A Derivation of the Newton Gravitation Constant and the Proton Mass From The GEM Unification Theory of Baryo-Genesis

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Abstract

A model of combined Sakharov and Kaluza-Klein baryo-genesis from the GEM unification theory, where the deployment of the Kaluza-Klein 5th dimension creates separate EM and gravity fields and also generates lepton and baryon numbers, uses a U(1) mass model with imaginary angle to give an expression ln $(r_o/r_P) = \sigma$ relating the lepton-baryon mass splitting parameter $\sigma = (m_p/m_e)^{1/2}$ to the hidden dimension size, r_o, where m_p and m_e are the electron and proton rest masses respectively, and , in cgs, $r_o = e^2/((m_p m_e)^{1/2} c^2)$ is a deployed hidden dimension size and where $r_P = (G \hbar/c^3)^{1/2}$ is the Planck Length. This expression can be inverted , without any free parameters, to yield a highly accurate formula for the Newton Gravitation constant (in cgs) : $G = (e^2/(m_p\ m_e))\alpha\ \exp(-2(m_p/m_e)^{1/2}) = 6.668\text{x}10^{-8}$ dynes-cm^2/g^2 which is within 1 part per thousand of the measured value, where α is the fine structure constant. The U(1) mass model can be extended without free parameters, where $q'/e = \alpha^{1/2}$ is the normalized Planck charge, to find $m_p = M_P\, \sigma^{-q'/e} = 1.71\ \text{x}10^{-24}$ g which is the proton mass to within 2.5% of its measured value, where M_P is the vacuum Planck mass $M_P = (\hbar c/G)^{1/2}$. This work is an outgrowth of the GEM unification theory, which is briefly summarized here. Correction of the relationship for the hidden dimension size as it deploys from the Planck scale, using constraints from Big Bang Nucleo-synthesis on quark-quark and quark electron associations yield for G :$G = e^2/(m_p\ m_e)\ \alpha\ \exp(-2((m_p/m_e)^{1/2} - 0.86/R\ldots)) = 6.67424 \times 10^{-8}$ dynes-cm^2/g^2 where $R = (m_p/m_e)$ and which is within 1 part per 10^5 of the accepted expression $G = 6.67428 \times 10^{-8}$ dynes-cm^2/g^2. Similar constraints yield the more accurate formula $m_p = M_P\, \sigma^{(-q'/e)(1+0.71/R)} = 1.683 \times 10^{-24}$ g for the proton mass. The seeming success of this approach appears to validate the utility of hidden dimension theories in understanding the cosmos.

Key Words: Cosmology, Big Bang, alternative cosmologies, plasma astrophysics, gravity-EM unification, Kaluza-Klein theory, ZPF, Planck Scale , Baryons, Leptons

1. Introduction: The GEM Theory and a Combined Sakharov and Kaluza-Klein Model of Baryo-Genesis

The GEM (Gravity-Electro-Magnetism) or "Grandis et Medianis" theory (Brandenburg, 1988, 1991, 1995, and 2007) is an outgrowth of the "Plasma Cosmology" school of thought in alternative cosmologies (Peratt 1991). The GEM theory has advanced over the years and provided a physically reasonable model for gravitational fields in terms of EM fields, and an accurate formula for the ratio of coupling constants between EM and gravity. This has been achieved by combining the models of Sahkarov (1967a,1967b) for gravitational fields and baryo-genesis , and the formalism of Theodore Kaluza and Oskar Klein theory for mathematically unifying EM and gravity (Klein, 1926). The GEM theory could thus be described as "$(SK)^2$" because it involves two of Sakharov's ideas plus the theory of Kaluza and Klein. In this introduction, we will briefly describe the GEM theory in its present state of development with its highly accurate formula for the Newton gravitation constant that involves no free parameters. A formula for the proton mass emerging from the Planckian vacuum, likewise without free parameters, is also found to high accuracy. We will then present an improved derivation and formula for the Newton Gravitation Constant and proton mass, yielding a theoretical value for G within experimental error of that measured, which is 1 part in ten thousand and parts per thousand accuracy for the proton mass.

GEM theory is an alloy of the concepts of Sahkarov (1967a, 1967b) concerning baryo-genesis and gravity's relationship to the EM ZPF, and Kaluza-Klein theory of EM-gravity unification (1926). To see this we begin with the Hilbert action principle in 4 spacetime dimensions with a zero cosmological constant.

$$W = (16\pi G)^{-1} \int g^{\mu\nu} R_{\mu\nu} \sqrt{-g}\, dx^4 ,$$

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

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

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, (1967), 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:

$$G^{-1} \cong \frac{h}{2c^5} \int_0^{\omega^*} \omega d\omega = \frac{h\omega_P^2}{c^5} ;$$

$$G = \frac{c^3 r_P^2}{h} = \frac{c^4}{r_P^2 T_o} ,$$

where ω_P is the Planck frequency c/r_p, where $r_p = (G\ /c^3)^{1/2}$ and the energy density T_o = ▪ 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, $S= cExB/4\pi$ (in esu) or a radiation pressure $P=\langle S\rangle/c$. This can be seen from two physical examples: the ExB drift of plasma physics, which gives all particles the same velocity, regardless of charge or mass (Chen, 1976).

$$V = c\frac{E \times B}{B^2} = \frac{S}{(B^2 / 4\pi)} \qquad (5)$$

Variation of this ExB drift velocity by varying the E field in time or space leads to an acceleration that affects all particles regardless of charge or mass (see: Figure 1). In the left of Figure 1, the uniform B field coming out of the page, acting in combination with the uniform E field between the plates, causes a uniform motion at velocity $V=ExBc/B^2$of all charged particles. In the right figure, the electric field is made non-uniform leading to identical acceleration of all charged particles. For E normal to B everywhere and weak accelerations, the effective gravity potential is $\phi = ½\ c^2E^2/B^2$ where B is constant.

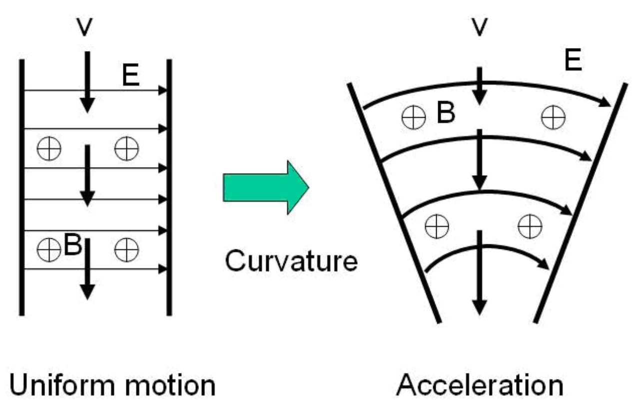

Figure 1. The ExB drift caused by crossed electric and magnetic fields affects all charged particles identically and in non-uniform E fields, but uniform B fields, can cause acceleration.

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 2. In Figure 2, the left figure shows hot-bright particles in a dark-cold enclosure, the right figure shows cold–dark particles in a hot–bright enclosure. Mutual radiation pressure forces are shown by block arrows.

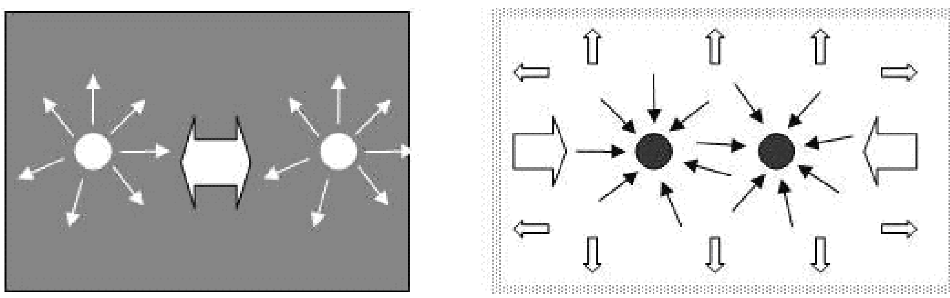

Figure 2. Radiation Pressure Affecting Particles in an Enclosure. Left: Two hot ideal radiators in a cold box repel each other by mutual radiation pressure. Right : Two cold ideal radiators in a hot box attract each other due to mutual shadowing.

As was shown in the first GEM article (Brandenburg, 1991), 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 2). It is understandable that Sakharov would arrive at this physical model for gravity, since he worked on the Soviet Hydrogen Bomb, where radiation pressure is crucial. We can derive the same idea, in relativistic- covariant form, from the expressions in the first GEM article, where the zeroth-order ZPF stress energy was caused to vanish (Brandenburg, 1992). That is, we can explain the Zeldovich Cancelation as EM-gravity unification physics.

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

$$g_{\alpha\beta} = \frac{4F_{\alpha}^{\gamma}F_{\gamma\beta}}{F_{\mu\nu}F^{\mu\nu}} \tag{6}$$

Then it will follow that the full EM momentum stress tensor vanishes everywhere

$$T_{\alpha\beta} = F_{\alpha}^{\gamma}F_{\gamma\beta} - g_{\alpha\beta}\frac{F_{\mu\gamma}F^{\mu\gamma}}{4} = 0 \tag{7}$$

We can expand this expression for the metric tensor in terms of the F tensor :

$$g_{\nu\mu} = \frac{4F_{\nu}^{\alpha}F_{\alpha\mu}}{F^{\alpha\beta}F_{\alpha\beta}} = \frac{2}{E^2 - B^2}\begin{pmatrix} -E^2 & 4\pi S_x/c & 4\pi S_y/c & 4\pi S_z/c \\ 4\pi S_x/c & E_x^{\ 2} - B_z^{\ 2} - B_y^2 & E_xE_y + B_xB_y & E_xE_z + B_xB_z \\ 4\pi S_y/c & E_xE_y + B_xB_y & E_y^{\ 2} - B_z^{\ 2} - B_x^2 & E_zE_y + B_zB_y \\ 4\pi S_z/c & E_xE_z + B_xB_z & E_zE_y + B_zB_y & E_z^{\ 2} - B_x^{\ 2} - B_y^2 \end{pmatrix} \tag{8}$$

where the S terms are components of the Poynting vector.

When we consider a model near the Planck scale where the ZPF is dominated , not by waves , but by regions of alternating ultra-strong electric and magnetic flux so that in adjacent regions $E^2 >> B^2$ and $B^2 >> E^2$ and E and B are parallel in adjacent regions. Particles travel as wave packets and sample a volume swept out by a wave-front. Consistent with a globally isotropic vacuum field we require an average over volume to yield $<B^2>=<E^2>$ and $<E\cdot B>=0$, this results in a volume average of two metric forms one dominated by electric flux, for instance, in its local direction E_y

$$g_{\alpha\beta} = \begin{bmatrix} -2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \tag{9a}$$

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

$$g_{\alpha\beta} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2 \end{bmatrix} \tag{9b}$$

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

$$< g_{\alpha\beta} >= \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{10}$$

This interpretation corrects a picture of magnetic flux dominance presented earlier and caused by a sign error in earlier work (Brandenburg 2007).

If we define in regions of spacetime curvature, part E' that intrudes into the magnetic rich region, so we have then $g_{oo} = 2E'^2/B^2 << 1$ for the magnetic dominated region and we then have then upon spatial averaging, $<g_{oo}>= -1+ E'^2/B^2 = -1 - 2\phi/c^2$ where ϕ is the gravity potential.

This definition of the metric allows the vanishing of the ZPF stress energy tensor with only residual "shot noise" at long wavelengths. The correspondence of the ExB drift vector field: $V/c = ExB/B^2$ to the metric tensor defined in Eq. 8 can be seen by understanding the Poynting vector $S= cExB/4\pi$. We have formally explained the Zeldovich Cancellation by saying that ultra-strong EM fields, such as the ZPF, cancel themselves, becoming the spacetime geometry itself and we can recover a covariant form of the ExB drift model of gravity.

Thus, the classical phenomenon of the ExB drift can serve as a physical basis for understanding gravity fields, and gravity can be understood as arising from a microstructure of EM ZPF fields. But what of the field equations? How do Maxwell's and Einstein's equations arise from a common basis? This is done in the GEM theory by the Kaluza-Klein formalism, by the introduction of a 5th dimension that effectively scatters part of the ZPF EM microstructure of spacetime into long wavelength E and B fields that are governed by Maxwell's equations. However, in the GEM theory the 5th dimension also creates the lepton and baryon numbers.

This new Kaluza-Klein 5th dimension, is "compact", that is, it is limited in extent, unlike the other dimensions of space-time. However, the 5th dimension must arise from the much smaller Planck length and deploy to its favored size. We will assume that at the Planck scale all particles and fields are unified and identical. The world we basically experience then results from the deployment of the compact 5th dimension from Planck scale, to form a cosmos with two particles: electrons and protons and two fields: EM and gravity. But what is the size of the fully deployed 5th dimension? Since the consequence of the appearance of the 5th dimension is appearance of real particle masses, m_e and $m_{p,}$ the new scale size r_o, termed a "mesoscale" size, most simply, will depend on "particle" quantities: e, m_p and m_e. The hidden dimension size then, is a completely new quantity, and not dependent on the vacuum quantities G, c, and ▪. We can write then for the new 5th dimension size r_o in terms of purely particle quantities that accompany its appearance: e, m_p, and m_e, the charge and masses of the proton and electron respectively, so that we have in esu units, where $m_o = (m_p m_e)^{1/2}$:

$$r_o = \frac{e^2}{m_o c^2} \tag{11}$$

We assume that the masses of the proton and electron can be derived near the Planck scale from the most primitive of symmetries, the U(1) symmetry:

$$m = m_o \cos(\phi) + i m_o \sin(\phi) \tag{12}$$

We assume real masses appear because of an imaginary splitting angle ϕ_o, so that we have

$$m = m_o \exp(\pm\left|\frac{q}{e}\right|\phi_o) \qquad (13)$$

This angle, in turn, must depend on the radius of spacetime curvature, r_c ,so that near the Planck length curvature, all particle intrinsic masses become the same:

$$\ln\left[\ln\left(r_c/r_P\right)\right] \cong \phi_o \qquad (14)$$

We couple the appearance of the 5th dimension from the Planck scale, to its fully developed but compact length r_o with the appearance of both Maxwell's and Einstein's equations, and protons and electrons. In brief, this results in the relationship.

$$\ln\left(r_o/r_P\right) = \left(\frac{m_p}{m_e}\right)^{1/2} = 42.8503.... \qquad (15)$$

If we examine the physical meaning of the ratio of the 5th dimension radius to the Planck radius r_o/r_P in Eq. 15, we discover it is a quantum normalized ratio of coupling constants between gravity and EM, in addition to being a ratio of lengths:

$$r_o/r_P = \sqrt{\frac{e^2\alpha}{Gm_o^2}} \qquad (16)$$

We can use Eq. 16 to invert Eq. 15 to find a formula for G with no free parameters. This formula was first published in 1988 (Brandenburg 1988) and a full derivation several years later (Brandenburg 1995). This formula bears some resemblance to the approximate formula for G published by T'Hooft (1989) based on "Instanton" theory.

The formula for G, shown in CGS units, is accurate to 1 part per thousand:

$$G = \left(e^2 / m_p m_e \right) \alpha \exp\left(-2 \left(\frac{m_p}{m_e} \right)^{1/2} \right) = 6.6684 x 10^{-8} dyne - cm^2 gm^{-2} \qquad (17a)$$

Thus, the GEM theory provides a physical model for gravity fields as based on fine structure of EM interactions, most similar to the phenomena of ExB drift arrays or radiation pressure, and also provides a model connecting the fact that two known particles dominate the universe: protons and electrons, and this is analogous to the two long range forces that dominate the universe: EM and gravity.

Extension of the U(1) mass model in Eq. 13 (Brandenburg 2011) to include a definition of m_o in terms of the Planck mass, and where we use the normalized Planck charge $q_P/e = \alpha^{1/2}$, gives us the expression:

$$m = M_P \exp(\pm \left| \frac{q_P}{e} - 1 \right| \ln \sigma) \exp(\pm \left| \frac{q}{e} \right| \ln \sigma) \qquad (17b)$$

We now simplify this expression and obtain, without free parameters, the value of the proton mass in terms of the Planck mass, $M_P = 2.17651 \times 10^{-5}$g:

$$m_p = M_P \sigma^{-\alpha^{-1/2}} = 1.713 \quad x 10^{-24} g \qquad (17c)$$

This expression is within 2.5% of the observed value of 1.673 x 10^{-24} g. We will now discuss the derivation of value of the Newton gravitation constant and the proton mass to better approximation from that portrayed in Eq. 17a-c using constraints on baryo-genesis from observational cosmology.

2. The Sakharov Proposal for Baryo-Genesis and a Gedanken Experiment

Sakharov (1967) proposed that in the early universe lepton and baryon number and CPT invariance were not conserved, resulting in the matter-anti-matter asymmetric cosmos we dwell in, at least locally. This local cosmos is dominated by hydrogen: protons and electrons, as opposed to their antiparticles. It is conventional wisdom that this condition of asymmetry is universal and not merely local. Other explanations are possible however, for the observed matter-antimatter asymmetry in the cosmos, including the possibility advanced by Hans Alve'n (1966) and Oskar Klein (1977) that the asymmetry was only local, and that the universe consisted of regions of matter and anti-matter that have segregated themselves. However, for our discussion, we will adopt the Sakharov view that the asymmetry is real and universal.

We will also adopt the view that the universe began as a hot, dense, plasma that began as a Planck scale system (Kolb 1994) and evolved as it expanded. This is the conventional BB (Big Bang) cosmology, which admittedly, has evolved from a simple, straightforward model of an expanding hydrogen plasma when first advanced, to a rather Byzantine model now containing such features as, inflation, dark energy and dark matter, all of which must add undetermined parameters and physical uncertainty to its predictions, as was pointed out by Micheal Disney who commented

"Any theory with more free parameters than relevant observations has little to recommend it..."

(Disney 2009). The simple BB model was itself a product of the interpretation of red-shifts of galaxies as indicating the expansion of the universe. Even this interpretation of the red-shift has been questioned by Arp (1998) and others (Ratcliffe, 2010). However, despite these problems, in the words of Eastman (2010):

"The Big Bang (BB) research program has been highly successful in generating fruitful scientific hypotheses and tests, and has achieved a significant level of confirmation for many hypotheses. However, outstanding questions remain and substantial alternative cosmology models, which also have been fruitful, remain viable and continue to evolve."

Despite these problems, we will use the BB model for this analysis, since it is simple and has had some predictive power. The present concept of the BB is that its first instant was a Planck scale plasma and that baryo-genesis followed after this as it expanded.

Accordingly, it is the premise of the GEM theory that out of Planckian “vacuum” quantities: G, c, and ▪ , emerge “particle” quantities : e, m_p, and m_e, that provide a rough description of the cosmos.

In the GEM theory the triggering event for the Big Bang is the appearance of the Kaluza-Klein 5th dimension (Klein 1926), that breaks the symmetry of the Planckian vacuum and allows a new degree of freedom, like girder goes from one dimensional to a two dimensional object when it buckles. This is similar to the proposed phenomena of “vacuum decay” found by Witten (1982) when a 5th dimension is added to a conventional 4 dimensional spacetime.

An improved derivation has now been found that gives G to higher accuracy. To see this improved derivation we begin with a Gedanken experiment where we squeeze hydrogen into a subatomic Black Hole from which it undergoes Hawking Decay (Hawking, 1988) into particles and antiparticles and EM radiation, that is: an effective vacuum.

In our Gedanken Experiment we confine a single hydrogen atom on a circular loop of radius of curvature r_c. As we shrink the loop to a radius approaching the Compton wavelength of the proton, the motion of the particles becomes relativistic and their effective masses increase and are described by the quantum uncertainty relationship

$$M = \frac{}{r_c c} \tag{18}$$

If we stop and break the loop and release the proton and electron at this point they will fly apart, slow down in the surrounding cosmos and reassume their rest masses m_e and m_p respectively. However, if we instead continue to shrink the loop a irreversible event will happen: the spacetime curvature caused by the two masses on the loop will increase until a Black Hole forms with Schwartzchild radius equal to the loop radius of curvature

$$\frac{4GM}{c^2} = r_c \tag{19}$$

We find the loop radius where this will occur by substituting the expression for M from Eq. 18 into Eq. 19 we obtain

$$\frac{4G}{c^3} = r_c^{\,2} \tag{20}$$

so that $r_c=2r_P$, where r_P= (G ▪ /c^3)$^{1/2}$ is Planck Length. Now that our hydrogen atom has become a Black Hole of radius $2r_P$ it must undergo Hawking decay into a shower of particles and antiparticles with canceling quantum numbers. Thus, the hydrogen turns effectively back into vacuum: the baryon number and lepton number of the proton and electron of the original hydrogen atom have disappeared. Therefore, we can see that baryon and lepton number must disappear at the Planck scale, where curvature radii of $r_c \sim r_P$. The simplest signature of baryon-lepton difference is the ratio of intrinsic masses m_p, and m_e of the proton and electron. We can form a model so that m_p and m_e merge smoothly as the curvature of spacetime approaches the critical tunneling length $r_c \sim r_P$ by writing a mass model for proton and electrons that will describe their rest masses near the Planck scale.

3. A Particle Mass Model

Modern Physics is built upon the concepts of symmetry groups. Particle mass formulas for hadrons are based of such symmetry groups such as the Gell Man-Okubo mass formula which is based on the SU(3) symmetry (Griffiths, 1987). The SU(2) symmetry group that controls the electro-weak interaction, and the simplest U(1) symmetry that controls quantum EM interactions. The Electro-Weak interaction is particularly interesting because here SU(2) symmetry breaks down to a simpler U(1) symmetry with a formula for the masses of the boson pair of the neutral vector boson Z_o and the photon from two mass components, W_o and B_o , with the Weinberg mixing angle θ_W:

$$Z_o = W_o Cos\theta_W + B_o Sin\theta_W \tag{21}$$

This is close to a the U(1) symmetry. The U(1) symmetry is complex valued with real and imaginary mixed together. Particles with imaginary rest masses are tachyons, alternatively described as particles that move faster than light (Feinberg, 1967) or that are unstable (Peskin and Schroeder, 1995). The simplest physical interpretations we can make for such imaginary particles is that they are particles that have fallen inside the event horizon of a Black Hole, accelerating effectively beyond the speed of light relative to particles outside the event horizon in the process and being out of communication with the real particles of the universe or else are unstable particles falling apart with the Black Holes into showers of more normal particles and anti-particles. This is important at the Planck scale because there particles appear out of the vacuum, form black holes and decay by Hawking instability into showers of photons, particles and anti-particles (Hawking, 1988), so that spacetime is effectively a chaotic “foam” of stable and unstable particles. Foamy spacetime features Black Holes that are so closely packed that it is impossible to determine whether a particle is inside or outside a event horizon or stable or unstable. Thus particles at the Planck scale can be physically represented as complex, half real and half imaginary, with masses satisfying a U(1) symmetry. As has been pointed out by Rhawn (2010), the entire idea of 4-dimensional spacetime may dissolve in the chaos of the Planck scale, leading to multi-dimensional and trans-dimensional physical phenomena. However, in the words of Einstein we must *"seek simplicity and then distrust it"* looking for a simple model of Planck scale physics that allows analysis to proceed, while bearing in mind it may be overly simplistic.

Let us consider a model of the primordial fireball of the Big Bang that is essentially a Planck scale plasma of quarks, electrons, and their anti-particles plus the quanta of their fields. Let us further assume, after Sakharov, that CPT invariance is broken to slightly favor ordinary matter and that the quarks are of the lowest mass variety, up and down. Careful measurements of relative abundances of primordial helium 4 and deuterium, believed to reflect BBN (Big Bang Nucleo-synthesis) (Burles, Nollett, and Turner 1999) can be used to constrain the "freeze-out" neutron to proton ratio of 1 neutron to 6 protons. It is this constrained ratio represents our only window on Big Bang early fireball physics. Therefore, for this discussion, we use this primordial proton to neutron ratio μ as being reflective of conditions in the Planck scale quark-electron plasma.

In the GEM model both protons and electrons begin in a U(1) symmetric field , the simplest possible field symmetry consistent with QED, for a mesoscale "union" particle with rest mass m_o. This union field exists at the Planck length with the U(1) symmetry.

$$m = m_o \cos(\phi) + i m_o \sin(\phi) \tag{22}$$

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 (Brandenburg 1995).

4. The Big Bang From a Broken Vacuum

Edward Witten has found the addition of Kaluza-Klien 5[th] dimension to standard 4 dimensional spacetime causes the vacuum to become unstable (Witten 1982). Let us assume the Big Bang was triggered by such a cosmic event, the appearance of the Kaluza-Kein 5[th] dimension. Let us model the effect of the compact fifth dimension by allowing angle ϕ in Eq. 22 to become an imaginary rotation angle to give two real particle masses corresponding to an "up" quantum state and "down" quantum state from the U(1) symmetry. Let us therefore assume a model of a "broken vacuum", where a new "out of plane" imaginary angle exists that changes the U(1) symmetry from complex to real valued:

$$m = m_o \exp(\pm\left|\frac{q}{e}\right|\phi_o) \tag{23}$$

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

Now, a feature of the Kaluza-Klein 5th dimension is that it is compact, that is, it deploys to a certain length and no further. Let us further assume this deployed length is much larger than the Planck length so that it changes the physics of a Planckian vacuum, so that when the new 5th dimension is fully deployed the real particle masses m_e and m_p are present, where before they did not exist. The appearance of the Kaluza-Klein 5th dimension breaks the symmetry of the vacuum so it now has a new preferred size scale, where before it had only r_P. Since the consequence of the appearance of the 5th dimension is appearance of real particle masses, m_e and m_p, the new scale size r_o, most simply, will depend on "particle" quantities: e, m_p and m_e. We can write then, as before, for the new scale size in terms of purely particle quantities that accompany its appearance:

$$r_o = \frac{e^2}{m_o c^2} \tag{24}$$

where $m_o = (m_p m_e)^{1/2}$ or approximately 22MeV, so that the size scale is neutral between protons and electrons. We will call this new scale size the "mesoscale radius" because it lies between the Planck scale and the cosmic scale. This mesoscale size is effectively the new 5th dimension size, when it is fully deployed.

We can model the appearance and deployment of the 5th dimension with a parameter ξ, such that $\xi = 0$ when the 5th dimension does not exist and $\xi = 1$ when the 5th dimension is "fully inflated" or deployed. We then have $\phi_o(\xi) = 0$ for $\xi = 0$ and $\phi(\xi) = \phi_o$ for $\xi = 1$. So that separate particle masses m_e and m_p are generated by Eq. 7 at $\xi = 1$ and we have

$$\left(\frac{m_p}{m_e}\right)^{1/2} = \exp(\left|\frac{q}{e}\right|\phi_o(\xi)) \tag{25}$$

where the normalized charge q/e =1 under the present cosmic conditions. Noting that the square root of the proton electron mass ratio is now a signature of the curvature scale of the spacetime we write, most simply,

$$\phi_o(\xi) = \ln\sigma \tag{26}$$

Where σ is the generalized value of the square root of the mass ratio: $(m_p/m_e)^{1/2}$.

To obtain a smooth transition to the union field in our earlier Gedanken experiment, as r_c collapses to the Planck scale $r_c \sim r_P$, the angle ϕ_o must be dependent on curvature r_c 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_c is for the rotation angle to have the dependence on our 5^{th} dimensional deployment parameter ξ. We write then approximately

$$\ln(r_c(\xi)/r_P) \cong \sigma = \exp(\left|\frac{q}{e}\right|\phi_o(\xi)) \tag{27}$$

so that $\phi_o = 0$ and lepton and baryon numbers disappear within approximately a tunneling length of the Event Horizon radius for two Planck masses ~ 2 r_P. In the limit of $\sigma = 1+\gamma$ where $\gamma \ll 1$ and $r_c/r_P = C_o+\varepsilon$, where we define near the Planck scale $\varepsilon = \xi\, r_o/r_P$ where $\varepsilon \ll 1$ we have then the series expansions for Eq. 27.

$$\ln C_o + \varepsilon / C_o \cong 1 + \left|\frac{q}{e}\right|\gamma \tag{28}$$

So that we have for a generalized normalized charge $d\varepsilon/d\gamma$ near the Planck scale

$$\frac{d\varepsilon}{d\gamma} = C_o\left|\frac{q}{e}\right| \tag{29}$$

At r_c/r_P and σ >>1 it is known that we can use C_o =1 and q/e =1 and get accurate formulas (Brandenburg 1995), so these are zeroth order values, however this does not work near the Planck scale since σ =1 outside the event horizon at r_c/r_p=2. In this model the conditions near the Planck must allow normalized charge states of greater than one representing exotic quark-electron associations. The Planck scale must be studied to determine the limiting normalized charge.

5. Conditions Near the Planck Scale From the Standard Model

To obtain a reasonable value for normalized charge at the Planck scale in our model we must turn to Standard Model Physics. In the Standard Model quark confinement fails at the Planck scale and so does the principle of integral electron charges, accordingly, we would expect to find exotic associations of quarks and electrons not seen under normal cosmic conditions. Near the Planck scale the Strong and Weak forces become weaker than the electromagnetic force (Georgi, Quinn, and Galshow, 1974), leaving two dominant forces as one approaches the Planck scale: gravity (Smolin, 2002) and EM. Thus we will ignore the strong and weak forces near the Planck length. Our insight into conditions near the Planck scale is limited and it is only the studies of the Big Bang which give us any insights into high density, high energy plasmas of large extent. Therefore, we adopt a simple model of a Planck scale plasma consisting of up and down quarks, electrons, their antiparticles, the quanta of their fields, and associations of these particles. Consistent with ignoring the Strong force, we assume asymptotic freedom: that the gluon fields which normally contribute most of the mass of a quark system will be suppressed and we simply assume they are absent. This leaves bare quark masses of approximately 4 MeV for up quarks and 8MeV for down quarks. The masses of the quarks and their associations in this primordial fireball are poorly constrained, but their charges are not, the electron charge must be balanced by an equal charge in its neighborhood. The EM force is strong near the Planck scale. This means exotic particles that are associations of more than three quarks will form around proton and neutron-like associations. Recent experiments may have found evidence of such exotic particles as tetra-quarks (Ahmed et al. 2010). In the GEM model the exotic proto-electron and proto-protons are approximately 22MeV in intrinsic mass. These can be formed simply by a penta-quark of a proton-like association and two up quarks for a normalized positive charge of 7/3 and a bare mass of approximately 24 MeV and a tetra-quark plus an electron that consists of an antiproton association plus down quark for a bare mass of 24 MeV and balancing charge of -7/3. The baryon number then begins as “up-ness’ in this model even before the proton appears. The next simplest arrangement in the plasma will be the same arrangement of free quarks in association with a neutron and antineutron for masses of approximately 26 MeV and charges of $\pm 4/3$. Given the Sakharov model of CPT invariance and the inferred freeze-out neutron to proton ratio $\mu \cong 1/6$ the mean charge of the proto-protons and proto-electrons is approximately

$$\frac{d\varepsilon}{d\gamma} = \left|\frac{q}{e}\right| = \frac{7/3 + 4/3\,\mu}{1+\mu} \cong 2.2 \tag{30}$$

This number is insensitive to the precise value of for μ <<1. The value of μ depends on the ratio of neutrinos to anti-neutrinos, and is thus reflective of the degree of parity violation in the early fireball. As it is μ is the earliest point of physics that is directly recoverable from the BBN model and is based on measured deuterium and He 4 abundances, and we will use it rather than extrapolating more complex models of the weak and strong force up to the Planck scale.

6. Mass Model With Standard Model Physics

Using our deployment parameter ξ we write simply:

$$r_c(\xi) \cong \xi r_o + C_o r_P \tag{31}$$

where C_o~1 so that $r_c \cong C_o r_P$ for $\xi = 0$ and $r_c = r_o$ for $\xi = 1$. The we can the write by Eq.27, 28, and 29, to good approximation:

$$\sigma - C_2/\sigma^2 \cong \ln\left(r_o/r_P\right) = 42.8499.... \tag{32}$$

where also C_2 ~1. The value of C_2 is determined by behavior near the Planck scale.

Because our model now has $\sigma = 1$ inside the surface $r_c = 2r_P$ particles can tunnel out as antiparticle pairs for Hawking evaporation outside the event horizon surface. Guided by Eq. 32 we write near the Planck scale a surface area relationship for $\sigma \approx 1$ and C_2 ~1

$$\ln\left(r_c^{\,2}/r_P^{\,2}\right) \cong \sigma \tag{33}$$

and then a string-like relationship far from the Planck scale where σ >>1

$$\ln\left(r_c/r_P\right) \cong \sigma \tag{34}$$

The relationship thus changes its effective dimensionality from the Planck scale to the mesoscale. We then write the transcendental relationship that satisfies Eq. 32 for $\sigma >>1$

$$\left(1+{C_2}/{\sigma^3}\right)\ln\left({r_c}/{r_P}\right)=\sigma \tag{35}$$

In the limit of $\sigma =1+\gamma$ where $\gamma <<1$ and $r_c/r_P = C_o+\varepsilon$, where $\varepsilon <<1$ we have then have the relationship between ε and γ for Eq. 35.

$$\ln C_o+\varepsilon/C_o ... =\frac{1+(1+{3C_2}/{1+C_2})\gamma ...}{1+C_2} \tag{36}$$

By choosing $\ln C_o = 1/(1+C_2)$ we obtain a system where $\sigma =1$ where $r_c/r_P = C_o < 2$, which is inside the surface of the black hole at $r_c/r_P = 2$ and we have for Eq. 36

$$1+\varepsilon(1+C_2)/C_o ... =1+(1+{3C_2}/{1+C_2})\gamma ... \tag{37}$$

We solve for the derivative $d\varepsilon/d\gamma$, which is our generalized normalized charge near $\sigma =1$

$$\frac{d\varepsilon}{d\gamma}=C_o(1+{3C_2}/{1+C_2})/(1+C_2)... \tag{38}$$

Where we have the normalized charge $d\varepsilon/d\gamma$ consistent with freeze-out

$$2.2=C_o(1+{3C_2}/{1+C_2})/(1+C_2) \tag{39}$$

This can be solved in terms of C_2 and yields the value $C_2 =0.86$ to two significant figures. This gives $C_o =1.71$

Therefore, in this model, the value of C_2 is constrained by conditions near the Planck scale which can be inferred from BBN.

7. The Improved Formula for the Newton Gravitation Constant

We once again examine the physical meaning of the ratio of the mesoscale radius to the Planck radius r_o/r_P in Eq. 35, which is a quantum normalized ratio of coupling constants between gravity and EM, in addition to being a ratio of lengths:

$$r_o / r_P = \sqrt{\frac{e^2\alpha}{Gm_o^2}} \qquad (40)$$

So that the size ratio of the Planck to the mesoscale length, or 5th dimension size, is actually a ratio of the strengths of interaction of gravity and electromagnetism between an electron and proton with a normalization factor of α . This also means the formula of Eq. 35 can be inverted to find an accurate expression for the gravitation constant.

We thus obtain for the Newton Gravitational Constant, using the measured value of the proton electron mass ratio, (Brandenburg 2011) to second order, in cgs units:

$$G = \left(e^2 / m_p m_e \right) \alpha \exp\left(-2\left[\left(\frac{m_p}{m_e} \right)^{1/2} - \frac{.86}{m_p / m_e} \ldots \right] \right) = 6.67424 x 10^{-8} dyne - cm^2 gm^{-2} \qquad (41)$$

this expression is within roughly a part per 10^4 of the measured value of

$6.67384 \times 10^{-8} \pm 0.0008$ dyne-cm^2 gm^{-2} (CODATA)

9. An Improved Planck-Proton Mass Ratio Calculation

The mass model can be extended to consider not just the bayron-lepton (proton-electron) mass splitting, but the appearance of the proton mass out of the vacuum Planck scale. Just as we have the U(1) mass model of Eq. 27 for the baryon-lepton end members, that is, dependent on the normalized charge q/e at low energies, we can then write the proton mass, the dominant mass of the lepton-baryon system, approximately at low energies, in terms of the Planck charge $q_P/e=\alpha^{-1/2}$

$$\frac{m_p}{M_P} = \exp(-C' \left| \frac{q_P}{e} \right| \ln\sigma) \qquad (42)$$

Where M_P is the Planck mass (c/G)$^{1/2}$ and C' is a coefficient containing higher order terms in $1/\sigma$, that are only important near the Planck scale. If we write the mass ratio of protons to Planck mass, then this can be written as merely a ratio of Compton radii r_c/r_P , near the Planck length we can write this in the form $C_p+\varepsilon$ with ε <<1 as in our earlier discussion. This complicated by the fact that here the proton is simply a single particle rather than part of a system with the electron, so C_p is not necessarily the same as C_o in the previous calculation but should be some number near unity. In general, the simultaneous approach of so many quantities to unity near the Planck scale, is difficult to constrain. However, despite this problem, we can write near the Planck scale $\sigma = 1 + \gamma$ with $\gamma \ll 1$. We also assume that near the Planck scale the electron charge approaches the Planck charge so effectively $q_P/e = \alpha^{-1/2} \rightarrow 1$. We have then near the Planck scale for Eq. 36:

$$1-\varepsilon/C_p \cong 1-\alpha^{-1/2}\gamma C' \qquad (43)$$

and from our previous expansion near the Planck length from Eq. 37.

$$\frac{d\varepsilon}{d\gamma} = C_p C' \alpha^{-1/2} \cong 2.2 \qquad (44)$$

This dependence near the Planck scale is satisfied by, in a simple form by the choice of $C_p = 1.29$, that is, a surface slightly greater than r_p, we obtain the same coefficient $C' = C_o = 1.71$, as in the gravity constant calculation of Eq. 39.

$$C' \cong 1 + 0.71/\sigma^2 \qquad (45)$$

We have then in general for the proton mass at low energy, that satisfies BBN constraints near the Planck scale.

$$m_p = M_P \sigma^{-\alpha^{-1/2}(1+0.71/\sigma^2)} = 1.683\,x10^{-24}\,g \qquad (46)$$

This formula is within 7 parts per thousand of the measured value 1.67 $x10^{24}$ g and goes to M_P near the Planck Scale, where $\sigma \rightarrow 1$, as it should.

10. Summary and Discussion

Therefore, a model of baryo-lepto-genesis can be written where the Big Bang is triggered by the appearance of the Kaluza-Klein 5th dimension that renders the vacuum unstable and this leads to the appearance of the baryon and lepton number. The reliance on the BBN model for this calculation is recognized to be simplistic, however, one must begin somewhere. The 5th dimension does "double duty" in this model, allowing both the separate appearance of EM and gravity fields from the Planckian vacuum and also the appearance of separate leptons and baryons. The effective dimensionality of the relationship changes from the Planck scale resembling a charge layer on a sphere to a line charge. Simple models of the primordial fireball plasma near the Planck scale allow constraints on the normalized charge of proto-baryon associations in the theory and lead to a highly accurate second order estimation of the gravitation constant. Similar analysis leads to an improved formula for the mass of the proton in terms of the vacuum Planck mass. The relationship of G to m_p leads to a closed transcendental relationship, termed here the "Transcendental Cosmos Equation", between σ =42.8503…and α (Brandenburg 2011), given to first order:

$$\sigma \cong \ln \sigma(\alpha^{-1/2} + 1) + \ln \alpha \cong 42.8\ldots \tag{47}$$

The value of second order terms in the expressions for G and m_p are consistent with the existence of exotic, non-integral charge, penta-quark and tetra-quark associations in a simple model of conditions near the Planck scale. Therefore, the Big Bang can be modeled as an event triggered by a transition from purely Planckian physics to a richer cosmos allowing larger scales and more diverse phenomena. The success of this approach appears to validate attempts to explain observed physics by models using hidden dimensions.

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