = \left\langle {F_0}_\alpha^\gamma F_{0\gamma\beta} \right\rangle + {F_1}_\alpha^\gamma F_{1\gamma\beta}, \tag{6}$$

$$\left\langle F^{\delta\varepsilon} F_{\delta\varepsilon} \right\rangle = \left\langle F_0^{\gamma\beta} F_{0\gamma\beta} \right\rangle + F_1^{\gamma\beta} F_{1\gamma\beta}. \tag{7}$$

However, the $F_1^{\gamma\beta}$ scalar terms are also near zero in Eq. 7, when averaged over local spacetime on scales much larger than the quantum wavelength of particles, that is $F_1^{\nu\mu} F_{1\nu\mu} = B_1^2 - E_1^2 \cong 0$ because the universe is predominately vacuum and EM fields are dominated by waves. Therefore, we have then

$$T_{\alpha\beta} \cong \left\langle F_{0\alpha}^{\gamma} F_{0\gamma\beta} \right\rangle + F_{1\alpha}^{\gamma} F_{1\gamma\beta}$$

$$- \frac{1}{4} \left(\frac{F_{0\alpha}^{\gamma} F_{0\gamma\beta}}{F_0^{\delta\varepsilon} F_{0\delta\varepsilon}} \right) \left(\left\langle F_0^{\delta\varepsilon} \; F_{0\delta\varepsilon} \right\rangle + F_1^{\delta\varepsilon} F_{1\delta\varepsilon} \right). \tag{8}$$

Taken together, we can make the approximation that Maxwell stress tensor is predominately self censoring with only weak long-wavelength fields predominating in an approximately flat space, where it is understood that powerful high frequency fields are self censored and so only weak long wavelength, vacuum dominated fields appear explicitly.

Thus, we recover the standard expression for the Maxwell-Stress tensor in nearly flat space

$$T_{\alpha\beta} \cong F_{1\alpha}^{\gamma} F_{1\gamma\beta} - \frac{\eta_{\alpha\beta}}{4} F_1^{\delta\varepsilon} F_{1\delta\varepsilon}. \tag{9}$$

The second postulate is that a KKE hidden dimension appears and in an inflationary manner deploys to a constrained size, allowing separate EM and Gravity fields as in KKE theory. The deployment occurs in a manner coupled to the separation of the electron and proton from the Planck masses, to form a new mass and charge scale as opposed to the Planck scale quantities of charge, mass, and length, respectively

$$q_P^2 = \hbar c, \tag{10a}$$

$$M_P = \sqrt{\frac{q_P^2}{G}}, \tag{10b}$$

$$r_P = \sqrt{\frac{G q_P^2}{c^4}}, \tag{10c}$$

where we can define the ratio of the Planck charge to the newly appeared electronic charge, as the square root of the fine structure constant

$$\alpha^{1/2} = \sqrt{\frac{e^2}{\hbar c}}. \tag{11}$$

We now assume the inflationary deployment of the new KKE 5th dimension from the Planck scale, to a new scale, which we will call the "mesoscale." This has the physical effect of producing a new charge-to-mass scale, e/m_0, which is in contrast to $G^{1/2}$, which has units of charge-to-mass $G^{1/2} = q_P/M_P$.

We assume this new charge, mass, and length scale appears as the KKE 5th dimension deploys in an inflationary manner, e, r_0 and m_0, so that the "fine structure constant $\alpha = e^2/\hbar c$ goes from being unity to becoming approximately $1/137$. We will call the final hidden dimension size r_0, or the mesoscale length, where the new length scale represents new information in the cosmos being composed of new quantities e and m_0, the mesoscale mass, which is $m_0 = (m_p m_e)^{1/2}$

$$r_0 = \frac{e^2}{(m_0 c^2)}. \tag{12}$$

We then posit the equation, defining the parameter $\sigma = (m_p / m_e)^{1/2}$ $\cong 42.8503...$, the square root of the proton-electron mass ratio, so that the deployment of the mesoscale is coupled to the separate appearance of protons and electrons from the particle-antiparticle system of the Planck mass particles.

$$\ln\left(\frac{r_0}{r_P}\right) = \sigma - \frac{1}{\sigma^2}, \tag{13}$$

where the $1/\sigma^2$ term is only of importance near the Planck scale where

$\sigma \to 1$. The ratio of the mesoscale size and the Planck length, is not only a geometric ratio but also an important parameter of the relative strengths of quantum mediated forces of Gravity and EM between a proton and an electron.

$$\frac{r_0}{r_P} = \sqrt{\frac{\alpha e^2}{(G m_p m_e)}}. \tag{14}$$

When equation is inverted to find an expression for G, the gravitation constant, we obtain the result for the everyday scale

$$G = \alpha \frac{e^2}{m_p m_e} \exp\left(-2\left(\left(\frac{m_p}{m_e}\right)^{\frac{1}{2}} - \frac{m_e}{m_p}\right)\right). \tag{15}$$

We can easily recover the MKS expression for G with the substitution $e^2 = e^2/(4\pi\varepsilon_0)$. Using 2018 CODATA values for all physical constants this yields, in MKS, $G_{gem} = 6.67539 \times 10^{-11}\,\mathrm{m}^3/(\mathrm{kgs}^2)$ and is within 0.015% of the presently accepted value of G_{CODATA} = $6.67430 \times 10^{-11}\,\mathrm{m}^3/(\mathrm{kgs}^2)$.

We also have the mass formula for protons and electrons

$$m = m_0 \exp\left(\pm \frac{q}{e} \ln \sigma\right), \tag{16}$$

where the charge state of the particle determines its mass, producing protons for positive charge and electrons for negative charge. Where we have also for m_0

$$m_0 = M_P \exp\left(\left(-\alpha^{-\frac{1}{2}} - \alpha - 1\right) \ln \sigma\right), \tag{17}$$

where $\alpha^{-1/2}$ is the Planck charge normalized to e, and α is a QED correction term, important near the Planck scale as is the $1/\sigma^2$ in the formula for G. This term must be included to give the proper limiting behavior near the Planck scale where we assume both σ and $\alpha \to 1 + \varepsilon$, where we assume $\varepsilon << 1$ near the Planck scale so that the product of the ratios of masses and lengths will go to unity to second order in ε as the Planck scale is approached, making it a local extremum

$$\frac{M_P r_P}{r_0 m_0} = \frac{1 - 3\varepsilon \ ...}{1 - 3\varepsilon \ ...} \to 1. \tag{18}$$

This gives a formula for the mass of the proton

$$m_p = M_p \exp\left(\left(-\alpha^{-\frac{1}{2}} - \alpha\right)\ln\sigma\right). \tag{19}$$

Using 2018 CODATA values for all physical constants this yields $m_{pgem} = 1.6664 \times 10^{-27}$ kg and is within 0.37% of the presently accepted value of $G_{CODATA} = m_p = 1.67262 \times 10^{-27}$ kg.

3. The Equations of KKE in the Context of the GEM Theory

We now examine the compatibility of the GEM theory with KKE theory. We have as a basic result of the standard KKE theory, where a new, unitless, scalar, field ϕ must appear [10].

$$R_{\alpha\beta} - \frac{1}{2} g_{\alpha\beta} R = \frac{1}{2}\phi^2 k^2\left(F_\alpha^\gamma F_{\gamma\beta} - \frac{1}{4} g_{\alpha\beta} F_{\gamma\varepsilon} F^{\gamma\varepsilon}\right)$$
$$+ \frac{1}{\phi}(\nabla_\alpha \nabla_\beta \phi - g_{\alpha\beta} \Box \phi). \tag{20}$$

In order for this to agree with standard GR, where the EM fields are those which are observed, we must assume ϕ near unity to yield standard GR theory with $k^2/2$ having the value

$$\frac{1}{2}k^2 = \frac{8\pi G}{c^4}. \tag{21}$$

We have then

$$R_{\alpha\beta} - \frac{1}{2}g_{\alpha\beta}R = \phi^2 \frac{8\pi G}{c^4}\left(F_\alpha^\gamma F_{\gamma\beta} - \frac{1}{4}g_{\alpha\beta}F_{\gamma\varepsilon}F^{\gamma\varepsilon}\right)$$

$$+ \frac{1}{\phi}(\nabla_\alpha \nabla_\beta \phi - g_{\alpha\beta}\Box\phi). \tag{22}$$

We must assume that ϕ is a constant to obtain the well verified equations of GR, equivalent to assuming that non zero-point EM fields are vacuum dominated, also a necessary condition from Eq. 5 to recover the GEM result of Eq. 9. The source equation for ϕ, in standard formalism is

$$\Box\phi = \frac{\phi^3}{4}(F_{\gamma\varepsilon}F^{\gamma\varepsilon}) \cong 0, \tag{23}$$

which requires ϕ being constant and unity, as a consequence of the vacuum dominance of spacetime.

We have the equation for spacetime interval, now including effects due to the KKE 5th dimension, in general

$$ds^2 = g_{\alpha\beta}dx^\alpha dx^\beta + \phi^2(g_{\alpha\beta}kA^\alpha dx^\beta + dx^5)^2. \tag{24}$$

Defining, incremental proper time via the expression $ds = cd\tau$, we have

$$v^\alpha = \frac{dx^\alpha}{d\tau}. \tag{25}$$

However, we will assume, for initial conditions of the new cosmos after deployment of the 5th dimension, from a Planck volume, in the GEM theory of the inflationary deployment of the hidden 5th dimension, that, after averaging, the net displacement of the cosmos in the new fifth dimension is zero, $dx^5 = 0$. That is, each region of deployed 5th dimension is initially charge neutral. We also assume that the deployment will occur at minimum, or zero, action. Therefore, for particle charge q and also defining the vector potential of the deploying 5th dimension in a manner completely uncorrelated with everyday spacetime, where define r_0 as the deployed length of the 5th dimension, like a light-like wavefront where we have

$$kA^{\alpha} = k\frac{q}{r_0 c}\frac{dx^{\alpha}}{d\tau}. \tag{26}$$

We can then write for the initial state of the new cosmos, for this wavefront, a zero action condition

$$g_{\alpha\beta}k\frac{q}{c}A^{\alpha}dx^{\beta} = g_{\alpha\beta}k\frac{q^2}{r_0 c^2}\frac{dx^{\alpha}}{d\tau}\frac{dx^{\beta}}{d\tau}d\tau = 0. \tag{27}$$

Therefore, we can write, for the initial zero action condition for the deployed 5th dimension

$$\left[\frac{q}{c}\right]^2(v_4^2 - v_1^2 - v_2^2 - v_3^2) = 0. \tag{28}$$

We now define, on a light-like wavefront, for the initial state of 5th dimensional deployment

$$\left[\frac{q}{c}\right]^2(v_4^2 - v_1^2 - v_2^2 - v_3^2) = (q_4^2 - q_1^2 - q_2^2 - q_3^2) = 0. \tag{29}$$

The STM (Space-Time Manifestation) of the 5th dimension, then, as it is born from a Planck volume, is as an effective multicomponent charge, a coupled spacetime-like system of 4 vectors. The charge of the electron, being the time-like portion and the three quark charges making up the proton as the space-like components. The fact that after deployment the 5th dimension, gives zero displacement of the cosmos in the 5th dimension ensures the sum of the four STM charge components add up to zero: $q_4 = -(q_1 + q_2 + q_3)$ and the zero initial action condition of the STM of the deployed 5th dimension appears as like a frozen light-like wavefront with $q_4^2 - (q_1^2 + q_2^2 + q_3^2) = 0$ containing the electron and quarks.

This previous analysis gives the interesting result that the electric charge of particles, when multiplied by k to yield kq has units of distance, that is $(8\pi G/c^4)^{1/2} q = dx^5$ and also that the uncorrelated nature of the inflationary deployment of the hidden dimension with ordinary spacetime dimensions makes the particle charge appear in the equation for distance as if it was four vector on a light-like front. Thus, the hidden 5th dimension, because of its inflationary deployment appears effectively as a frozen wavefront of light in everyday spacetime, with, effectively time-like, and spatial-like components. It deploys as a multiparticle system. We will call this effective result the STM of the 5th dimension, even though we consider the 5th dimension to be a single new dimension. That is, for the deployed 5th dimension $dx^5 = kq_0$

$$\sqrt{\frac{8\pi G}{c^4}}\, q_0 = \ell. \tag{30}$$

Thus, 5th dimension is electric charge, which, when multiplied by the factor $(G/c^4)^{1/2}$, which has units of charge to mass-energy ratio, yields units of a distance, ℓ.

Returning to the STM of the deployed 5th dimension as a distance, the space vector of q_1, q_2, q_3, the quark charges, should define a minimum volume to minimize initial charge separation. Given the previous two constraints we can then write the Lagrange multiplier problem of minimization of the quantity

$$U = q_1 q_2 q_3 + L_1({q_1}^2 + {q_2}^2 + {q_3}^2) + L_2(q_1 + q_2 + q_3). \tag{31}$$

With condition of $\delta U = 0$ resulting in the three coupled equations

$$q_1 q_2 + 2L_1 q_3 + L_2 = 0, \tag{32a}$$

$$q_2 q_3 + 2L_1 q_1 + L_2 = 0, \tag{32b}$$

$$q_1 q_3 + 2L_1 q_2 + L_2 = 0, \tag{32c}$$

with the solutions

$$L_1 = 1/3, \qquad L_2 = -2/9, \tag{33a}$$

$$q_1 = -1/3, \qquad q_3 = q_2 = 2/3. \tag{33b}$$

Accordingly, the constrained deployment of the 5th dimension, results in a STM, that is, the electron-quark system, with the zero action initial state, effectively a light-like 4-vector. The inseparability of the quarks at ordinary energies then follows from the identity of the quarks as the spacelike portion of the STM of the 5th dimension. The spacelike portion must behave like an inherently three-dimensional wavefront frozen in time whose dimensionality cannot be reduced, it must have three dimensions and no less. Thus, the quarks cannot be seen separately, yet must behave as three separate particles in a confined space that is the deployed manifestation of the 5th dimension.

This all leads to the KKE geodesic equation, which includes not only the effect of Gravity on particles but also EM forces. It is a physical requirement that these equations reproduce the observed gravitational and electro-dynamics, and this imposes requirements of some terms to go to zero to empirically even if not required from obvious physical or mathematical arguments. We then define

$$\frac{dv^{\mu}}{d\tau} + \tilde{\Gamma}^{\mu}_{\alpha\beta} v^{\alpha} v^{\beta} + 2\tilde{\Gamma}^{\mu}_{\alpha\beta} v^{\alpha} v^{5} + \tilde{\Gamma}^{\mu}_{55} (v^{5})^{2} + v^{5} \frac{d}{d\tau}\left(\ln\left(c \frac{d\tau}{ds}\right)\right) = 0. \tag{34}$$

Following standard KKE formalism, we have for the term with the factor

$v^{\alpha}v^{\beta}$ which provides the gravitational geodesic term, $\Gamma^{\mu}_{\alpha\beta}$, the additional terms going to zero, phenomenologically, and by the required constancy of ϕ

$$\tilde{\Gamma}^{\mu}_{\alpha\beta} = \Gamma^{\mu}_{\alpha\beta} + \frac{1}{2} g^{\mu v}\phi^2 (A_{\alpha}F_{\beta v} + A_{\beta}F_{\alpha v} - A_{\alpha}A_{\beta}\partial_v(\ln \phi^2)). \tag{35}$$

The term first order in v^5 Eq. 34 provides the Lorentz force term

$$\tilde{\Gamma}^{\mu}_{5\alpha} = \frac{1}{2} g^{\mu v}\phi^2 k(F_{\alpha v} - A_{\alpha}\partial_v(\phi)^2), \tag{36}$$

where the derivative of ϕ^2 goes to zero because by Eq. 23 it is constant.

The charges and masses of observed particles cannot be derived from KKE theory but must be introduced to yield the equations describing reality. To reproduce observed electrodynamics, the parameter with units of velocity, v^5 must assigned “by hand” the seemly unphysical magnitude of approximately moving a classical electron radius in each Planck time.

$$v^5 \approx \frac{r_e c}{r_P} = \sqrt{\frac{c^5}{G\hbar}}\,\frac{e^2}{m_e c^2}. \tag{37}$$

The explanation for this seemly unphysical speed, in the context of the GEM theory, is that it is an “inflation rate” during which the 5th dimension deploys from the Planck length to its constrained final size, in an approximate Planck time.

Therefore, the seemly inexplicable value of this “speed” in KKE theory, required for it to reproduce observed and tested electrodynamics, can be understood as evidence for “inflationary physics” in the apparently singular and explosive beginnings of the cosmos.

4. The GEM Theory in the Context of EM Quantum Theory

The key parameter of the GEM theory is $\sigma = (m_p/m_e)^{1/2} \cong 42.8503$, which has always been puzzling, but now can be seen in the context of EM quantum theory, through its foundational result, the successful derivation by Max Planck, of the Planckian distribution, seen throughout nature. Its appearance in the GEM theory, as will be discussed later, may provide a pathway to quantization of Gravitation, since if GR has an underlying EM basis, and since EM is quantizable, the doorway to quantization of GR may have been opened. However, let us first demonstrate the deep connection of Planckian thermodynamic physics to the key GEM parameter σ.

As we have seen the GEM model of a hidden 5th dimension undergoing an inflationary deployment from the Planck scale, the STM of the 5th dimension makes electric charge appear as a four vector, with one time-like component, the electron, and three spatial components, the quarks making up the proton. Let us now imagine the quark system is born in a state of maximum entropy, constrained to a small volume. To avoid large charge separations, equivalent to displacement of the cosmos in kx_5, we must assume that the electron and quarks occupy effectively the same volume as the hidden dimension deploys. Phenomenologically, this common spherical volume has the radius of r_c

$$r_c = \frac{e^2}{2m_e c^2} = 1.40897 \text{ fm}. \tag{38}$$

This, of course a classical result, but none-the-less useful, for it provides the scale of the observed effective cross section for scattering of light by free electrons. In the GEM theory it also provides the effective radius of the proton and neutron in nuclear drop models, also approximately 1.4 fm and also, more fundamentally, it is the Compton radius of the charged pion, $\lambda = 1.41382 \text{ fm}$, the main carrier of the Strong force. This is seemly a coincidence of nature, however, in the GEM theory it is part of the STM of the deployment of the hidden dimension to a finite size and thus not coincidental, but full of physical meaning.

Let us assume a simple; physics model of three quark fields, and their associated photon-like gluon fields filling the volume of the proton in maximum entropic manner, so that, the gluon fields, where the mass-energy actually resides, are Planckian. We will assume the temperature of the 3 quark associated distributions to be the mass energy of the neutral pion, 134.9768 MeV which can decay into a pair of EM photons. Due to the confinement of the Planckian distributions, the wavelengths longer than r_c, we will assume to be cutoff, yielding only approximately 0.97, of the energy density of an unconstrained Planck distribution. This model is therefore equivalent to modeling the proton as a sphere of radius r_c, full of 3 EM fields, corresponding to the color field of the three quarks, of temperature corresponding to the rest energy of the neutral pion. We can then calculate its energy in terms of electron mass-energies, at 0.511 MeV each.

$$m_p \cong 3.\frac{4\pi}{3} r_c^3 .0.97.K(m_{\pi 0} c^2)^4, \tag{39}$$

where we have

$$K = \frac{4\sigma_{SB}}{c} = 4.\frac{6\pi^5}{45(\hbar c)^3}. \tag{40}$$

We then obtain

$$m_p \cong 6\pi^5 m_e.(1.04), \tag{41}$$

where the factor of 1.04 one can be considered an artifact of the imperfect accounting of the cutoff of the Planckian distribution in its confined space and, for this model calculation, is considered to be effectively unity.

As is well known, the mass ratio of the proton to the electron $m_p/m_e = \sigma^2$ is given to great precision by the seemly unlikely number, $6\pi^5 = 1836.118$, the Lenz formula [1], which can now be seen, in the context the GEM theory, as due to its presence in the Stefan Boltzmann constant, and which is the key parameter of the energy density of Planckian fields. Therefore the key parameter of the universe $m_p/m_e = \sigma^2$, in the GEM theory, is due to maximum entropy of quantized boson fields, photons and gluons, which are ubiquitous in nature, rather than simply a property of the system of nature's two most common, stable, massive particles. The GEM unification theory is then based on numerical factors found in the most important and fundamental phenomena of nature, from the light of stars, and the CBR (Cosmic Background Radiation) to the light and heat of a campfire, and the radiant warmth of living things.

5. The Sakharov-Puthoff Model of Gravity Fields as EM Phenomena

It was argued even in the time of Newton by Fatio and Lesage that Gravity fields could be physically modeled as due to the pressure of a radiation field. This can be easily seen physically by the concept of two bright objects in a weightless condition, that repel each other by mutual radiation pressure with $1/r^2$ force. (See Figure 2) as can also be seen, two dark objects in a box, with white hot walls, will attract each other with a $1/r^2$ force due to mutual shadowing.

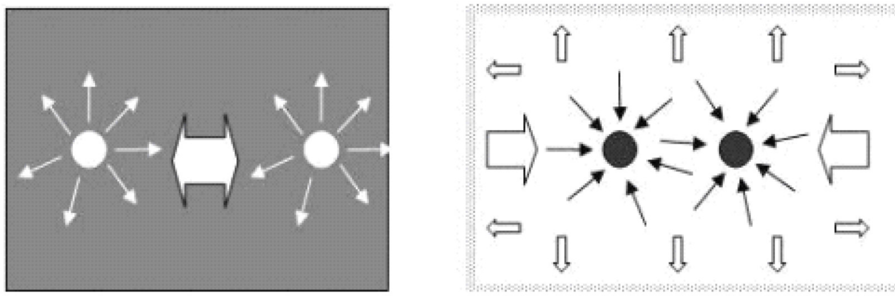

Figure 2. The Poynting flux pressure model of Gravity.

This was first formalized using quantum zero-point EM radiation pressure by Sahkarov [6] and later refined by Puthoff [7] who both obtained similar expressions for the Newton Gravitation Constant from these physical models.

$$G = \frac{r_P^2 c^3}{\hbar}. \tag{42}$$

Evidence for this physical model of Gravity fields as EM phenomena can found cosmologically from the argument that the cosmos appears to be at near the mass-density of the critical value where it is flat and gravitationally open. This can be seen from the following expression for this critical number density n_c of protons and its relationship to the Hubble radius R_H

$$\frac{8\pi G}{3c^2} m_p n_c R_H^2 \cong 1. \tag{43}$$

Solving for the critical number density

$$n_c \cong \frac{3c^2}{8\pi G m_p R_H^2}. \tag{44}$$

If the EM model of GR is correct, then, using the principle of quasi-neutrality in Plasma Physics, which says that in a hydrogen plasma the density of protons and electrons will be nearly identical, we can write a condition of the same critical number density as an electron density that will give the critical "gray body" optical condition of the universe being one EM scattering mean free path thick [2]

$$\sigma_{Th} n_c R_H \cong 1, \tag{45}$$

where $\sigma_{Th} = 8\pi r_e^2/3$ is the Thompson scattering cross section of the electron for low frequency light.

$$\frac{3}{8\pi r_e^2 R_H} \cong \frac{3c^2}{8\pi G m_p R_H^2}. \tag{46}$$

Upon simplification, we recover the remarkable mathematical relationship

$$\frac{R_H}{r_e} \cong \frac{e^2}{G m_p m_e}, \tag{47}$$

which is the Dirac Large Numbers Hypothesis [2]. This observation of Dirac can then be argued to indicate the large scale equivalence of Gravity fields to a field of EM quanta.

A further cosmological argument can be made by equating the Gravity force between two electrons to the differential radiation pressure exerted by a Planckian thermal radiation bath.

$$G m_e^2 = \frac{4\sigma_{SB} T_G^4}{3c} \sigma_{Th}^2. \tag{48}$$

This expression can be solved for T_G the temperature of the thermal radiation bath [2]

$$\left[\frac{3G m_e^2 c}{4\sigma_{SB}\sigma_{Th}^2}\right]^{1/4} = T_G = 2.65\ \text{K}. \tag{49}$$

This is within 2.7% of the measured temperature of the CBR $T_{CBR} = 2.728\text{ K}$ and so suggests that the CBR may represent a quantum scattering of a zero-point field, as is suggested by $T_G(1 + 4\alpha) \cong T_{CBR}$.

However, a major problem with the conceptual model of Gravity fields as due to a thermal bath is the Poynting-Robertson Effect which leads to a drag force for any particle moving through a thermal bath of radiation. However, we can write for a body being accelerated by the perturbed radiation pressure u' of other matter that radiation balance can exist in a moving frame, due to the unperturbed background radiation field u_0, where we assume $u'/u_0 << 1$, that is, a cosmos dominated by vacuum.

$$\frac{u'}{3}\sigma_{Th} = \frac{v}{c}u_0\sigma_{Th}, \tag{50}$$

$$\frac{u'}{3u_0} = \frac{v}{c}. \tag{51}$$

Therefore, in the frame of the accelerating electron, the Poynting vector S, which leads to the radiation pressure $\sigma_{Th}\, S/c$ on the electron, is opposed by the radiation pressure that causes the Poynting-Robertson Effect, thus in the accelerated frame of the electron, net S, forward and backward, vanishes. Therefore, the accelerated electron sees a uniform bath of thermal radiation and 'Gravity' vanishes.

6. Discussion and Conclusions

Therefore, the GEM theory appears to be deeply compatible with both the KKE theory and the Sakharov-Puthoff theories of gravity. Despite the rudimentary nature of the GEM theory at this stage of development, its interesting initial results suggest that a path to quantum Gravity may be possible, based on the fact that EM fields can be quantized successfully. It is also encouraging that in the GEM theory model of Gravity fields, the

Poynting vector of EM theory plays a central role, and this same vector also plays, in turn, a central role in the quantization of EM fields. Accordingly, the Poynting vector may provide the key connection between quantized EM and quantized Gravity. The GEM theory may, therefore, have practical implications for near-term technology.

In a previous article, the VBE (Vacuum Bernoulli Equation) was derived based on the GEM theory [11]

$$\frac{S^2}{u_0 c^2} - \frac{g^2}{2\pi G} = \text{Constant}, \tag{52}$$

where u_0 is the background EM field and g is the local gravity in the moving frame and S is the net Poynting vector. Since $S \propto E \times B$ vanishes in the accelerated frame, so does g and this expression satisfies the Equivalence Principle. This expression also suggests that modification of Gravity fields can be accomplished by powerful EM fields, as is also suggested by Puthoff [Private Communication].

Interestingly, in the ancient Indian writings, wingless flying craft are described, called "Vimana" which can mean in Sanskrit, "measure", or literally "to apply a metric."

References

[1] J. E. Brandenburg, GEM unification theory, J. Multidisciplinary Eng. Sci. Studies 2(7) (2016), 694.

[2] J. E. Brandenburg, Unification of gravity and electromagnetism in the plasma universe, IEEE Transactions on Plasma Science 20(6) (1992), 944.

[3] T. Sauer, Einstein's Unified Field Theory Program, Einstein Papers Project, California Institute of Technology, 2007. http://philsci-archive.pitt.edu/3293/1/uft.pdf

[4] Theodor Kaluza, Zum Unitätsproblem in der Physik, Sitzungsber. Preuss. Akad. Wiss. Berlin. (Math. Phys.) (in German), (1921), pp. 966-972, Bibcode: 1921SPAW.......966K.

[5] Oskar Klein, Quantentheorie und fünfdimensionale Relativitätstheorie, Zeitschrift für Physik A (in German) 37(12) (1926), 895-906, Bibcode: 1926ZPhy...37..895K, doi: 10.1007/BF01397481.

[6] A. D. Sakharov, Sov. Phys. Dokl. 12 (1968), 1040.

[7] H. E. Puthoff, Gravity as a zero-point-fluctuation force, Phys. Rev. A 39 (1989), 2333.

[8] David Hilbert, Die Grundlagen der Physik [Foundations of Physics], Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen - Mathematisch-Physikalische Klasse (in German) 3 (1915), 395.

[9] Fulvio Melia, The cosmic horizon, Monthly Notices of the Royal Astronomical Society 382(4) (2008), 1917-1921.

[10] L. L. Williams, Field equations and Lagrangian for the Kaluza metric evaluated with tensor algebra software, Journal of Gravity, Volume 2015, Article ID 901870. doi: 10.1155/2015/901870.

[11] J. E. Brandenburg and J. Kline, Joint Propulsion Conf. AAIA-98-3137, 1998.