The GEM (Gravity-EM)Theory : the Unification of the Strong, EM , Weak ,and Gravity Forces of Nature

John E. Brandenburg PhD , Morningstar Applied Physics LLC
Madison USA

***Abstract*—This manuscript presents the initial results of the GEM (Gravity-Electro-Magnetism) theory which unifies the four forces of nature. The two long range forces Gravity and Electro-Magnetism are first unified, and out of this unification also proceeds the unification of the short range Weak and Strong Forces. They are unified under the two postulates that: 1. Gravity fields are an array of electromagnetic cells and 2. The separate appearance of Gravity and EM fields from each other is correlated with the separation of protons and electrons from each other as they emerge from the Planck scale with the appearance of a compact or hidden dimension. In the Standard Model all massive particles are charged and move freely at short distances and even photons spend time as charged particles. The quark-electron split occurs based on the asymmetry in dimensionality between space and time. The proton mass is found by assuming Planckian neutral pion fields inside the proton. The theory produces the value of G: the Newton gravitation constant, and the proton mass accurately from the Planck scale with no free parameters. The theory produces the values of the masses, charges and spins for the pions of the Strong Force and the W and Z bosons of the Weak Force as quantum Mie scatterings off the compact dimension structures associated with the proton and electron masses. The Higgs Boson mass follows from similar formalism. The GEM theory extends the Standard Model to include Gravitation. The theory predicts a short lived, neutral spin 0 particle will be found at approximately 22MeV, that matter can emerge from the bare vacuum, and that a basic cosmic parameter is the number 42.8503.**

Keywords—GEM Unification Gravitation Electromagnetism quarks, Strong Force, Weak Force, Pions, W and Z Bosons, Higgs Boson

I. INTRODUCTION

According to present understandings, the cosmos, as we know it, began with a tremendous explosion, the Big Bang, that became the expansion of the universe. This can be interpreted as the sudden appearance of charged massive particles from the vacuum, along with entropy. Such an occurrence can be understood, in turn, as the result of the formation of a compact or hidden dimension, leading to the appearance of other particles and forces. This scenario is proposed in the GEM (Grandis et Medianis) *"the unity of the great and middle"* theory [1-5]. The GEM theory unites the "middle" or "mesoscale" of particle classical radii with "great" scales of both the Cosmos and Planck Scale. The GEM theory is combination of two concepts- the compact 5th dimension concept of the Kaluza-Klein [6] theory unifying gravity and electromagnetism, and the Sakharov [7,8] concepts of an electro-dynamic vacuum-spacetime as the origin of an electro-dynamic gravity, and CP Violation (favoring matter over antimatter) in the Big Bang giving rise to hydrogen.

Under the conjecture of Dr. Alfred Luhen, (Private Communication) one cannot create mass without creating gravity, meaning the Higgs Boson, the quanta of the mass generating scalar Higgs field, must be fundamentally connected to General Relativity. This fundamental connection is illuminated by the GEM unification theory, as will be shown and is also discussed in more depth in ref. [5].

A. *The Theory in Summary*

The four forces of nature consist of two long range forces Gravitation and Electro-Magnetism with infinite effective range, and two short range forces, the Strong and Weak forces, with effective ranges of only subatomic distances. Gravity shapes the stars, planets, and galaxies, Electromagnetism illuminates the universe and determines basic atomic structure. The Strong force is responsible for basic nuclear structure, binding the protons together against their mutual electrostatic repulsion, and also causes the massive energy releases in fusion that lights the Sun and stars, and also the fission reactions that generate power on Earth. The Weak force is responsible for beta decay of radioactive nuclei. Whereas the long range forces are well described by exchanges of massless bosons, the photon and graviton, the short range forces are best described as exchanges of massive bosons. The pion is the exchange boson of the Strong force outside the nucleons and the W and Z bosons are exchange quanta of the Weak Force. The effort to unify these forces began with unification of the two long range forces, and then continued with the discovery that the short range forces were unified as well. In the GEM theory quantum electro-magnetism is the basic underlying force that creates the other forces, this reflected in the charged character of all fundamental massive particles in the Standard Model and their free movement at short distances.

The resulting theory can be summarized briefly: **1.** It is postulated that gravity fields can be modeled as an array of ExB drift cells familiar from plasma physics, making spacetime electrodynamic and cellular in structure due to the presence of a compact dimension. **2.** It is also postulated that the separation of EM from gravity is correlated with the separation of protons and electrons from the Planck scale with the appearance of a compact 5th dimension of subatomic size. The presence of the compact 5th Kaluza-Klein dimension required to have separate EM and gravity fields in the vacuum also destabilizes the vacuum by breaking its scale symmetry at the physical size (in cgs) $r_o = e^2/m_oc^2$ where $m_o=(m_pm_e)^{1/2}$ with m_p and m_e, being the proton and electron masses respectively. This predisposes the cosmos to the be dominated by hydrogen. As proposed by Witten [9] the presence of the compact dimension makes the vacuum unstable. In the GEM theory the instability of the vacuum leads to its decay into proton-electron pairs, or hydrogen[3]. A physical interpretation of this compact dimension is as electric charge.

In order to preserve a vacuum interval of zero length the charges must split into a time-like charge: the electron, and spatial part with three sub-dimensions: the quarks in an image of spacetime. Since this can occur many ways this must introduce entropy. The mass of the proton is found by assuming Planckian pion fields inside a classical radius. The proton is thus stabilized and the quarks confined by a geometric constraint of maintaining compact dimensionality. This geometric constraint allows the proton to be dealt with as a fundamental particle in the theory.

In a strange quantum phenomenon, the classical electrodynamic radii of the electron and proton support resonant Mie scatterings off the background quantum ZPF (Zero Point Fluctuation) giving the masses, spins and charges of the exchange bosons of the Strong and Weak nuclear forces, which are the pions and W and Z particles respectively and creates a resonant Mie scattering Higgs Boson mass of approximately m_p/α ~128 GeV. It is found that the spins and charges of the exchange bosons reflect the intrinsic dimensionality of electrons and protons that they scatter off of. The theory predicts a new, elusive, neutral particle called an M* at approximately 22MeV and that rare vacuum decays will occur, making hydrogen and radiation out of empty space [5].

B. Outline of Approach

The GEM theory is based on simple physical concepts and mathematical models derived from them. Like a pathfinding journey across a vast wilderness, one must travel light, carrying only basic essentials. The GEM theory essentially combines the Kaluza-Klein 5th dimensional approach with the Sakharov concept of 'metric elasticity of space' due to the ZPF. The Kaluza-Klein approach gives both Maxwell's equations of EM and the Einstein Equations of General Relativity with proper couplings. It also requires a scalar EM field which resembles the Higg's field. Thus the mass producing scalar field and gravity are born together in this theory. The Sakharov approach gives the physical picture of spacetime and particles as electrodynamic. Given the difficulty of unifying the four forces of nature, it was decided to achieve this by successive approximations, this theory being the first level, with minimal constraints and conditions. Thus, a rudimentary "Bohr Model" of field unification results, that extends the Standard Model to include Gravitation at low energies. Hopefully, like the Bohr model of the hydrogen atom, the GEM theory can form the basis for deeper and more sophisticated understandings in the future and at length become the basis for the engineering of the future.

In the remainder of this brief article, the basic physical models of the GEM theory will be presented along with their results. The quarks and electron will be shown to arise from preservation of charge and vacuum interval as an image of normal spacetime. It is found that the proton, at least at the low energies of interest here, is geometrically constrained to confine its quarks and to be stable, and thus can treated as a fundamental particle. A physical model of gravity as electrodynamic will be presented. The separate appearance of the proton and electron with the appearance of the compact 5th dimension will be modeled with precise calculations of the proton mass and value of Newton Gravitation constant G resulting from the vacuum. The line path integral method giving rise to the Higgs Boson mass and exchange boson masses will then be analyzed in terms of an exchange of quanta with a background quantum ZPF.

II. The Postulates, Models, and Basic Results of the GEM Theory

The following explains how the basic concepts of the GEM theory are turned into models and their basic results.

A. Gravity Fields and Spacetime as Electrodynamic

The first basic postulate of the GEM theory is that gravity fields can be synthesized as arrays of ExB drifts familiar from plasma physics. The concept for a synthesis of a gravity field from electromagnetism was the outgrowth of the effort to achieve controlled thermonuclear fusion, most specifically the magnetic confinement of plasmas for fusion. As part of this effort the motion of charged particles in magnetic and electric fields was carefully studied and an effect called an "E-cross-B drift" or ExB drift[10], was identified.

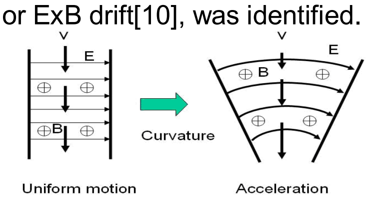

Fig. 1. *The ExB drift caused by crossed electric and magnetic fields affects all charged particles identically and in non-uniform E fields, but uniform B fields, can cause acceleration.*

This effect is remarkable in that it affects all charged particles identically regardless of charge or mass. We can derive this model of a gravity field simply by first assuming uniform E and B fields at right angles to each other, as in Figure 1, for example, E_x and B_z in the x and z directions respectively. We have then for motion of a charged particle in the x and y directions or r, θ, using esu units:

$$m\frac{\partial V_x}{\partial t} = qE_x + \frac{V_y}{c}B_z \quad (1)$$

$$m\frac{\partial V_y}{\partial t} = qE_y - \frac{V_x}{c}B_z \quad (2)$$

Where we have included an E_y for a curvilinear E field. We can solve this by assuming a velocity function of two parts, in x and y coordinates. Here we make the simplification that $E_x >> E_y$, i.e. a particle at the center of the region between the two plates in Figure 1.

$$V = V_{osc} + V_d \quad (3)$$

$$V_d = \frac{cE_x}{B_z} \quad (4)$$

in the y direction with the definitions

$$V_{osc_y} = V_{\perp}(\sin \omega_c t) \quad (5)$$

$$V_{osc_x} = V_{\perp}(\cos \omega_c t) \quad (6)$$

Where $V_{\perp}$ is assumed to be a constant with $V_{\perp} \leq V_d$ and we have defined

$$\omega_c = eB/mc \quad (7)$$

Note this drift velocity shown in Eq. 4 is independent of charge and mass.

If we leave the magnetic field uniform and vary the E field at right angles to its direction, in the direction of the drift, the particle will experience an acceleration in the direction of its ExB drift in the y direction:

$$\frac{\partial V_d}{\partial t} = \frac{c^2 E_x}{B_z^2}\frac{\partial E_x}{\partial y} = \frac{\partial \phi}{\partial y} \quad (8)$$

$$\phi = \frac{1}{2}\frac{E_x^2}{B_z^2}c^2 \quad (9)$$

This is easily confirmed by a particle simulation where an electron and a 'heavy positron' of positive charge but 10x the mass of electron are released in uniform magnetic field but between two plates set at an angle between each other, as seen in Figure 2.

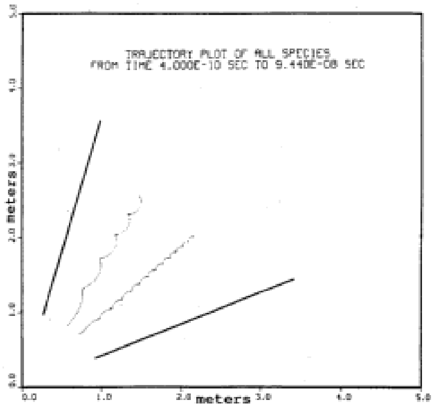

Fig. 2. *A simulation of an EM-synthetic gravity field with the trajectories of an electron and a "heavy positron" of 10x an electron mass are seen.*

The gyro-motion radius a_o of the particles seen here vanishes in the limit of very strong magnetic fields ($B_z \rightarrow \infty$) thought to be present in the vacuum due to the quantum ZPF (Zero Point Fluctuation) whereas the gravity produced velocity is cE_x/B_z is much less than light for ordinary gravity fields.

$$a_o = \frac{E_x}{B_z^2}\frac{mc^2}{e} \rightarrow 0 \quad (10)$$

We have found this physical model of gravity fields as being composed of locally uniform magnetic and varying electric fields. Flat spacetime then, we can conceive of as being composed of uniform magnetic and electric fields. But the vacuum is observed to be massless, or even to have a tiny negative mass density. How then, is the vacuum full of powerful fields to create an ExB drift array to create gravity, but yet has no mass density? To be consistent with GR, the mass density of the very E and B fields causing gravity must be considered as a source of gravity. This problem is not unique to the GEM theory but is a pressing problem for any theory of a quantum vacuum.

Einstein discovered the ZPF (Zero Point Fluctuation) in 1910, showing that as a consequence of the Heisenberg Uncertainty principle the vacuum itself must be populated with EM modes. The physical presence of these modes can be seen in the existence of the Casimir Effect. However, the fact that these modes do not create an observable mass-energy density in the vacuum is one of the great mysteries of physics. This problem was considered by the great Russian physicist Yakov Zeldovich [11] who argued that a ZPF mass density term would appear as a Cosmological Constant term, allowed by General Relativity, and that another such term existed to cancel the ZPF term. The Zeldovich Cancelation term would then be required for a massless vacuum that we experience. Here we have the basic field equation for GR including the Cosmological Constant Λ:

$$R_{\nu\mu} - \frac{1}{2} g_{\nu\mu} R = \frac{8\pi G}{c^4} T_{\nu\mu} - \Lambda g_{\nu\mu} \qquad (11a)$$

$$\frac{8\pi G}{c^4} T_{\nu\mu} - \Lambda g_{\nu\mu} = 0 \qquad (11b)$$

GEM theory is an alloy of the concepts of Sahkarov [7], in gravity's relationship to the EM ZPF, and the Kaluza-Klein theory [6] of EM-gravity unification, and its relationship to a hidden 5th dimension. To see this we begin with the Hilbert action principle in 4 spacetime dimensions with a zero cosmological constant.

$$W = (16\pi G)^{-1} \int R\sqrt{-g}\, dx^4 \qquad (12)$$

where R is the Curvature Scalar. Finding the extremum of this action leads to the vacuum gravity equations with canceled ZPF EM fields.

$$R_{\nu\mu} - \frac{1}{2} g_{\nu\mu} R = 0 \qquad (13)$$

Sakharov interpreted the integrand as a real energy density. 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 Yakov Zeldovich [11], who was a colleague of Sakharov's. This "Zeldovich Cancelation" ensures that only the perturbations due to curved space cause the effect of 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:

$$W = G^{-1} \cong \frac{\hbar}{2c^5} \int_{o}^{\omega^*} \omega d\omega = \frac{\hbar \omega_P^2}{c^5} \qquad (14)$$

$$G \cong \frac{c^3 r_P^2}{\hbar} = \frac{c^4}{r_P^2 T_o} \qquad (15)$$

where ω_P is the Planck frequency c/r_P, where $r_P = (G\hbar/c^3)^{1/2}$ 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 as due to imbalances of the EM Poynting vector, S= cExB/4π (in esu) or a radiation pressure P=<S>/c. The second example of radiation pressure or Poynting vector acting on particles in a box whose walls absorb and emit radiation is shown in Figure 3. In Figure 3, the left figure shows hot-bright particles in a dark-cold enclosure, the right figure shows cold–dark particles in a hot–bright enclosure. Mutual radiation pressure forces are shown by block arrows.

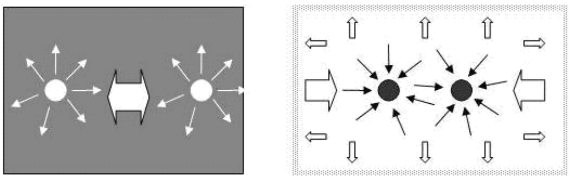

Fig. 3. *Radiation Pressure Affecting Particles in an Enclosure. Left: Two hot ideal radiaiors in a cold box repel each other by mutal radiation pressure. Right : Two cold ideal radiators in a hot box attract each other due to mutual shadowing.*

As was shown in the first section an ExB 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 3). 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 [3], 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:

However, if the fundamental structure of spacetime is electro-magnetic we can write the metric tensor as an electromagnetic tensor[3] :

$$g_{\alpha\beta} = \frac{4F_{\alpha}^{\ \gamma}F_{\gamma\beta}}{F_{\mu\gamma}F^{\mu\gamma}} \tag{16}$$

For the case of statistically uniform isotropic vacuum fields it is easy to see that the elements of the gradient of the metric will vanish.

When this expression is used, the EM stress tensor for the ZPF can be made to vanish as shown in the first article on the GEM theory [2].

$$T_{\alpha\beta} = F_{\alpha}^{\ \gamma}F_{\gamma\beta} - g_{\alpha\beta}\frac{F_{\mu\gamma}F^{\mu\gamma}}{4} = 0 \tag{17}$$

Here we assume a model of spacetime containing adjacent regions of strong E or B fields. The particles however, travel as wave packets and sample a volume swept out by a wave-front, thus they see an average spacetime. An average over volume so that $\langle B^2 \rangle = \langle E^2 \rangle$ and $\langle E \cdot B \rangle = 0$ results in a volume average of two metric forms one dominated by electric flux, for instance, in its local direction E_y

$$g_{\alpha\beta} = \begin{vmatrix} 2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & -2 & 0 \\ 0 & 0 & 0 & 0 \end{vmatrix} \tag{18}$$

And another, in an adjacent region, by magnetic flux also in B_y

$$g_{\alpha\beta} = \begin{vmatrix} 0 & 0 & 0 & 0 \\ 0 & -2 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -2 \end{vmatrix} \tag{19}$$

Upon volume average, assuming large scale isotropy, we recover the familiar Lorentzian flat space metric.

$$\langle g_{\alpha\beta} \rangle = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{vmatrix} \tag{20}$$

Using the observation that, for nearly flat spacetime, gravity fields and their potentials are linearly additive, we can derive the effective gravity potential for the ExB drift model of gravity assuming the EM form of the metric tensor required for self-censorship. We then find for the upper left diagonal element of the metric tensor: g_{oo} , and from it the effective Newtonian gravity potential.

$$g_{\alpha\beta} = 2\left[B^2 - E^2\right]^{-1} \begin{vmatrix} -E^2 & 0 & 0 & 0 \\ 0 & E_x^2 - B_y^2 - B_z^2 & 0 & 0 \\ 0 & 0 & E_y^2 - B_x^2 - B_z^2 & 0 \\ 0 & 0 & 0 & E_z^2 - B_y^2 - B_x^2 \end{vmatrix} \tag{21}$$

We have then for perturbing fields and a gravity potential in terms of an *E*×*B* drift model of gravity that is valid for both DC and oscillating *E* fields, where charged particles are accelerated into the strongest part of the perturbing E field. How then does the Newtonian gravity potential between charged particles come about? We begin with the expression for a gravity potential in terms of *E* and *B* fields in the vacuum, where V_D is the particle drift velocity in the crossed *E* and *B* fields:

$$\langle g_{00} \rangle = 1 + 2\phi / c^2 \quad \cong \frac{-E^2}{B^2 - E^2} \quad , E^2 = \quad E_x^{\ 2} \tag{22}$$

We obtain from GEM Metric tensor to first order in E_x/B_z <<1 and averaging with a flat metric.

$$-1 - 2\phi / c^2 = -\frac{E_x^2}{B^2} \tag{23}$$

As was first proposed by Puthoff [12], it can be shown [13] that point charges floating in a ZPF will create and interference pattern E^2 between their scattered 1/r radiation E fields and the impinging ZPF E fields, leading to a Newtonian potential around each particle. It was also pointed out by Puthoff that under the Standard Model all fundamental massive particles are charged and move freely at short distances, consistent with electrodynamic gravity. QED ensures that even photons spend part of their time as charged particles and are thus subject to electrodynamic gravity [5]. Using the metric formulation of Eq. 16 and spatial averaging a full Schwarzchild Metric: g_{rr}= 1/(1-2GM/c^2r) , arises statistically around each charged particle [13, 5].

B. *Particles From the Vacuum: The GEM Concept*

We have the vacuum quantities associated with the Planck scale, the Planck length, the Planck mass,and the Planck charge , respectively:

$$r_P = \sqrt{\frac{G\hbar}{c^3}} \quad (24a)$$

$$M_P = \sqrt{\frac{\hbar c}{G}} \quad (24b)$$

$$q_P = \sqrt{\hbar c} \quad (24c)$$

The simplest result then would use the vacuum derived Planck charge q_v as the length of the path in the 5th dimension. Using this we could obtain the proton mass as the simplest result.
We must now consider other constraints to such a theory. Nothing, especially the cosmos itself, is by definition simple. In particular, the appearance of one particle does not increase entropy in the universe, and entropy requires complexity. Also, we must consider that a charged particle cannot simply pop out of the vacuum without violating the electromagnetic constraint of charge neutrality. So the same simple process of a path integral allowing the appearance of a proton must also allow the appearance of an electron to balance it and to maximize entropy. Therefore, we must have the proton appear as part of a system that includes the electron, so that hydrogen results:

$$q_p = -q_e \quad (25a)$$

$$q_p = e, \qquad -e = q_e \quad (25b)$$

Another constraint occurs because the path length in the vacuum that cannot be simply a distance, but must be a spacetime interval. In the vacuum state all particles must be masses and move at the speed of light and have a spacetime interval of zero:

$$r_o^2 = (x_o{}^2 + y_o{}^2 + z_o{}^2) \quad (26a)$$

$$r_o^2 - c^2 t_o^2 = 0 \quad (26b)$$

It is seen that the appearance of the new hidden dimension occurs in a form analogous to the splitting of a canceling charge pair of particles from the vacuum, by splitting of a quantized light-like, or vacuum, space-time interval of length zero. In the GEM theory the hidden dimension size, where the hidden dimension can mix with the non-hidden dimensions, is the quantized particle size. The hidden dimension quantities are thus able to mix with the normal spacetime quantities because they are similar at smaller scales. This will lead to, as we experience them, two particle types. One is associated with the time-like portion of the constrained interval, leading to a one-dimensional scalar character, an electron, and another of equal size with a space-like vector character having three constrained sub-dimensions, a proton. The gravitation constant *G*, functions in the vacuum as the "interpreter" of charge into either mass or distance. Thus, ironically, charge and mass, the source terms for EM and gravity, are unified already in the vacuum quantity *G*, which has units of charge to mass ratio squared in the esu system used here.

$$q\sqrt{G/c^4} = r_o \quad (27a)$$

$$r_o^2 = (G/c^4)(q_x{}^2 + q_y{}^2 + q_z{}^2) \quad (27b)$$

$$r_o^2 = c^2 t_o^2 = (G/c^4) q_t{}^2 \quad (27c)$$

Therefore, the quantized vacuum scale length, the Planck length, gives birth to a quantized larger scale hidden dimension. Because the quantized hidden dimension is an image of macroscopic space-time in a light-like interval, and its structure is part of a split "lightlike" spacetime where charge ***q*** is analogous to macroscopic dimensions as a length, we have charge conservation and interval conservation. We obtain from these conditions the following constraints on the charges of the particles:

$$q_o = -q_4 = q_1 + q_2 + q_3 \quad (28)$$

$$q_o^2 = q_4^2 = q_1^2 + q_2^2 + q_3^2 \quad (29)$$

where the subscripts, 1,2,3,4 denote x,y,z,t the corresponding time or space dimensions in the unconstrained Cosmos.

Thus, the space-like portion of the split interval, the proton, has three sub-dimensions that we interpret as quarks or sub-charges, while the electron acts like a single entity.
This concept then makes the electron-quark family a reflection of the dimensional assymetric of spacetime, with a scalar time and a three dimensional spatial dimensions. However, we have here specified the Planck length as the shared radius of the quarks and electrons. But the physics of the world depends on the much larger scale of subatomic particles. Here the electrostatic radius of the electron enters as the final

"deployed" length for the electron. By the requirement The default radius upon "full deployment" of the hidden dimension and its physics would be the electron electrostatic radius $r_c = \frac{1}{2} e^2/m_e c^2 = 1.4\times10^{-13}$cm where we assume this radius will be shared by the quarks so that we have also $r_c = \frac{1}{2}(q_1^2 + q_2^2 + q_3^2)/m_e c^2$ and this is the nucleon radius $r_n \cong 1.4 \times 10^{-13}$cm [14]determined by Strong force scattering, and also the charged pion Compton wavelength, considered the range of the Strong Force.

Thus, the conservation of vacuum interval and charge neutrality requires that the electron and proton share the same radius, as is approximately observed. This requires two conditions on the three dimensional array of quark charges

This concept of the electron and proton being born together explains both quark confinement and the absence of proton decay as geometric requirements, seeing as the proton must preserve its dimensionality in quark space. That is, it is three dimensional and like any three dimensional object it cannot become an object of lower dimensionality.

This can only be satisfied by a SO(3) symmetry group, similar to the SU(3) symmetry group of conventional quark theory.

C. The Charges of the Quarks

Quarks in three colors appear naturally in the GEM theory. As was previously discussed the Kaluza-Klein fifth dimension can be considered to be a new dimension which can replace either time or space in a light-like interval, as was seen in Eq. 26 a, b. The fifth-dimension then becomes a constrained image of either the time or space portion of spacetime and thus has four sub-dimensions. The electron corresponds to a "time-like" or scalar entity while the proton corresponds to a space-like component, having three sub-dimensions. We can minimize the volume of this three-space, given the two constraints of charge conservation and the conservation of mesoscale radius, defined in Eq. 28, 29, which is a constraint on the sum of the quark charges, and sum of the squares of quark charges. We have then the constrained relaxation of the system, in the form a Lagrange multiplier system:

$$q_1 q_2 q_3 + \lambda_1 (q_1^2 + q_2^2 + q_3^2) + \lambda_2 (q_1 + q_2 + q_3) \qquad (30)$$

Where we minimize the three-volume formed by the quark charges: $q_1q_2q_3$, subject to the constraints on their total charge and interval from Eq. is that of the electron (in electron units)

Where we minimize the three-volume formed by the quark charges: $q_1q_2q_3$, subject to the constraints that their total charge is that of the electron (in electron units)

$$q_1 + q_2 + q_3 = 1 \qquad (31)$$

And the sum of their squares is also unitary, so the classical radius of the compound particle is that of an electron:

$$q_1^2 + q_2^2 + q_3^2 = 1 \qquad (32)$$

We have then, upon varying the values of q_1, q_2, q_3 respectively, the three equations:

$$q_1 q_2 + 2\lambda_1 q_3 + \lambda_2 = 0 \qquad (33)$$

$$q_1 q_3 + 2\lambda_1 q_2 + \lambda_2 = 0 \qquad (34)$$

$$q_3 q_2 + 2\lambda_1 q_1 + \lambda_2 = 0 \qquad (35)$$

which have the solutions:

$$\lambda_1 = \frac{1}{3} \quad \lambda_2 = -\frac{2}{9} \qquad (36)$$

$$q_1 = -\frac{1}{3}, q_2 = q_3 = \frac{2}{3} \qquad (37)$$

This corresponds to the standard quark model, and the second, trivial, solution is that of an electron with $\boldsymbol{q_1}$ =-1 and $\boldsymbol{q_2}$ and $\boldsymbol{q_3}$=0. Thus, in solving the problem of the structure of a 5th dimension, one finds that its 3-volume, upon being minimized, with constraints, yields the charges of the quark system. Thus, the GEM theory is actually compatible with the standard model.

In the GEM theory, the splitting apart of the proton and electron is correlated to the splitting apart of the gravity and EM forces. In the Standard Model context, this means that baryon and lepton number: ***B*** and ***L*** respectively, are not conserved but their difference (***B-L***) is conserved and the non-conservation of ***B*** and ***L*** separately occurs at the Planck scale, where gravity and EM unify. The appearance of charge and mass at the subatomic scale occurs with the appearance and deployment of the 5th dimension, which is slightly smaller than the EM cross-section of the electron. This means that, instead of subatomic particles being considered points, they must be treated as objects of definite size similar to the 5th dimension radius. This means that in the presence of the vacuum ZPF the structural sizes of the particles support resonances, and these resonances in-turn take on a quantum existence of their own.

In quantum electrodynamics, it is found that the sizes of various quantum objects can be understood as being created through orders of EM interaction. The Bohr radius of the hydrogen atom, and the Compton radius of the electron, for instance, can be found as the electron classical radius $r_e = e^2/m_ec^2$ for instance, can be found as the $1/\alpha^2$, and $1/\alpha$ respectively times the electron classical radius. However, the electrostatic radius for the electron is ½ the electron classical radius. This factor of ½ can be understood as the difference between monopole or "scalar" EM interactions, which cannot propagate farther than r_e and dipole "vector" EM waves which can propagate.

C. The Mass of the Proton

The proton has inside its radius of approximately r_c, three dynamic entities, quarks, as a reflection of the space-like structure is acquires when the 5th dimension split the vacuum spacetime interval. The quarks are inseparable, and cannot be seen in isolation. In the GEM theory this is due to the fact that the proton is a three-dimensional object and cannot be made into something of lower dimensionality, just like a rubber ball can be squashed but not reduced to infinitesimal thickness, when released from pressure it rebounds to its normal spherical shape. What also occurs in the GEM theory is that the proton is isotropic and spherical and this means that the quarks are best modeled as chaotically mixed at all times. In the GEM theory the proton is full of entropy.

We can therefore model the proton, since we consider it full of chaotic EM fields as, a spherical shell of radius r_c full of Planckian radiation fields, one field for each of the 3 color charge fields(see Figure 4.) We will consider that the electric charge resides on the surface of the shell, which is full of neutral π mesons. We will consider the shell to be thin. We will assume an emissivity of close to one $\varepsilon \cong 1.0$ so the Black Body model will be valid. We will choose the temperature of the Planckian fields to be $kT = m_{\pi o}c^2 = 264.15m_ec^2$, the mass of the neutral pion, which is what would occur if every quark was accompanied by its corresponding anti-quark. Black Body modes of longer wavelength than the radius of a spherical cavity are cut off, however, the wavelength of energy maximum for a Planckian distribution is approximately-1/5 that of $\lambda = kT/(hc)$ =9.183 x 10^{-13} cm where h is the normal form of Planck's constant. A cutoff of wavelengths longer than that corresponding to kT thus leaves approximately 97% of the energy in shorter wavelength modes intact, thus such a cutoff does not violate our Planckian assumption.

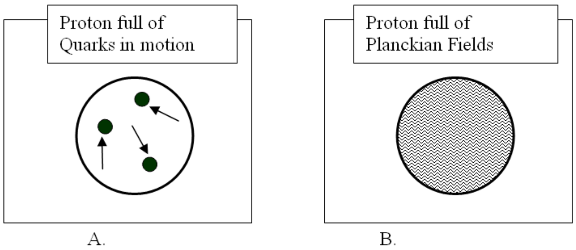

Fig. 4. *A. A model of the proton has having three rapidly and chaotically moving quarks. B. A model of the fields in the proton as being at maximum entropy, due to quark free motion, that is: Planckian.*

Therefore, we will assume the proton is full of EM energy W in 3 Planckian modes or colors in a volume $V_c = 4\pi r_c^3/3$ of a sphere of radius r_c:

$$W = \varepsilon 0.97 V_c 3\left[\frac{8\pi^5}{15}\left(\frac{(kT)^4}{(hc)^3}\right)\right] \quad (38)$$

Here the Planckian modes must be considered independent, so they simply add to each other. Using the fact that $r_c(m_{\pi o}c^2/hc)$ = 1/6.518, and assuming an emissivity ε = 97% we obtain approximately:

$$W = 6\pi^5 0.94\left[\frac{16\pi}{45}(264.15)m_ec^2\left(\frac{r_c^3}{\lambda_{\pi o}^3}\right)\right] \quad (39)$$

$$W = 6\pi^5 m_ec^2(0.94)\left[1.12\left(\frac{264.15}{277.06}\right)\right] = 6\pi^5 m_ec^2(1.004) \quad (40)$$

$$W \cong 6\pi^5 m_ec^2 \quad (41)$$

Therefore, the Lenz-Wyler formula, $m_p/m_e = 6\pi^5$ which is accurate to 17 parts per million, can be derived to high accuracy from a simple model of the proton as containing 3 independent Planckian fields of temperature corresponding to the rest energy of the neutral π meson. This means that the proton-electron mass ratio hides in the Stefan-Boltzmann constant, and that entropy exists even in the subatomic scale.

Thus we can see that the basic electron-quark picture of the structure of matter can be derived from its appearance from the vacuum as a charge opposed pair but also with the constraint that the charges act as spatial lengths and preserve a vacuum interval. However this analysis also indicates that quark confinement and proton stability have their origins in topology, and hence, at least for low energies, the proton-electron pair can be treated as a pair of fundamental particles.

D. *The Value of G and the Proton Mass From the Planck scale*

The second GEM postulate is that Gravity and EM forces separate in correlated way with the appearance of electrons and protons from the Planck Scale. We can examine this by a Gedanken experiment where we squeeze a single atom of hydrogen in sphere until it becomes the size of a Planck radius and forms a Blackhole. The Blackhole then evaporates via Hawking radiation [15] into a shower of gamma rays and particles and antiparticles and thus destroys the baryon and lepton number of the original electron ad proton.

Let us consider a "Gedanken" experiment [3] where a single atom of hydrogen is confined in a sphere whose size is shrunk continuously until it reaches approximately the radius of a Planck length $r_P = (\hbar G/c^3)^{1/2}$, (See Figure 5.) at this point the electron and proton making up the hydrogen will have long since ionized and increased in mass due to Heisenberg Uncertainty. The proton and electron will then form a Black Hole which will then undergo Hawking Evaporation [15] (Figure 5.) into a shower of photons, particles and their anti-particles. It is noticed that this evaporation will destroy the baryon and lepton number of the proton and electron, leaving only the quantum numbers of the vacuum. This is in accordance with the observation that many of the quantities we observe in the present day cosmos are "running constants" and change under radically smaller spacetime curvature, to merge eventually with Planck Scale quantities. Therefore, what we consider to be physical constants may be tied to specific range of scale-size for the radius of curvature of spacetime, and these physical quantities will change dramatically when the radius of curvature approaches the Planck Scale.

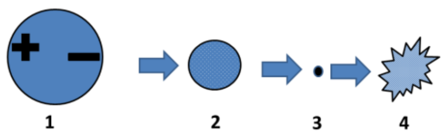

Fig. 5. *A Gedanken experiment where 1. A single atom of hydrogen, a proton and an electron, is shrunk within a sphere 2. And ionizes. Finally it reaches the Planck size 3. And becomes a Black Hole, whereupon, 4., it undergoes Hawking Evaporation and becomes a cloud of gamma rays, matter and antimatter so that original hydrogen is lost.*

In the previous chapter we were able to formulate gravity fields as electro-magnetic but this appeared to require a cellular nature for spacetime, in order to allow gravity fields, and spacetime itself, to be composed of regions of powerful electric and magnetic fields. At first, such a physical picture seems perfectly consistent with the concept of the Planck Scale, where spacetime is a foam of scale size equal to the Planck Length: $r_P = (G\hbar/c^3)^{1/2}$. However, at the Planck scale only a limited group of physical constants are possible and these do not include many of those constants that describe the universe we experience. We can imagine that in the primordial first instants of the Big Bang the entire universe was in a compressed state at the Planck Scale but that it expanded form this scale to "deploy" a new larger scale that carried with it the physics of the cosmos we know. Therefore, in this chapter we must further quantify the concept of cellular spacetime to define a range of scale size for a cellular structure in spacetime that is distinct from the Planck Scale and represents an expanded scale that emerges from that primordial scale.

Thus, based on our Gedanken experiment, we consider that any cellular scale size in the vacuum is "fully deployed" to its proper size in the present cosmos, and helps determine its physics, but this scale size is crushed out of existence at the Planck scale, where hydrogen disappears. Accordingly, our Gedanken experiment to squeeze a proton-electron pair into the vacuum, also squeezes the cellular scale-size into the Planckian vacuum.

Let us assume however, in our thought experiment, that the wave functions of the proton and electron, carrying with them all their identifying quantum numbers have merged as the Black Hole forms at the Planck Scale, that is, the radius of spacetime local spacetime curvature $r \rightarrow r_P$ before this happens. To model this behavior we will use a simple U(1) symmetry model for the proton and electron masses, considering that since all information disappears we will formulate the model only in terms of charge q ,mass m, and mass ratio $m_p/m_e = \sigma$. Accordingly we have a simple U(1) mass model:

$$m = m_o \cos(\phi) + i m_o \sin(\phi) \quad (42)$$

The U(1) symmetry is complex valued with real and imaginary mixed together. Particles with imaginary rest masses are tachyons, particles that move faster than light. The simplest physical interpretation we can make for such imaginary particles is that they are particles that have fallen inside the event horizon of a Black Hole, accelerating beyond the speed of light in the process and being out of communication with the real particles of the universe. This is important at the Planck scale because there particles appear out of the vacuum, form black holes and disappear, so that spacetime is effectively a "foam." Foamy spacetime features Black Holes that are so closely packed that it is impossible to determine whether a particle is inside or outside an event horizon. Thus particles at the Planck scale can be physically represented as complex, half real and half imaginary, with masses satisfying a U(1) symmetry. So the Planck scale is completely chaotic, mixing imaginary masses with real ones.

Let us imagine that at the Planck scale everything becomes simple, the EM and gravity forces unify to one force obeying U(1) symmetry and lepton and baryon number also disappear, in fact everything disappears but "vacuum" quantities: G, c, and $\hbar$, the Newton gravitation constant, the speed of light , and the rationalized Planck's constant respectively. These determine the Planck Length: $r_P = (G\hbar/c^3)^{1/2}$. Planck mass $M_P = (\hbar c/G)^{1/2}$, and Planck charge $q_P = (\hbar c)^{1/2}$ However, let us assume also that since EM forces still exist and enforce quantization of charge and the charge neutrality of the vacuum, so that quarks remain grouped in groups of 3 having one positive electron charge to cancel the charges of electrons. Thus, a plasma consisting of quarks and electrons occurs at the Planck scale, but protons are still identifiable as groups of quarks because the vacuum must be charge neutral.

Therefore, at the Planck scale we can have Planck masses of real and imaginary masses consisting of a quark-electron plasma which can still be represented as relativistic mass-dilated electrons and protons because of the requirement of charge neutrality.

On the other end of the spectrum of sizes we assume a "fully deployed" cellular scale of subatomic size, which we propose to be of the size range

$$r_o = \frac{e^2}{m_o c^2} \tag{43}$$

where $m_oc^2 = (m_pm_e)^{1/2}c^2 = 21.897$MeV so that the size scale is neutral between protons and electrons, and a size parameter which is determined entirely by low energy physics quantities. We will call this energy and size scale the "mesoscale" because it lies between the Planck Scale and the Cosmic Scale.

This is all based on the GEM postulate that baryon and lepton number disappear at the Planck scale coincidentally with the separate identity of Gravity and EM fields. The vacuum is thus as simple as possible at the Planck scale, only particles and anti-particles of Planck mass and charge exist there and gravity and EM are basically merged.

In contrast the appearance of the cellular scale size as the universe expands from the Planck scale represents the appearance of a new degree of freedom. This is similar to when a molecular layer evaporates from a surface and becomes a 3-dimensional gas. We will consider then, accordingly, that the expansion from the Planck Scale allows the appearance of a 5th dimension, represented by the appearance of a new scale size : r_o, which is the appearance of particles: electrons and protons with their classical radii. That is, the appearance of the 5th dimension allows the appearance of the mesoscale. The expansion of the universe from the Planck Scale thus allows a new 5th dimension, a new degree of freedom, of much larger scale size than the Planck Scale, to appear, and with it new physics. But how shall we include this into our U(1) mass model?

The angle ϕ, we will consider, in this model, corresponds to charge state and is thus quantized as a canceling pair $\pm\phi_o$, even in the Planck Scale. However let us model the appearance of the fifth dimension by allowing this angle 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 scale dependent vacuum where the existence of a 5th dimension breaks the vacuum scale invariance. We now have for the mass model:

$$m = m_o \exp(\pm\phi_o) \tag{44}$$

Where ϕ is a parameter such that $\phi = 0$ at $r \sim r_P$. That is, near the Planck scale, when the 5th dimension does not exist and thus protons and electrons are identical. At the other extreme $\phi = \phi_o$ when the 5th dimension is "fully deployed" and separate particle masses are generated at ϕ_o from Eq. 44 as $r \rightarrow r_o$. This suggests a formula $\phi_o \sim \ln \ln (r/r_P)$, so that ϕ_o very strongly near the Planck scale but varies very little at everyday scale.

$$\sqrt{\frac{m_p}{m_e}} = \exp(\phi_o) = \sigma \tag{45}$$

Where σ is a mass asymmetry parameter, being the square root of the mass ratio of the electron to the proton.

Thus, even though mass symmetry is broken in terms of the new 5 space we experience, it is actually preserved in terms of a geometry involving the imaginary angles in the original U(1) symmetry. That is, the new particle dimension looks symmetric in the space of imaginary angle.

We require that this simple mass model give the behavior as $m_o \rightarrow M_P$, $\sigma \rightarrow 1$ as $r/r_P \rightarrow 1$

To obtain a smooth transition to the Planck scale as curvature collapses to the Planck length the angle ϕ_o must be dependent on curvature near the Planck length but very insensitive to it at larger curvatures, where the new fifth dimension is fully deployed. Based on the lack of observation of proton decay, lepton and baryon numbers are obviously strongly conserved. The simplest model to obtain this mixture of scale sensitivity with curvature r is for the rotation angle to have the dependence on our 5th dimensional deployment parameter

$$\phi \cong \ln(\sigma) \tag{46}$$

$$\sigma \cong \ln(r / r_P) \tag{47}$$

So that lepton and baryon numbers disappear, with $\sigma \rightarrow 1$ as $r \rightarrow r_P$

Therefore, in the GEM model, the separate appearance of proton and electron pairs from the vacuum is, like the separate appearance of EM and gravity forces, linked to the appearance and full development of the fifth dimension. The physical description of this new 5th dimension is that it comes into being at scale size that corresponds to the size of a particle classical radius r_o.

However, it is apparent Eq. 47 cannot be correct near $r = r_P$ where $\sigma \to 1$, thus we must modify the formula slightly so that both the right and left side go to zero smoothly at $r = r_P$ and $\sigma = 1$, where we assume σ goes to one with the vanishing of a small parameter $\varepsilon \to 0$

$$\sigma = 1 + \varepsilon \ldots \qquad (48)$$

We rewrite Eq. 29:

$$\ln\left| r / r_P \right| = \sigma - \frac{1}{\sigma^2} \qquad (49)$$

We now see that both sides of this expression go to zero as both quantities r/r_P and $\sigma \to 1$ as they should. We have added the correction factor as second order in σ, that is $\sigma^{-2} = m_e/m_p$ to be similar to the reduced mass correction of the conventional dynamics of the electron-proton system. Therefore, when the new 5th dimension is "fully deployed" we have for σ =42.8503…

$$\ln\left| r_o / r_P \right| = \sigma - \frac{1}{\sigma^2} \qquad (50)$$

We note how both sides of this expression go to zero with leading order in ε, as $r/r_P \to 1$:

$$\ln\left| r / r_P \right| = \sigma - \frac{1}{\sigma^2} \cong 3\varepsilon \qquad (51)$$

We must also correct the mass formula so that $m_o = M_P$ at the Planck scale. So we must write, using the Planck charge q_P. We will assume that the normalized charge state assumes the role of determining mass q/e but that as we approach $r = r_P$ that $e \to q_P = (\hbar c)^{1/2}$ so that $\alpha \to 1$ and also all masses approach the Planck mass $m_o \to M_P$

$$m = m_o \exp\left(\frac{\pm q}{e} \ln \sigma\right) \qquad (52)$$

This formula gives the observed mass difference between the electron and proton and also ensures that this difference disappears as $r/r_P \to 1$. However, not only mass the mass difference disappear but the mass m_o must undergo the process $m_o \to M_P$, as $\sigma \to 1$ We therefore extending this formula, where normalized charge controls mass, to obtain

$$m_o \cong M_P \exp\left(\frac{q_P}{e} \ln \sigma\right) \qquad (53)$$

Where this gives the proper limit as $m_o \to M_P$, $\sigma \to 1$.

However, we also require the condition, as $m_o \to M_P$ that we must have the condition that r , r_P , m_o and M_P have the proper quantum relationship $r_o = \hbar/(m_o c)$ so that near the Planck scale

$$\ln\left|\frac{m_o r_P}{M_P r_o}\right| = \ln\frac{m_o}{M_P} + \ln\frac{r_o}{r_P} = -3\varepsilon + 3\varepsilon = 0 \qquad (54)$$

We obtain this behavior in ε for the m_o system by modifying Eq. 53, like we did the σ expression in Eq. 50, with a second order term α to ensure the proper behavior for m_o, as $\alpha^{-1/2}$ and $\sigma \to 1$

$$m = M_P \exp(-(\alpha^{-1/2} + \alpha + 1)\ln\sigma)\exp((q/e)\ln\sigma) \qquad (55)$$

This requires, at normal spacetime curvature and charge state q/e =+1 the expression for the proton mass , with $M_P = 2.17645 \times 10^{-5}$g :

$$m_p = M_P \exp(-(\alpha^{-1/2} + \alpha)\ln\sigma) = 1.6665 x 10^{-24} g \qquad (56)$$

This expression agrees with the observed rest mass of the proton 1.67262 x10 $^{-24}$ g , to 3.6 parts per thousand and goes to the proper limit of $m_p = M_P$ as $\sigma \to 1$.

We now return to primary expression relating normalized spacetime curvature to the mass ratio.

The expansion of the effective curvature to r_o, which we will term the "mesoscale" radius -since it is the range of scales of classical particle radii and lies between the Planck and Cosmic scales- then yields, by Eq. 50 the relation:

$$\ln r_o / r_P = \sigma - \frac{1}{\sigma^2} = 42.850.... \qquad (57)$$

If we examine the ratio of the mesoscale radius to the Planck radius, we discover it is also a quantum normalized ratio of coupling constants between gravity and EM,

$$r_o / r_P = \sqrt{\frac{e^2 \alpha}{G m_o^2}} \qquad (58)$$

This suggests that the gravitational interaction between two masses is mediated by the emission and absorption of EM photons. This is as we would expect if both EM and Gravity were both part of the same general phenomenon. The formula of Eq. 39 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 first order:

$$G = \frac{e^2}{m_p m_e} \alpha \exp\left(-2(\sigma - 1/\sigma^2)\right) = \quad (59)$$
$$6.67384x10^{-8}\, dyne - cm^2 - g^{-2}$$

this expression is within 3.6 parts per 100 thousand of the measured value of G:

6.67408 x10^{-8} dyne-cm^2 gm^{-2}. Note that the expression gives proper limiting behavior at the Planck scale, yielding G even as all masses go to M_P , $e^2 \rightarrow \hbar c$ and α and $\sigma \rightarrow 1$.

Therefore , a simple mass model, bridging the lepton-baryon mass system at its lowest energy end-members the electron and proton, that fulfills the expectation of our Gedanken experiment and has proper limiting behavior at both the Planck scale and scale of the fifth dimension, which is the subatomic scale, yields accurate expressions for both the proton mass and the gravitation constant.

A formula similar to Eq. 59 was originally published in approximate form in 1987 and corrected in1988 [1] and bears some resemblance to the formula published by T'Hooft [16] based on "Instanton" theory that combines Hawking Evaporation with Thermal physics.

III. The Exchange Boson Masses and Selection Rules Governing their Generation

The existence of a hidden 5th dimension in an otherwise 4 dimensional space time breaks the scale symmetry of the vacuum by inserting a length at which physics must change. Since the 5th dimension is independent of the other coordinates, the 5th dimension looks like a spherical particle from a distance in any direction, that is, it looks like a particle of a certain size. It is a well-known phenomenon in physics that particles of well-defined sizes in otherwise uniform media support Mie scattering, that is, they support both radial and surface resonances. At the suggestion of Dr. Eric Davis (Private Communication) the consequences of such structural resonances were explored.

Mie scattering would be expected on a hidden dimensional structure in the presence of the ZPF and would give rise to particle quanta. We will also consider the classical particle surface of charged particles as a spherical surface that can support Mie structural resonances. This seems, at first, very unlikely, even bizarre. It is like General Motors walking into a bar, and having a drink. The classical surface of a charged particle appears, at first glance, to be a mathematical artifice and not to define a real dynamic entity. However, since this is quantum mechanics, even seemingly unlikely and bizarre events can contribute to observables. This also shows the underlying electromagnetic character of the short range forces. We will call the particles caused by these quantum Mie scattering events "Mieons." Two fields are available in the ZPF to drive quantum Mie scattering, these are the EM field and Radion field, which must come into being as part of the Kaluza-Klein scheme for having both EM and Gravity and which has the source term E^2-B^2 [17]. We will identify EM resonances with the factor $1/\alpha$ and we will identify the Radion resonances with the factor σ. This will give rise to new particles, Mieons, at resonances on the hidden dimension. The EM resonances will be vector resonances around the circumference of the spherical classical surface. The Radion field, being a scalar field, would be expected to produce, at least in lowest order, a simple radial mode inside the spherical classical particle surface. It will also give rise to Mieons on resonances on the classical electrostatic radii of the electron and proton, which will behave like conducting surfaces to first order. The fundamental and lowest order resonances can be expected to be most important as determined by radial and circumferential resonances. The fundamental resonance will be considered as well as a 5-fold resonances because the 5 dimensionality of the entire system for low intensity oscillations.

Since the concept of a quantum resonant path on a classical charged particle surface seems to be but one of many quantum possibilities, we will generalize it to include alternative paths of lower quantum probabilty, in orders of our coupling strengths, α and $1/\sigma$. Therefore, we express mathematically this concept of Mie resonances, generalized to include virtual paths of reduced probability of order α, for the EM ZPF, or $1/\sigma$, for the Radion field, by the following, for each spin component of the boson:

$$E\ell_{EM} / c = Nh \quad (60)$$

$$E\ell_R / c = N\sigma \frac{e^2}{c} \quad (61)$$

Where we have for the path lengths ℓ for EM ZPF excitations, where N and P are integer multiples of ½, and express for the Mie quanta agency:

$$\ell_{EM} = (2\pi r_c + \alpha P 2\pi r_c) \quad (62)$$

And likewise for Radion excitations, which are radial:

$$\ell_R = (2r_c + (P/\sigma)2r_c) \quad (63)$$

Where E is the particle rest energy, c, is the speed of light h is Planck's constant. Rearranging we obtain for the EM ZPF:

$$E = \frac{Nhc}{(2\pi r_c + \alpha P 2\pi r_c)} = \frac{N\hbar c}{r_c(1+\alpha P)} \quad (64)$$

$$E = \frac{2Nm_c c^2}{\alpha(1+\alpha P)} \quad (65)$$

Where m_c is the particle mass generating the classical radius

$$E\ell / c = N\sigma \frac{e^2}{c} \quad (66)$$

$$\ell = (2\pi r_c + (P/\sigma)2\pi r_c) \quad (67)$$

$$E = \frac{2\sigma N m_c c^2}{(1+P/\sigma)} \quad (68)$$

The scattering of quanta out of the ZPF by a particle will imprint the quanta with the character of the particle form which it scatters. It must give a spin-state dimensionality of a scalar spin-0 particle off the time-like-scalar nature of the electron and a vector spin-1 particle off the space-like-vector proton. The simplest scatterings will be reactive charge state off the charges of the electron-proton system.

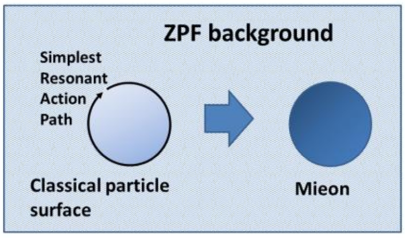

Fig. 6. *A quantum Mie scattering caused by a fundamental resonant excitation vector on a classical particle surface*

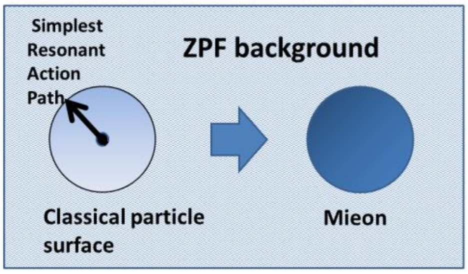

Fig. 7. *A quantum Mie scattering caused by a fundamental Radion ZPF resonant scalar excitation of a classical particle shell.*

A. *The Simple Mie Scattering Results*

We begin with the simplest case where N=1/2 and P=0 at classical radius of the mesoscale particle $r_c = r_o/2$. We then obtain the mass of the proton as a Radion excitation.

(69)

$$m_p = \sigma m_o$$

We then obtain , under the same circumstances of N=1/2 , M=0 for an EM ZPF scattering, with m_o=21.896 MeV

(70)

$$m_{\eta c} = m_o c^2 / \alpha = 3000.6 MeV$$

This mass is then the EM ZPF Mieon associated with hidden dimension and is very close to the mass of the elusive Σ(3000) baryon [18] at a mass of 3000MeV, the eta-c charmed scalar meson, at a mass of 2983.6 MeV with no charge or spin, and the much longer lived long lived J/ψ vector meson at 3096.9MeV with spin 1. So this a mass- energy region of much activity, as we would expect if it corresponded to a Compton wavelength nearly matching the hidden dimension size.

We then proceed to look at the simple cases N=1, P=0, or first order, Mieons resulting from resonant modes on the electron classical surface. We obtain from Eq. 45:

$$m_{\pm\pi} = 2m_e c^2 / \alpha = 140.0 MeV \quad (71)$$

Which is the mass of the charged π-meson which has spin 0. At first it is confusing to associate the electron classical radius with the proton, however because CP violation favors matter over anti-matter the existence of positive charge of +e must induce negative electrons to appear in the vacuum at that radius. This means even though it is a proton, virtual electrons are present around it because of QED. This, and fact that positive charges are treated differently by nature than negative ones- protons and electrons are both stable- means that a positive charge e can have associated with it a radius associated with an electron and 'strike forth' pions. When we look at the electric classical radius of the proton we obtain, from Eq. 65:

$$m_{\pm W} = 2\sigma m_p c^2 = 80.41 GeV \quad (72)$$

This is the mass of the charged W-boson which has spin 1 reflecting the dimensionality of the proton as having 3 sub-dimensions. These formulas are quite accurate as is seen in Table 1. In both cases the spin of the Mieon is the spin on the classical surface of the parent particle is plus or minus $\hbar/2$. We can take the ratio of the masses of these two bosons:

$$\frac{M_W}{m_{\pi\pm}} = \sigma^3 \alpha = 574.3 \quad (73)$$

This is versus the actual experimental value $m_W / m_{\pi\pm}$ = 574.2, so again agreement is good. The particles resulting from simple Mie scattering (P=0) in the GEM theory are summarized in Table 1.

TABLE 1. Particle Masses Predicted by the GEM theory for Simple Mie , P=0, Scattering Theory and Observed Masses

Particles	Particle Properties		
	Predicted Mass	***Measured Mass***	***% error***
π±	140.05MeV	139.6MeV	0.3%
W±	80.409GeV	80.398GeV	0.01%
η_c	3000.6MeV	2985MeV	0.7%

We understand from this that the charged nature of the particles results from the polarization of the vacuum at the classical particle surfaces of the electron and proton. The spin states of the pion and W particles reflect the dimensionality of the electron as a one dimensional particle-yielding a scalar pion, and the three dimensional spin 1 vector character of the W particle is required for it to interact with the three quarks.

B. *The Complex Mie Scattering Results*

We can consider that the path integrals on classical particle surfaces "tumble" in 5 space and to first order all the degrees of freedom are identical. This will allow 5-fold perturbations to develop on the path integral so that virtual paths exist that add or subtract to the effective length of the path, (see Figure 8 and 9) so we will have M=5.

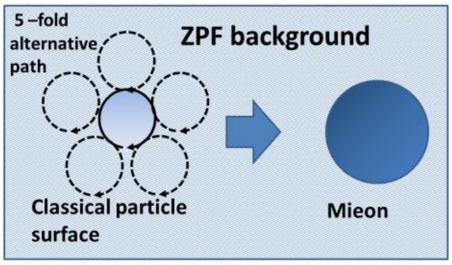

Fig. 8. *A quantum Mie scattering caused by a resonant excitation on a classical particle surface plus a five-fold alternative quantum path.*

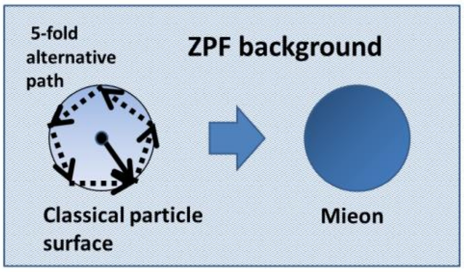

Fig. 9. *A quantum Mie scattering caused by a resonant excitation on a classical particle structure with a 5-fold alternative path also being excited.*

$$E = \frac{2Nm_o c^2}{\alpha(1+5\alpha)} \quad (74)$$

for the electron we obtain the neutral pion:

$$m_{\pi o} = \frac{2m_e}{\alpha(1+5\alpha)} = 135.1MeV/c^2 \quad (75)$$

We have then for the case of N=1/2 and P= - 5 for m_o

$$m_{J/\psi} = \frac{m_o}{\alpha(1-5\alpha)} = 3114.2MeV/c^2 \quad (76)$$

This result is within 6 parts per thousand of actual J/ψ particle mass of 3096.6MeV.

We can look thus propose a similar "tumbling in 5 dimensions" process operating in the Radion field except that in case it gives a negative "backflow" or "shortcut" contribution to the path integral.

We return to the path integral model for Mieons generated by the Radion field where m_c the particle mass generating the classical radius, in this case m_e

$$E = \frac{2\sigma N m_o}{(1+P/\sigma)} \quad (78)$$

Where we have P=-5 N=1 scattering off the proton. As before, the particle must be a spin 1 vector boson because of the "vector" or triune character of the proton. This perturbation features the "backflow", or "shortcut" negative contribution to the path integral:

$$m_z = \frac{2\sigma m_p}{(1-5/\sigma)} = 91.03GeV/c^2 \quad (79)$$

The perturbed pathway mechanism generally takes charge off of particles because is an averaging over neutral space.

Following this procedure for N=1/2 M=0 we obtain for the scalar σ excitation off the uncharged scalar eta-c particle with the uncharged scalar result

$$m_H = \sigma m_{\eta c} / (1+5\alpha) = 124.1 GeV/c^2 \quad (80a)$$

We also obtain EM ZPF excitation off the proton classical surface at spin 0:

$$m_H = m_p / \alpha (1+5\alpha) = 124.1 GeV/c^2 \quad (80b)$$

These both give the approximate mass of the Higgs Boson [19] of spin 0 and charge 0. This result (as $m_H \cong m_p/\alpha$) was obtained and presented at the 2012 STAIF Meeting in Albuquerque NM , four months before it was known [4].

So that we have approximately

$$\frac{m_H}{m_{\eta c}} \cong \sqrt{\frac{m_p}{m_e}} = \sigma = 42.85035 \quad (81)$$

The experimental value is $m_H/m_{\eta c} \cong 42.6$, so agreement is good.

Finally, we have for N=1/2 and for P=0 a Radion scattering off the electron, which is a new particle.

$$m_o = \sigma m_e = 21.9 MeV \quad (82)$$

This is the mesoscale particle, which we will term the M* ("Morningstar") particle in honor of the sponsors of this research. It has never been observed, but some evidence for its existence can be found, and will be discussed in the next section of this chapter. We would expect it to be charge-neutral and have spin 0 like the Higgs Boson. It should decay into electron-positron pairs and photons.

The predicted particle masses and those experimentally observed are summarized in Table 2.

TABLE 2. Particle Masses Predicted by the GEM theory and Observed Masses Including the New Predicted M* Particle

Particles	**Particle Properties**		
	Predicted Mass	***Measured Mass***	***% error***
π_o	135.12MeV	134.98MeV	0.1%
Z	91.03GeV	91.19GeV	0.2%
Higgs	124.1GeV	125.1GeV	0.8%
M*	21.98MeV	****	***

Unexpectedly, the GEM theory created a doorway to understanding with two short-range forces of nature the Weak and Strong nuclear forces, because in unifying gravity and EM in a geometric theory, it produced a geometric scale regime for subatomic particles and the regime for their interactions. The quantum particles which create the short range forces are thus scatterings out of the full spectrum of the ZPF by these resonant structures. The fact that the scattering structures are EM classical radii shows the underlying electromagnetic character of the short range forces. The GEM theory produced the picture of EM forces not only between charged objects but also between uncharged structures that can be extended to include short-range nuclear forces.

IV. Summary and Discussion

Under the conjecture of Dr. Alfred Luhen, (Private Communication) one cannot create mass without creating gravity. The Higgs Boson thus cannot exist and generate mass outside the context of General Relativity. Accordingly, the simplest way for this to occur in the GEM context is that the Higgs scalar field occurs in Kaluza-Klien theory as the Radion scalar field so that both gravity, EM-mass energy as gravity source term, and particles are born together with the Radion field. The concept of the Higgs Boson as the creator of mass in the GEM theory is obvious because of the relationship $m_{Higgs} \cong m_p/\alpha$ so that the Compton radius of the Higgs Boson is the EM interaction length of the proton:

$$\lambda_{Higgs} = \frac{e^2}{m_p c^2} \quad (83)$$

Thus, the known source of mass in the universe, the proton, is in EM resonance with the Higgs Boson, that is, the proton EM self-interaction time is the Compton oscillation time of the Higgs. The Higgs boson can thus be viewed as the most general excitation, by both EM and Radion fields, of a structural resonance of the hidden Kaluza-Klien 5th dimension, and thus part of the mechanism in the vacuum that gives rise to separate EM and gravity fields and also a cosmos dominated by hydrogen.

The GEM theory had its original goal as the unification of the two long range forces of nature, EM and gravity, however, it was found that could not be done without a hidden dimension whose size corresponded to the size of classical radii of protons and electrons. It was found that particle masses of first and second generations from this hidden dimension size could be generated by quantum Mie scattering. In this quantum model, the classical particle surfaces themselves support quantum Mie scattering resonances. This process appears to create a pattern of changes of spin and charge, creating bosons from fermions and vice versa, and charged and neutral particles. The central importance of the EM classical radii in this unification theory suggests the underlying EM character of the forces. The model gives the correct masses, spins and charges reflecting the dimensionality of the electron or proton they scatter off of.

The result is a rudimentary "Bohr Model" of field unification which gives G, the mass of the proton, and the masses of the pions and W and Z exchange bosons of the Strong and Weak force. It also gives an accurate estimate of the Higgs Boson mass. It also predicts a new particle and other phenomena, particularly that hydrogen and radiation can appear occasionally from the vacuum, particularly at Black Hole mergers [5] This theory suggests that manipulation of Gravity, Strong, and Weak Forces by Electromagnetism may be possible. It is hoped this work can form the basis for future advances in understanding and engineering.

Acknowledgment

The author wishes to thank Morgan Boardman and Paul Murad of Morningstar Applied Physics and Eric Rice of Orbital Technologies Corporation and Jess Sponable of DARPA for their support and encouragement of this research as well as Abe Meghed for many useful comments, and finally thanks to my industrious cousin Axel for his good example. The author is also very grateful to JMESS for this opportunity to codify the GEM theory in its present, early, state. *Laus Deo*

References

[1] Brandenburg J.E. (1988) "Progress on the GEM (Gravity-Electro-Magnetism) Theory" APS Bull., 32, 1, p. 32.

[2] Brandenburg J.E. (1992) "Unification of Gravity and Electromagnetism in the Plasma Universe" IEEE Transactions on Plasma Science, Vol 20, 6, p944.

[3] Brandenburg, J. E., "A Model Cosmology Based on Gravity-Electromagnetism Unification", Astrophysics and Space Science, **227**,133-145, (1995).

[4] Brandenburg, J.E., "An Extension of the GEM Unification Theory to Include Strong and Weak Nuclear Forces and an Estimate of the Higgs Boson Mass STAIF II Conference Albuquerque NM March 2012. Published in Journal of Space Exploration, Vol 1, Issue1 (2012)

[5] Brandenburg, J.E. "The GEM Unification Theory: Extending The Standard Model to Include Gravitation" Lambert Academic Publishing (2016).

[6] Klein, Oskar: "Quantum Theory and Five-Dimensional Relativity Zeitschrift fur Physik, 37, 895, (1926).

[7] Sakharov A.D.:(1968) "Vacuum quantum fluctuations in curved space and the theory of gravitation" Sov. Phys. Doklady 12,p.1040-104.

[8] Sakharov. A D. *(1967).* "Violation of CP invariance, C asymmetry, and baryon asymmetry of the universe". Journal of Experimental and Theoretical Physics ***5****:* 24–27.

[9] E. Witten, Nucl. Phys. B 195, 481 (1982).

[10] "Introduction to Plasma Physics" , Francis Chen,(1974) p34.

[11] Zel'dovich, Y.B., JETP letters **6**, 316 (1967); "The Cosmological Constant and Elementary Particles" , Soviet Physics Uspekhi **11**, 381 (1968)

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

[13] Brandenburg, John, Derivation of the Schwartzchild Metric From the ``Self Censorship'' of the ZPF (Zero Point Energy) in the GEM Theory, Fall 2012 Meeting of the APS Ohio-Region Section, October 5-6, 2012, abstract #EC.008

[14] Marmier P. and Sheldon E., *Physics of Nuclei and Particles* (Academic Press, New York, 1969), vol. 1.

[15] Hawking, S. W. (1974). "Black hole explosions?". *Nature* **248** (5443)

[16] t'Hooft G., "A physical interpretation of gravitational instantons." Nucl. Phys. **B315** (1989) 2, 517-527.

[17] Williams L.L. "Field Equations and Lagrangian for the Kaluza Metric Evaluated with Tensor Algebra Software" Journal of Gravity, Volume 2015, Article ID 901870

[18] K.A. Olive et al. (Particle Data Group), Chin. Phys. C38, 090001 (2014)

[19] Evidence for the direct decay of the 125 GeV Higgs boson to fermions, The CMS Collaboration, *Nature Physics,10, 557-560 (2014)*