The GEM theory of Forces Observed in the Eaglework Q-V Thruster

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Abstract

The experimental forces observed in the Eagleworks Q-V thruster indicate that it may be possible to generate propulsive forces by the application of RF power into suitable shaped cavities. This approach to assess these forces uses the GEM theory where it is assumed the Poynting Vectors of the applied RF power acts upon a background Poynting Flux against the gravity field of the Earth. This analysis implies that the observed force loss is an effect upon the gravity (g) field of the Earth. This hypothetical premise assumes that quantum gravity is part of the space-time manifold which is constantly fluctuating, a quantum ZPF (Zero Point Fluctuation) and that what we perceive "space-time" is merely as smooth and steady of an average of these oscillations. The GEM theory predicts that we can change the steady state Poynting fields associated with Gravity via a GEM-derived "Vacuum Bernoulli Equation" similar to the Bernoulli Equation of aerodynamics. This preliminary analysis provides the basic equations and assumptions of the GEM theory of the Q-V thruster laid out with a simple calculation to explain the forces and their scaling with applied power. Approximate agreement as to the magnitude and scaling of the observed forces seen with force predicts a power ratio of ~0.2μN/W.

I. Introduction

The Q-V Thruster[1] appears to create a force due to an interaction between applied RF power and the vacuum itself, within a specially shaped container. A conceptual model has been proposed based on an interaction between the RF and virtual particles whose presence is required by quantum theory. The thrust detected by the device being a reaction force to momentum is transferred to the virtual particles. Two problems are present in this model, one is the global conservation of momentum and the other is the problem of the divergence-free nature of the

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vacuum EM field that would seem to preclude transfer of momentum to the virtual particles. However, both of these problems can be solved by considering that the Q-V thruster and other similar devices are exchanging momentum directly between EM fields and space-time itself. This effect occurs in the GEM^2 theory because, in that theory, the fabric of space-time itself is electromagnetic and EM fields can interfere constructively and destructively to change the structure of space-time. In this brief manuscript, the basic GEM theory will be presented and its application to the Q-V thruster to explain the origin of the measured forces with their approximate magnitude and scaling with applied power will be discussed.

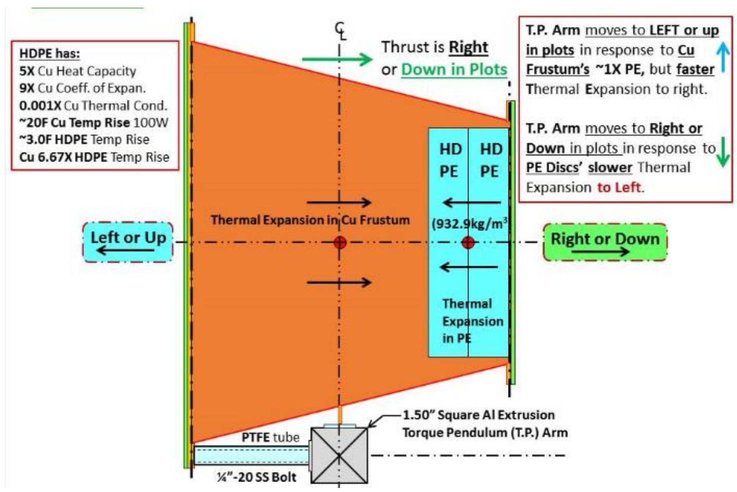


Figure 1 The Frustum of the Q-V Thruster

II. The GEM theory and the Vacuum Bernoulli Effect

The Poynting vector is a fundamental quantity in EM theory and transports momentum and energy in EM fields. For example: a beam of light travels through space-time as a transverse electromagnetic wave expressed as the Poynting vector ***S*** as:

$$S = \frac{E \times B}{\mu} = E \times H \tag{1}$$

This operation propels fundamental information about the elementary perturbation of space-time across the universe. The ***E*** and ***B*** fields expressed above are shown through the fundamental Poynting vector equation to be coupled at the point where the Poynting vector exists and couples to particles and space-time.

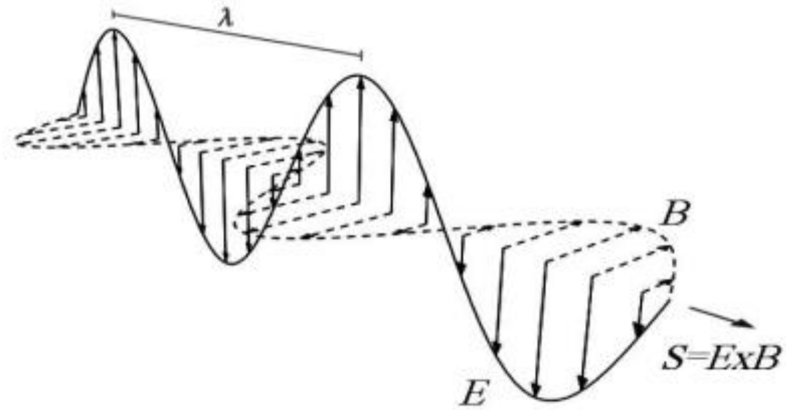


Figure 2. components of a transverse light wave noting the propagation due to the Poynting vector.

The Poynting fields around the "Morningstar Energy Box" [3]device can be visualized as seen in Figure 3 and are in the form of generating an electromagnetic vortex. Following our fluid concept of space-time, we can imagine that since the fluid space-time is stationary far away from the center of the Poynting vortex. A velocity gradient must exist, such velocity gradients lead to turbulence when they exceed a small threshold as is seen in everyday fluid flows. Added to this effect is the nonlocal nature of the wave functions of the particles, which sample the Poynting field at many locations at once, and thus do not see the vortex as a coherent entity but as a collection of interactions. So we can assume that the quantum mechanical matter waves will experience the Poynting vortex as a source of turbulence.

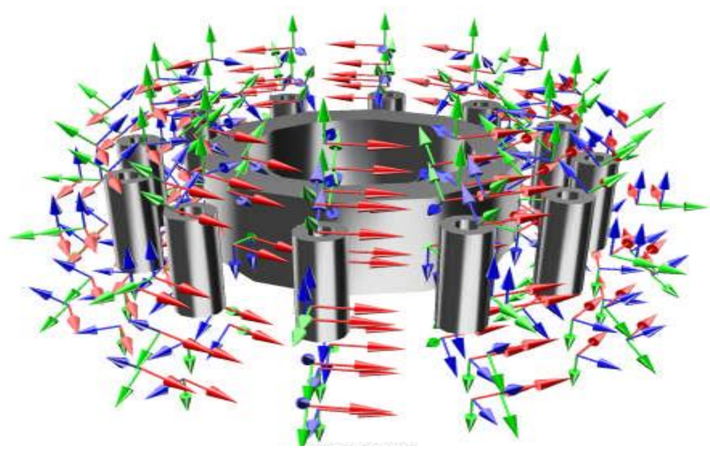


Figure 3. The electromagnetic fields surrounding a rotating "energy box" array of magnets. Magnetic fields are shown in blue, electric fields are shown in green, and the Poynting vector is shown in red. Note that the Poynting vectors form a vortex pattern.

This intersection of fields is expressed in the Murad-Brandenburg equation, a Poynting conservation equation, which treats the Poynting vector field as a wave field and away from its sources can be written:

$$\mu_0 \left[\frac{1}{c^2}\frac{\partial^2 \bar{S}}{\partial t^2} - \nabla^2 \bar{S}\right] = 0 \tag{2}$$

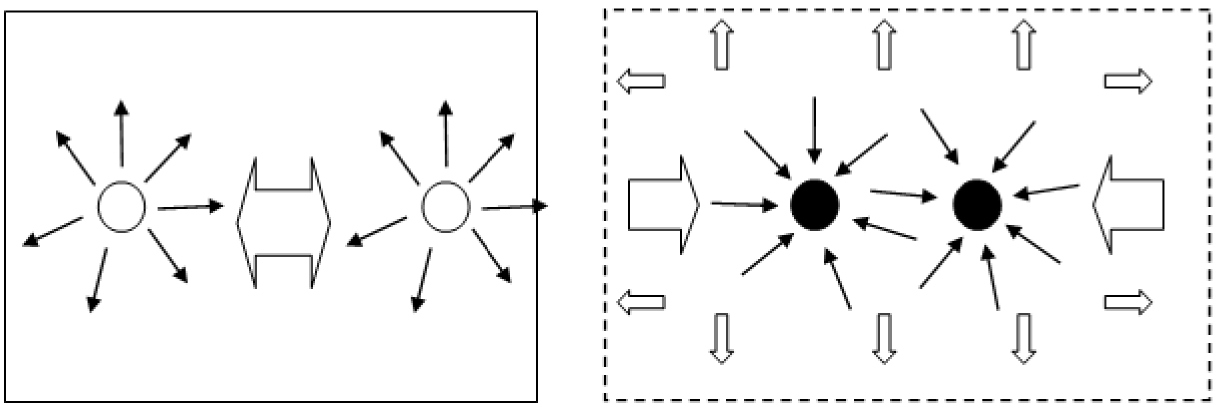
When near field source terms are included we have:

$$\left[\frac{1}{c^2}\frac{\partial^2 \bar{S}}{\partial t^2} - \nabla^2 \bar{S}\right] = \nabla\cdot\left[\varepsilon_o EE + BB/\mu_o\right] + \nabla\times\nabla\times\bar{S} \tag{3}$$

where it can be seen the vorticity of the Poynting vector: $\nabla\times \boldsymbol{S}$, is prominent.

Away from sources, Poynting fields can be considered as a chaotic sum of waves, moving through each other. The Murad-Brandenburg Equation is a result of standard EM theory but we can move beyond this theory to extend this with the GEM (Gravity Electro-Magnetic) theory.

The GEM theory[2] is a combination of the Sakharov theory of gravity as consisting of radiation pressure. That is, gravity fields are an array of *ExB* drifts arising from the quantum ZPF (Zero Point Fluctuation), and the Kaluza-Klein theory of EM gravity unification by a hidden 5th dimension.



Two bright objects in dark box repel each other Two dark objects in a bright box attract each other

Figure 4. The Sakharov model of gravity.

It provides basic mathematical results with:

$$\ln\left(\frac{m_p}{m_o}\right) = \frac{\alpha^{-1/2}}{e}\ln\sigma \tag{4}$$

And

$$\left(\frac{m_p}{m_e}\right)^{1/2} = \ln\left({r_o}/{r_P}\right) = \sigma \tag{5}$$

Where r_o is the hidden dimension size, $r_p = [G\eta/c^3]^{1/2}$ is the Planck length, and σ =42.8503 is a parameter relating the electron and proton masses. This model also leads to the fundamental relations:

$$\ln\left(\frac{r_o}{r_P}\right) = \left({m_p}/{m_e} \right)^{1/2} = 42.8503 \qquad (6)$$

This can be inverted to yield the formula for the Newton Gravitation constant:

$$G = \left({e^2}/{m_p m_e} \right) \alpha\, exp(-2\sigma) = 6.6684 \times 10^{-8} dyne - cm^2 gm^{-2} \qquad (7)$$

Which is within 1 part per thousand of measured value for *G*. And from Eq. 4 we find the proton mass from the vacuum:

$$\frac{m_p}{M_P} = \left[ln\left(\frac{r_o}{r_P}\right)\right]^{-\alpha^{-1/2}} = 1.713 \times 10^{-24} g \qquad (8)$$

This result is within 2% of the measured proton mass of 1.67 $\times 10^{-24}$ g. This demonstrates the importance and accuracy of the GEM theory.
Looking at the Poynting vector:

$$S = \frac{E \times B}{\mu} = E \times H \qquad (9)$$

$$S = \frac{E \times B}{\mu_0} \qquad (10)$$

Now the *E*×*B* drift will move all charged particles at the same speed and can be written in terms of *S*. For a vacuum we have, with u_o as a steady state magnetic field energy density, the *E*×*B* drift velocity:

$$V = \frac{E \times B}{B^2} = \frac{S}{B^2 / \mu_0} = \frac{S}{2u_o} \qquad (11)$$

This *E*×*B* velocity depends only on the ratio *E/B* and not on the mass of the particles affected or their charge. As a practical matter, the particles only assume this *E*×*B* motion after a cyclotron period, but we assume they are all “up to speed.” We can adopt the physical model that *E/B* is the speed of the quantum vacuum since it obeys the equivalence principal and effects all masses the same. This means we can assume all the quantum particles appearing and disappearing from Heisenberg Uncertainty move at this rate. We can keep the magnetic field constant and create a gradient in the E field by tilting the plates relative to each other while keeping the E field everywhere normal to the B field as seen in Figure 5. This model has been tested and verified with a particle simulation code for the curvature E and B field configuration and the results are shown in Figure 6.

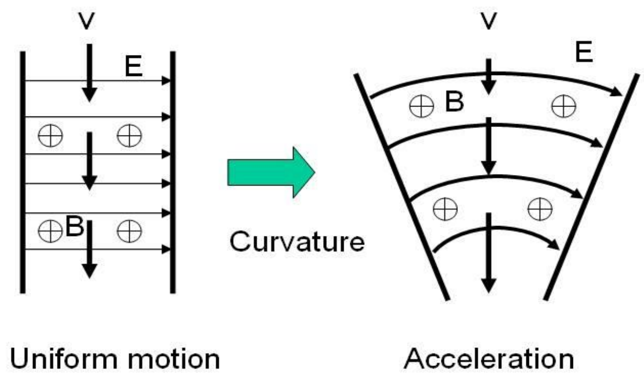


Figure 5. Motion of charged particles in cross *E* and *B* fields, with *E* vector formed between charged plates and *B* vector coming out of the paper. In the second case using tilted plates the charged particles accelerate. Velocity for all particles is the same regardless of charge or mass.

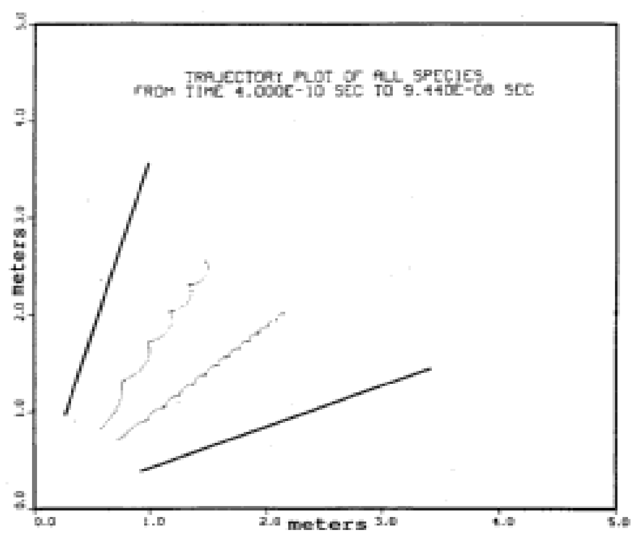


Figure 6. A Particle code simulation of the *ExB* drift gravity model showing an electron and a 10x electron mass positron

When this model of EM gravity is combined with Poynting's theorem, the Kaluza-Klein action falls out as a conserved quantity and can be called the VBE ("Vacuum Bernoulli Equation") [4] A brief version of it derivation shown below. We assume $B^2/2\mu_o$ is constant and vary E in time, then the charged particles will all accelerate at the same rate:

$$\dot{V} = \frac{\dot{E} \times B}{B^2} = \frac{\dot{S}}{2u} \qquad (12$$

We can also write form Newtonian gravity theory with gravity vector field g, where *G* is Newton's gravity constant

$$\nabla \cdot g = -4\pi G \rho \qquad (13)$$

Where we assume $E = mc^2$ and so an EM energy density can form a mass density as a source for a gravity field. This density becomes:

$$\rho = \frac{u}{c^2}, u = (\varepsilon_o E^2 / 2 + B^2 / 2\mu_o) \qquad (14)$$

This means when EM energy flows into a spherical region from all sides, gravity vectors pointing into the region increase in time so that, for the case of a spherically symmetric region, we have:

$$\nabla \cdot \dot{g} = -4\pi G \dot{\rho} = -4\pi G \nabla \cdot S / c^2 \qquad (15)$$

Where both vectors can generate an additional vortex-like field $F = \nabla \times A$ that include curls of a vector potential.

For the simplest case of no "curl fields" we have

$$\frac{\dot{g}}{4\pi G} = \frac{S}{c^2} \qquad (16)$$

$$\frac{\dot{g}}{4\pi G} \cdot g = S \cdot \frac{\dot{S}}{2u_o c^2} \qquad (17)$$

$$\frac{g^2}{4\pi G} = \frac{S^2}{2u_o c^2} \qquad (18)$$

$$\frac{g^2}{2\pi G} - \frac{S^2}{u_o c^2} = 0 \qquad (19)$$

This is the VBE expression we get from the Kaluza-Klein Action in the Newtonian limit, with $\langle E \bullet B \rangle = 0$ in the vacuum, that is, a vacuum made of EM waves.

$$Kaluza - Klein \quad Action = \frac{R}{16\pi G} - \frac{F^{\mu\nu}F_{\mu\nu}}{4} \Rightarrow \frac{g^2}{2\pi G} - \frac{S^2}{u_o c^2} = 0 \quad , \tag{20}$$

Therefore, the same $E\times B$ drift theory of gravity is also the basis for the coupled equations of General Relativity and Electromagnetism.

The Vacuum Bernoulli Equations says that gravity fields are associated with a net Poynting Flow in the vacuum. Therefore, we can change the local gravity field by changing the Poynting fields.

Now we perturb the Poynting flow with a new an artificial Poynting flow, in the case of the Q-V thruster, created by the applied RF field. This perturbing flow is at right angles to the main Poynting flow and assumed of equal magnitude and is due to photon-photon scattering[5], a commonly observed phenomena so the two flows can have a constructive interference term $dS \bullet S_\perp \approx |dS||S|$

$$\frac{dg \bullet g}{2\pi G} = \frac{dS \bullet S}{uc^2} \tag{21}$$

$$\frac{|dg|}{|g|}\frac{g^2}{2\pi G} = \frac{dS \bullet S_\perp}{|S^2|}\frac{S^2}{u_o c^2} = \frac{|dS|}{|S|}\frac{S^2}{u_o c^2} \tag{22}$$

$$\frac{|dg|}{|g|} \cong \frac{|dS|}{|S|} \tag{23}$$

Now since we can assume each Poynting or $E\times B$ flow S is a "flow of the vacuum" and all it contains, and that it is a continuous flow field we can perturb the flow fields as though they are of comparable under-lying energy. We will assume the flow rate of the vacuum at the Earth' surface to be the escape velocity $V_{esc} = 1.1 \times 10^{4}$ m/sec, since that is the velocity of a particle falling from outer space. We will call this the assumption that "all vacuums are weightless," which is an extension of the equivalence principle to the vacuum itself, and says we can combine their *ExB* flows.

II. The Newtonian Gravity Potential

We have then for perturbing fields and a gravity potential in terms of an $E\times B$ 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. Here we use esu units for electromagnetic quantities:

$$< g_{00} > = -1 - 2\phi / c^2 \quad = \frac{E^2}{E^2 - B^2} \quad , E^2 = \quad E_0^{\ 2} \, or \, E_1^2 \tag{24}$$

$$-1 - 2\phi / c^2 = -1 - \frac{E_1^2}{B^2} \tag{25}$$

$$\frac{\partial V_D}{\partial t} = V_D \frac{\partial V_D}{\partial x} = \frac{E}{B} c \frac{1}{B} \frac{\partial E}{\partial x} c \tag{26}$$

We now consider the mechanisms of how gravity arises from our $E \times B$ drift model and the interaction of charged particles with the quantum vacuum. We obtain the Newtonian potential as the perturbing E electric energy density divided by the powerful ZPF magnetic field:

$$\phi = \frac{1}{2} \frac{< E_1^2 >}{B_o^{\ 2}} c^2 \tag{27}$$

Note that this is expression for the gravity potential.

We can now proceed approximately with the derivation of the Newtonian potential from the GEM model of gravity potential shown in Eq. 25 as an array of $E \times B$ drifts.

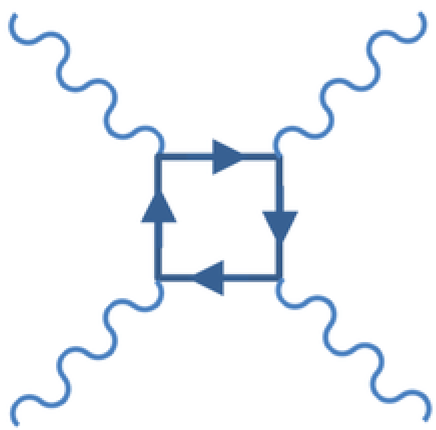


Figure 7. A Feynman diagram of photon-photon scattering, a well-known process in the quantum vacuum.

According to the Standard Model all massive particles, electrons and quarks making up ordinary matter, are charged point particles. These charged particles all move freely in the presence of the ZPF fields of the quantum vacuum. It has been pointed out by Puthoff [6] that under the Standard Model even the quarks, making up the moves freely because of the phenomenon of "Ultraviolet Freedom" and hence their interaction with the quantum vacuum can be considered in isolation. All these free charged particles are in constant motion, or "Zitterbewegung" or quantum jitter because of their accelerated motion must radiate as discussed by Puthoff. The radiation field is irregular, but statistically isotropic, the radiation E field is normal to the radiation direction coming from the particle and decays as 1/r, where r is the distance from the particle. This radiation field constructively interferes with a portion of the ZPF that is isotropic and uniform to surround the particle resulting in an electric field energy density. It is this electric energy density that forms the numerator of the fraction shown in Eq. 25. The magnetic energy density of the ZPF is the denominator of the fraction. Using our expressions for the classical radius of a charged particle, the Planck length and writing G as $G= c^4/ (T_o r_P^2)$ as from Eq. 27, we can write, using $B_o^2=T_o$

$$\frac{1}{2}\frac{E_1^2}{B_o{}^2}c^2 = \frac{Gr_P^2}{2c^4}E_1^2 \tag{29}$$

The particle radiating because of its motion the ZPF creates an electric field stress on the surface of a sphere of radius r, centered on the particle, and is proportional to the radiated power of the particle, where a is the acceleration of the particle.

$$4\pi r^2 \frac{E_1^2}{8\pi}c = \frac{2}{3}\frac{e^2}{c^3}a^2 \tag{30}$$

This expression limited to $a<c^2/r_c$, where $r_c = e^2/mc^2$ is the particle classical radius in esu units. We limit the acceleration to the value $a=c^2/r_c$, and obtain, upon simplification.

$$E_r^2 = \frac{4}{3}E_c^2\frac{r_c{}^2}{r^2} \tag{31}$$

Where $E_c = e/r_c^2$, the electric field at the classical particle surface. We then write the mean constructive interference term between the particle radiation and the background ZPF fields where $E_o = q_P/r_P^2$ takes into account the geometrical variations and time fluctuations, and obtain approximately:

$$< E_r \sin 2\pi t > \cong \frac{1}{2\pi}E_r \tag{32a}$$

From this expression we then obtain:

$$< E_r E_o > \cong \frac{1}{2\pi}\left(\frac{4}{3}\right)^{1/2} E_c \frac{r_c}{r}\frac{q_P}{r_P^2} \tag{32b}$$

Gravity fields arise in the GEM theory from the constructive interference of the action of the ZPF:

$$\frac{1}{2}\frac{<E_r E_o>c^2}{B_o^2} \cong \frac{c^2}{2\pi}\left(\frac{4}{3}\right)^{1/2}\frac{e}{r_c}\frac{1}{r}\frac{q_P}{r_P^2}\frac{Gr_P^2}{c^4} \tag{33}$$

Using the expression for the Planck charge $q_P = e\alpha^{-1/2,}$ where α is the fine structure constant, we simplify Eq. 30 and obtain:

$$\frac{1}{2}\frac{<E_r E_o>c^2}{B_o^2} \cong \frac{\alpha^{-1/2}}{4\pi}\left(\frac{4}{3}\right)^{1/2}\frac{Gm}{r} \tag{34a}$$

$$\frac{\alpha^{-1/2}}{4\pi}\left(\frac{4}{3}\right)^{1/2} = 1.07 \tag{34b}$$

$$\frac{1}{2}\frac{E_1^2}{B_o{}^2} \cong \frac{Gm}{r} \tag{34c}$$

Thus, the Newtonian gravity potential can be recovered, to within factors close to one, from a physical model of *ExB* drifts of particles in a combination of the fluctuating fields of the particles radiation in response to the ZPF and fibrous magnetic flux and fluctuating *E* fields of the ZPF. The presence of the charged particle breaks the symmetry of the spacetime and causes a 1/r electric field energy density to form. The gravity force is thus not a steady force on an individual particle but an average acceleration in this model. The weakness of gravity, caused by the smallness of G, is due to the strong nature of the ZPF magnetic fields, the 1/r dependence of the potential stems from the 1/r dependence of the radiation fields of the jittering particle, constructively interfering with the uniform background of the ZPF electric field fluctuations. These effects are, of course very small, however, the radiation fields inference terms are independent for each particle and can add, causing the gravity force to combine in large ensembles of particles in a way that the pure EM force cannot. The gravity force can thus be said to be the result of the statistical mechanics of the fields of charged particles interacting with the vacuum around them, and combining in large ensembles.

Let us assume in the frustum that the EM waves follow the pattern of the simulations and create a concentration of field near the large end of the frustum. We will assume here, as in our derivation from the principle of a massless vacuum of Eq. that the magnetic field need not be that of the EM waves but is a magnetic field from the ZPF.

$$\phi = \frac{1}{2}\frac{<E_1^2>}{{B_o}^2}c^2 \tag{35}$$

Using the model of the gravity potential as created by a gradient of E^2 in a uniform background B field we find that the inclusion of plastic disks in the small end of the frustum suppresses the E field in that region. Thus the region near the wide end of the frustum has much more E field than the small end even without plastic dielectric disks, but that the inclusion of the disks in the small end will amplify the E^2 gradient. In the GEM theory this will create a curvature of space-time creating a gravity field pulling on the large end of the frustum and thus pulling the frustum towards the small end.

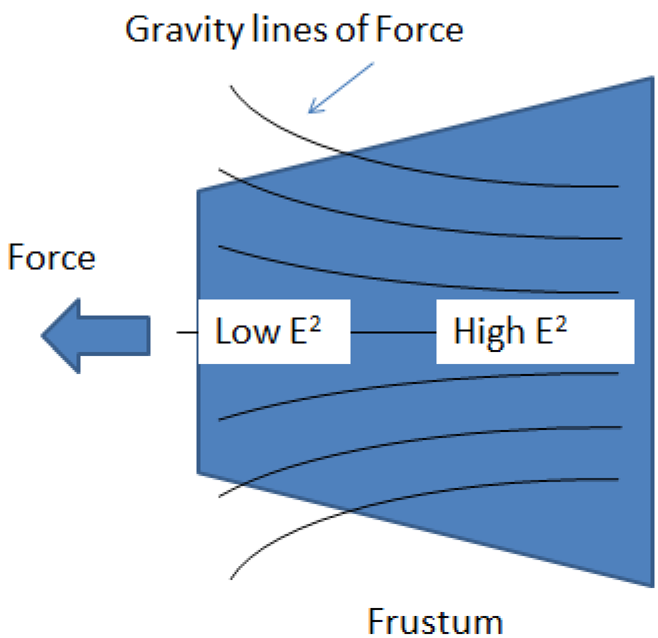


Figure 8. The gradient of E^2 caused by the standing EM fields in the Frustum create, via the GEM theory a curved metric and thus a net gravity force on the Fustrum .

We can estimate the magnitude of the force via the GEM theory by using the vaccum Bernoulli equation.

IV. Action-Reaction and Momentum Conservation in the GEM theory of the Q-V Thruster

In a normal plasma thruster, real particles are accellerated by EM fields to depart the thruster and this gives a reaction force in agreement with Newtons' 3rd law of motion. The reaction force accelates the thruster and the spacecraft it is attached to will give an equal and opposite momentum to the exhaust. If we did not use plasma but merely radiated microwaves out of an open metal vessel instead, this would also give a reaction force, howbeit a small one per unit of power expended because the EM waves carry momentum via the Poynting vector. However, by standard EM theory, if the metallic vessel is closed the EM waves cannot escape and instead bounce around in the vessel exchanging no net momentum with the walls, thus producing no net Poynting flow and thus no thrust. However, standard EM theory must be modified to include GEM effects, the fact that spacetime is electromagnetic and thus can carry momentum itself. In the case of the Frustum, the intense EM fields inside can modify spacetime, inducing a space-time curvature, and thus create gravity fields that create a net force on the Frustum. Interpreting this thrust as a reaction force, where is corresponding action? Stated differently: what then is this a reaction force to the force on the Frustum and if it freely accellerated in space? Where would the momentum be that balanced its accleration? The answer from the GEM theory is that the force on the frustrum occurs by Eq. because of the GEM interaction with the gravity field (curved spacetime) of the Earth and thus the Frustrum is pushing against the Earth via its gravity field. By this analysis, a spacecraft propelling itself by a Q-V thruster away from the Earth would cause the Earth to recoil. This is because gravity fields, even in the Newtonian limit, transfer momentum like EM fields.

A simple example of gravity fields exchanging momentum with EM fields is the bending of light by gravity fields. Obviously, the momentum carried by the light ray is changed, the global momentum flow is then to deposit the reaction to this exchange of momemtum to the mass creating the spacetime curvature.

V. The Thrust Versus Power Relation

To complete this calculation we need to estimate *S* in the gravity field at the Earth's surface. The GEM theory says that gravity is essentially an EM interaction at the subatomic scale and so we can write the gravity force acting on each nucleon as a radiation pressure acting on an EM cross section that is proportional to mass. The GEM theory allows us to write for a nucleon in the Earth's gravity field:

$$P_{EM}\sigma_n \cong m_n g \qquad (36)$$

Where $\sigma_n \cong 10^{-26}$ cm^2 is the EM cross section of a nucleon, similar to the Thompson cross section of an electron and m_n is a typical mass of 1 amu =1.7 x 10^{-24} g. This model is aided by the fact that nuclear matter occupies a fixed volume per unit mass, so individual nucleons preserve their size in a nucleus:

$$P_{EM} \cong (m_n / \sigma_n) g \qquad (37)$$

The mass per unit area is then $m_n/\sigma_n \simeq 50$g/cm^2 or 500kg/m^2, surprisingly similar to macroscopic matter. Using g at the Earth' surface we obtain $P_{EM} \simeq 5\times10^3$ J/m^3

Outer space vacuum is thus arriving at V_{esc} =1.1x 10^4m/sec and we can write:

$$S = P_{EM} V_{esc} \cong 6\times10^7 W/m^2 \tag{38}$$

The perturbing Poynting flux , which we assume is asymmetrically absorbed in the wall nearest the field concentration, on the large end of the frustum (area approximately 0.1m^2) is approximately *P/A* =500W/m^2 . Thus, under this interpretation of the GEM theory, we can write for the steady-state perturbation of space time curvature due to the asymmetric S field in the thruster as a perturbed gravity field acting on the mass of the frustum : of approximately 0.1kg as the thruster force.

$$F_{QV} \cong m_{QV}\, g \frac{dS}{S} \cong 1\times10^{-5} N = 10\mu N \tag{39}$$

We can also write this force as a function of applied RF power.

$$\frac{F_{QV}}{W} \cong \frac{m_{QV}\, g}{AS} \cong 2\times10^{-7} N = 0.2\frac{\mu N}{W} \tag{40}$$

In approximate agreement with the experimental results of F_{QV}/W = 0.7μN/W.

Therefore, the results of the Q-V thruster experiments and other similar experiments can be explained through the GEM theory. This GEM model is somewhat primitive, but can be refined with the help of more experimental data. The GEM interpretation appears much different than the Quantum virtual plasma model of the Q-V thruster but is actually very similar. Both models assume a reaction mass tied to the vacuum itself. In the case of the GEM theory, that vacuum is spacetime itself and is tied to the Earth and others nearby masses. In the case of the Q-V theory, it is the virtual particles that are part of the quantum vacuum, and must close the momentum transfer equation by transferring momentum through spacetime to nearby masses.

VI. Conclusions

The GEM theory predicts that gravity fields are a distortion of the quantum ZPF fields and have a net Poynting flow. That is, the fabric of spacetime is electrodynamic, consisting of ZPF fields. This theory also predicts that we can change the Poynting flow associated with gravity by constructive and destructive inference between the ZPF and artificially applied Poynting flows. Thus, in the GEM theory Poynting flows can create artificial curvatures in the ZPF and by this curve spacetime creating local gravity fields that can create forces on a spacecraft or its components. The reaction force to this created force is felt by spacetime itself and transferred to the nearby astronomical masses such as the Earth. This is similar to the bending of light, an EM field, in a gravity field where EM momentum is exchanged with the gravity field. Therefore, the application of EM Poynting field in carefully controlled geometries can, in the GEM theory, create gravity forces. This preliminary analysis suggests the frustum experiment at Eagleworks may be creating forces by bending spacetime, and the GEM theory allows the calculation of magnitude and scaling behavior to be made, and gives approximate agreement with what is observed.

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