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Article

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The transition dynamics and force constants of energy-bearing warped-space mediator structures

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Summary

A comprehensive description or model of "matter in the universe" at the fundamental level, which improves on the "Newtonian r^{-4} gravitational force model" (mathematically has an infinity at r = 0 labelled a singularity), is proposed. Matter and force concepts are to be replaced by more "ab initio" or "first principle" energy-producing, Geometry-based, structural modeling concepts. We have developed a description of matter as a "distorted or warped, non-flat and therefore energy-dense geometric" structure, a geometric-mimic of matter's defining physical characteristics, formulated from a solution of Riemann's geometric equations with both an Electromagnetic (EM) and Gravitational coupling-constant) (see Supplementary Information below).

The geometric equations describing the “local region in examination”, a region extending to the “local-origin- r” = 0 since no “matter stress-energy-elements” are present, are the 3-dimensional, static, spatial, “Riemannian geometric-curvature equations ($1/r^2$ or $1/r$ by definition)” [1, 2(pp 264)]. By expressing these geometric-curvature elements (using a spatial 3-dimensional (stationary) spherical-coordinate system with indices (index 1 ≡ radial index r, index 2 ≡ azimuthal index θ and index 3 = azimuthal index ϕ) in “energy-density” form by applying a “stress-energy coupling-constant” (classically a gravitational coupling-constant has been used), we produce a geometrically-based, 3-dimensional, spatial version of the Riemannian “energy-density (matter)” tensors (Joule/meter^3)] as a description of the “stressed” region of space.

The model is essentially the “Curved empty space as the building material of the physical world” supposition of Clifford [3] in 1876 and is the conceptual basis for this “distorted-geometry” modeling. Such a geometric description of localized warping or distorting of the spacetime manifold would seem to constitute a “first-principle” model of the universe achieved only by ascribing to the spatially-distorted (warped) region a “material”, or “distortable”, characteristic.

This work describes a geometrically warped (or distorted) region of space as an energy-mimic of matter and in a particular form as the “energy-transition mediator” structure [Mediator particles or Force_carriers] in “fundamental-particle energy-transformation processes”, which is a “theoretically-posited intermediate form (a 3rd

-phase or intermediate stage formed after the starting stage and before the final-stage structure)", and is a transitory fundamental-particle structural-form such as the W-boson in the beta-decay-process for example.

Quoting the above "Mediator particles or Force carriers" encyclopedia entry, "In quantum field theory, force carriers or messenger particles or intermediate particles are particles that give rise to forces between other particles. These particles are bundles of energy (quanta) of a particular kind of field. There is one kind of field for every type of elementary particle. For instance, there is an electromagnetic field whose quanta are photons. The concept is especially important in particle physics where the force carrier particles that mediate the electromagnetic, weak, and strong interactions are called gauge bosons."

A black-body emission-based energy-transition dynamics to describe the transition process is postulated and presented.

At The International Congress for Logic, Methodology, and Philosophy of Science in 1960, Wheeler [4] began by quoting William Kingdon Clifford's [3] "Space-Theory of Matter" of 1876 and stated "The vision of Clifford and Einstein can be summarized in a single phrase, 'a geometrodynamical universe': a world whose properties are described by geometry, and a geometry whose curvature changes with time – a dynamical geometry."

Although these authors were trying to include motion and therefore time dependence in their considerations, the present work and modeling is restricted to local-regions which can be modelled with time-independent, or static-only, spatially-dependent metrics and energy-density tensor entities.

Similar "static-modeling" was accomplished by Schwarzschild [5](also see Tolman [2, p245] and see the Wikipedia entry [https://en.wikipedia.org/wiki/Schwarzschild_metric]) which is quoted here in this regard: "In Einstein's theory of general relativity, the Schwarzschild metric (also known as the Schwarzschild solution) is an exact solution to the Einstein field equations that describes the gravitational field outside a spherical mass, on the assumption that the electric charge of the mass, angular momentum of the mass, and universal cosmological constant are all zero. The solution is a useful approximation for describing slowly rotating astronomical objects such as many stars and planets, including Earth and the Sun. It was found by Karl Schwarzschild in 1916."

Clifford's work, at least his conceptual"Curved empty space as the building material of the physical world" supposition, or the "Space-theory of Matter", predated Einstein's concepts and work on General Relativity by 40 years.

Additional work in this field continues, some of which is cited in references [6-11]. The present treatment departs from these cited "constructional methods" in that we do not constrain the warped-geometry descriptions to only gravitational-coupling-constant (G/c^4) produced structures.

The task or undertaking of the present work can be stated as follows; "{1} Construct the geometric description (equations) of a static, warped (distorted), spherically-symmetric, localized region of 3-dimensional space satisfying, or being characterized by, a material-like quality expressed as an "equation-of-state". {2} Solve said geometric equations and utilize the solutions, if possible, to try to mimic the physical descriptors (characteristics) of matter."

Riemann [1] has provided the basic mathematically-geometric equations to initiate this endeavor. Another quote from Wikipedia [Riemannian_geometry] reads "Development of Riemannian geometry resulted in synthesis of diverse results concerning the geometry of surfaces and the behavior of geodesics on them, with techniques that can be applied to the study of differentiable manifolds of higher dimensions. It enabled the formulation of Einstein's general theory of relativity, made profound impact on group theory and representation theory, as well as analysis, and spurred the development of algebraic and differential topology."

The mathematical rendering of the spatial (3-dimensioal) "stress-energy-density" equations (energy-density geometric-equations describing the warped spatial region), as produced by applying a forcing-function or "geometry-to-physical-energy" translation (a coupling-constant in meters per Joule) to the "Riemannian-geometric-curvature equations" [a mathematical description of multi-dimensional (1,2,3,4….) geometric manifolds (also used in general relativity modeling as detailed above)], are applicable for 3-dimensional spatial static (no time-dependent motion or time-dependent characterization) systems. The Riemannian equations are applicable for time-dependent 4-dimensional systems as well as for 2-dimensional systems, and, in the present rendition with the “distinctively-generated metrics, [Supplementary Information equations (SI-4) through (SI-9)]”, successfully produce an excellent mathematical-representation, ($1/r^4$), of Newtonian gravitational ($1/r^4$) and electromagnetic ($1/r^4$ and $1/r^6$) energy-density-formulated (think pressure) physical phenomena.

The present resulting geometric description of matter (mass-energy) successfully mimics the classical-physics electromagnetic (EM) and gravitational-field models at large radii of the distorted (warped) region, or energetic-matter region, but the distorted-geometry-regional equations (a description of these same classical forces) depart significantly from Newtonian $1/r^4$ behavior at small radii (an infinity at $r = 0$) and thereby produce a magnetic-field (spin) matter-mimic as well as a weak-field matter-mimic (beta decay and the Fermi-constant, a force-constant which describes the magnitude of the strength of the weak fields); a strong-field mimic is also mathematically-manifest without an infinity at the origin. There are no infinities or singularities, which are the undesirable hallmarks of pure classical Newtonian and electromagnetic physical models of matter, in these presently, geometrically-constructed, structural models [12].

Classically, physical forces have been characterized as independent entities, each with an associated strength (force constant), a Newtonian gravitational-force, an electromagnetic (electric and magnetic)-force, a weak-force describing the physical phenomenon of beta-decay and a strong-force describing short-range-repulsion effects. These forces are all manifested in the mathematical attributes (force-characteristics or force-constants) of this ONE distorted-geometric form (the solution to the Riemannian geometric tensor equations $\mathbf{Td_4^4}$,$\mathbf{Td_3^3}$, $\mathbf{Td_2^2}$ and $\mathbf{Td_1^1}$), that is, the "metric-solution",

$$\mu'(r) = \frac{2}{(Iu + R0\ C1)\ \mathbf{f(r)}}\frac{u^2}{R0} = \frac{2(1 - u^3)}{(Iu + \gamma)}\frac{u^2}{R0} ,$$

where R0 is a "distortion-describing" radius and $Iu(u) = u\left[-1 + \frac{3}{4}u^3 - \frac{3}{7}u^6\right]$; $u \equiv \frac{R0}{r}$.

The geodesic equation for this spherically-symmetric geometry is

$$ds^2 = g_{11}[\ dr^2 + r^2 d\Omega\ ] + g_{44}dt^2 = -\ e^{\mu}[\ dr^2 + r^2 d\Omega\ ] + e^{\nu}dt^2.$$

The "metric-solution" μ' is further expressed fundamentally in the tensor energy-density (pressure) elements $\left[(\mathbf{Fd_{14}})^2, (\mathbf{Fd_{mag}})^2 \ \mathbf{and}\ (\mathbf{Fd_{core}})^2\right]$.

The μ' "metric solution" satisfies the "Minkowski" requirement that the "Metric-element coefficient-functions must be consistent with $\mathbf{T_{\mu\nu} = 0}$ (empty spacetime in the vicinity of a source mass) and must approach 1 as r approaches infinity, to become the Minkowski metric in spherical coordinates (the metric should be asymptotic flat.)" This present "distorted geometry" "metric solution" satisfies the Minkowski requirement that

$$\mu'(r) = 0 \ \text{ at } \ r = \infty ,$$

and also intrinsically satisfies the condition that

$$\mu'(r) = 0 \text{ at } \ r = 0 ,$$

therefore no infinities (actually dictated by the tensor energy-densities; see SI).

This "particular form" of the metric quantity μ'(r) is the solution to the actual metric equation (SI-6d) generated by the "Maxwellian-like" and "material-like" tensor relationship expressed in equation (SI-4) taken from the SI:

$$\mu'' + \frac{f'}{f}\mu' + \frac{1}{2f}\left[(f - 3)(f - 1) + f \right] \mu'^2 + \frac{2\mu'}{r} = 0$$

with $\nu'(r) = [-2 + \mathrm{f}(r)]\mu'(r)$ (equation (SI-6a) from SI) and u ≡ R0/r . It should be understood that this equation is the fundamental, constraining or restricting and defining differential equation for the metric entity $\mu'(r)$. The metric is not arbitrarily defined, it must satisfy this differential equation in the context of, and as dictated by, the Riemannian geometric equations (SI-4) and (SI-5); see the SI Supplementary Information for details. The inclusion of an "equation of state" as an additional "necessary or constraining" descriptor of "the distorted space", in conjunction with the four Riemann tensor energy-density equations, produces the metric-defining differential equation (SI-6d).

We use the "Black Hole Distortional Extremum", (see "Black Holes as Geometric Distortional Extrema [13]" (a minimum hole mass) mass-energy" for calculating the "gravitational-interaction-strength" constant GG."

The geometrically-warped structure is constituted by a core-region within which the propagation-velocity, by virtue of the distorted-region metrics, is greater than c and exhibits a “partial light trapping phenomenon”, facilitating and duplicating “black hole” behavior. Warping or distorting our spatial-manifold requires energy but with limits as to the degree of distortion thereby predicting and describing fundamental-electromagnetic-particle structures as well as gravitational (dark-matter, black-hole) structures.

Abstract

It is shown in the present work that the distorted-space model of matter can describe conventional force-constants and transition-mediator structures. We use the verbiage “distorted” to communicate the concept of “energetic warping” to distinguish “spatial warping” from “classical matter warping”, although the concept of “matter” is in fact, in the present context, the “geometric distortion energy” of the spatial manifold itself without a classical “matter stress-energy source”. The “distorted-geometry” structures exhibit non-Newtonian features wherein the hole or core-region fields of the structures are energetically-repulsive (negative pressure), do not behave functionally in an r^{-4} manner and terminate at zero at the radial origin (no singularity). Near the core of the distortion the magnetic fields dominate the energy-densities of the structures thereby departing from classical particle-structure descriptions. Black-body and gray-body radiation-emission and structural modeling lead to a description of transition dynamics and photonic entities.

1. Introduction

Physical transition processes are presently mathematically represented in “quantum-mechanical-terms” as a manifestation of a “strength-of-interaction coupling-constant” operating on an “initial-state” wave-function particle-descriptor to produce a “final-state” different wave-function particle-descriptor; one particle transforms to another particle (a different energy-state) via the forces present at the transformation site. The actual physical description of the structural-changing dynamics is not part of these quantum-mechanical operational-mathematical renderings although an "intermediate-phase" mediator-structure [14] is envisioned.

The intermediate-phase mediator-structure in the beta-decay transition process, the conversion of a neutron into a proton, electron and a neutrino, is a W^-BOSON PARTICLE and the "strength-of-interaction" has been labelled "the Fermi-constant GF" after the physicist who successfully modelled this physical process. Since energetically such a massive particle would seem to pose an energy-conservation problem, an introduction of the Heisenberg principle is incorporated to constrain the "existence time interval" or lifetime of the mediator-structure; $\Delta t\ \Delta U \equiv \hbar/2$; $U \equiv$ energy and $t \equiv$ time,

We have also successfully and precisely modelled and mimicked this transition process in the "distorted-geometry" model of matter [12] as a product of boson mass-energy and boson physical-volume, a "geometric maximum-curvature condition" and a magnetic-field based (r^{-6}) distortion-energy, with structural details which are not forthcoming in present-day quantum mechanics, force-carrier-fields [14] notwithstanding.

2. Theoretical Foundations

Fundamental theoretical and mathematical foundations for this undertaking are presented in the Supplementary Information section.

3. Calculational Methods for Mediator Modeling

For the "distorted-geometry, maximum-curvature" model, precise to the mass-characterization of the W-boson (see equations $\mathbf{Fd_{mag}}^2$ and $\mathbf{Fd_{14}}^2$ in the SI),

$$\mathbf{Fd_{mag}}^2\, r^6\pi^4 = \frac{1}{8\pi\kappa} 2\ \mathrm{Rs}\ \mathrm{R0}^3\ \pi^4 = \frac{\pi^3}{2}\, m_w c^2\ \mathrm{R0_w}^3 =$$

$$\equiv \mathrm{GF(distorted\ geometry)} =$$

$$= \mathrm{GF(Fermi)} = 1.435851\ 10^{-62}\ \mathrm{Joule\ meters^3}\ . \qquad (1)$$

The energy-density for the $\mathbf{Fd_{mag}}^2$ (magnetic energy) component evaluated @ r = $\mathrm{R0_W}$ is

$$\frac{1}{2\pi}\, \mathrm{m_w c^2\ R0_w}^3\ \mathrm{R0_w}^{-6} = 2.87\ 10^{46}\, \frac{\mathrm{Joule}}{\mathrm{meter^3}}\ . \qquad (2)$$

The "distorted-geometry" mathematical symbols are

$$\kappa \equiv \kappa_{EM} + \kappa_G \cong \text{"}W_{boson}\ \text{coupling constant"} = \kappa_{EM} = \alpha\, \frac{\hbar c}{2} \left(\frac{Q}{3\ m_w c^2}\right)^2 =$$

$$= 6.93\ 10^{-13}\, \frac{\mathrm{meters}}{\mathrm{Joule}}\ \ (\text{for } Q = 3),\ \ (\text{since } \kappa_G \text{ is infinitesimal compared to } \kappa_{EM}),$$

$$\alpha = \text{fine structure constant}\,.$$

$$\hbar = \text{Planck's constant}\,, \qquad c = \text{velocity of light and } m_w = \text{boson mass}\,.$$

The distorted-geometry radial descriptor R0 is

$$R0 = \left(\alpha\,\frac{2}{3}\,\left(S\,\frac{ge}{2}\frac{Q}{3}\right)^2\right)^{1/3}\ \hbar c\ (mc^2)^{-1}\,, \tag{2a}$$

where S = spin quantity (S = 1 for the boson), ge = gyromagnetic ratio and Q = a quantized electric charge quantity (Q = 1,2 or 3 and Q = 3 for the boson), then,

$$R0_w = \left(\alpha\,\frac{2}{3}\right)^{1/3}\ \hbar c\ (m_w c^2)^{-1} \quad \text{and} \quad Rs_W = 2\,\kappa\, m_w c^2\,.$$

The energy-density structural nature of the 'distorted geometry" metric-solution [11] (Eq. (SI-7)),

$$\mu' = \frac{2(1-u^3)u^2}{(\mathrm{I}u - \gamma)R0}\,, \qquad u \equiv \frac{R0}{r}\,,$$

gives rise inherently and comprehensively to the fundamental force quantities (**Fd_{12} , Fd_{13}** , and **Fd_{14}),** heretofore characterized as independent entities; a weak-magnetic-force, an electric-force and a strong-force at the nuclear core. These force characterizations are here manifested as r^{-6}, r^{-4} and complex repulsive-core r^{-n} components of the "ONE geometric structure". The structure is a balanced internal/external high-energy-density configuration, the difference in internal-pressure vs external-pressure manifested as particle mass-energy. The magnitude of the structural energy-density descriptor function is determined by the mass-energy or geometric-curvature with a geometry-to-energy coupling constant (meters/Joule) also dependent on these physical characteristics; a constant coupling-constant component G/c^4 (G = gravitational constant = 6.67408 $(10)^{-11}$ $m^3/(kg\ sec^2)$) describes gravitational structures. The "distorted-geometry-solution (≡ DG)", is generated from Riemann's geometric description of a 4-dimensional spacetime manifold, applied at 3-dimensional localized warped- or distorted-space energy centers.

With the geometric success of mimicking the Fermi-constant as a particle-structure descriptor (the W^-boson), which is a "$\text{mass_energy} \times R0^3$" product and which is a magnetic-energy-density weak-force maximum and a geometric-curvature maximum (inverse dependence) [11], we posit gravitational, electromagnetic and strong (core)-force "strength-of-interaction-DG" constants as energy-density coefficients of the various r-dependent components of a DG W-boson structure.

However since such tensor-force ($(\mathbf{Fd_{14}})^2$, $\left(\mathbf{Fd_{mag}}\right)^2$ and $(\mathbf{Fd_{core}})^2$) entities are geometrically coupled entities, the classical "independently separable" model (**weak** plus e**lectromagnetic** (**EM**) plus **strong**) is not applicable. We instead use the energy-density maxima in the core region and in the extra-core region to establish the physical strengths (force constants) of the classical-differentiated force functions. To elicit a present-day mental-model (picture or understanding) of the "force" concept, one would actually need to determine or describe the physical-spatial-region of interaction, a mathematical-integration process. We use the "Black-Hole Distortional Extremum [13] (a minimum hole mass) mass-energy" for calculating the "gravitational-interaction-strength" constant GG. Note that the "gravitational coupling-constant, $G^*c^{-4} = 0.826\ 10^{-44}$ meters/Joule, is ~32-42 orders of magnitude smaller than the "EM (electromagnetic) coupling-constants" $8\pi\kappa_W$ or $8\pi\kappa_{electron}$.

4. Calculational Method for the W-boson mediator

The positive-pressure (positive energy-density) quantity, $(\mathbf{Fd_{14}})^2$(electric, $\mathbf{Q \neq 0}$), for the W^-boson, evaluated at the core-radius functional-extremum, is

$$\mathbf{Fd_{14}}^2(r^{-4} \text{ component}) = \frac{\mathrm{Rs}^2}{2}\frac{1}{8\pi\kappa}\frac{1}{r^4} = \frac{\hbar c}{8\pi}\,\alpha\,\frac{1}{R0_W{}^4} =$$

$$= \left(\frac{3}{2}\right)^{\frac{4}{3}}\left(\frac{1}{\alpha}\right)^{\frac{1}{3}}\frac{(m_W c^2)^4}{8\pi(\hbar c)^3}\ (\text{Joule/meter}^3)\,. \qquad (3)$$

The actual DG functional value at the energy-density maximum is

$7.64\ 10^{47}\ \frac{\text{Joules}}{\text{meter}^3}$ @ $r = 2.37\ 10^{-19}$ meters while the classical r^{-4} value is

$$\mathbf{Fd_{14}}^2(\mathrm{r}^{-4} \text{ component}) = \frac{\mathrm{Rs}^2}{2}\frac{1}{8\pi\kappa}\frac{1}{\mathrm{r}^4} = 2.89\ 10^{45}\ \text{Joules/meter}^3 \text{ @ r}$$

$$= 2.37\ 10^{-19}\ \text{meters},$$

illustrating the magnitude of the contribution to $\mathbf{Fd_{14}}^2$ from the r^{-6} and other r^{-n} components.

Similarly, the negative-pressure (negative energy-density) core-maximum (for a W-boson structure) is

$$(\mathbf{Fd}_{boson\ core})^2(\text{max @ r} = 1.46\ 10^{-19}\text{meter}) = \text{-2.51}\ 10^{48}\ \text{Joule/meter}^3 \equiv$$

$$\equiv \text{strong force energy density maximum} = 869\ \mathbf{Fd_{14}}^2(r^{-4}\ \text{component}) =$$

$$= 87.5\ \mathbf{Fd_{mag}}^2(r^{-6}\ \text{component})\ . \qquad (4)$$

These field quantities are displayed in Fig.1.

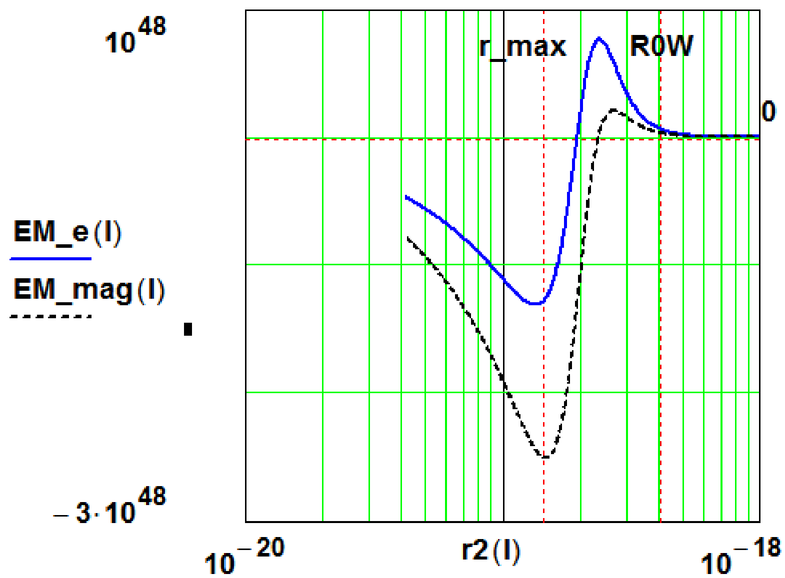

Fig.1. Distorted Geometry Electromagnetic Energy-Density (field) functions (**EM_e** for $\mathbf{Fd_{14}}^2$ and **EM_mag** for $\mathbf{Fd_{mag}}^2$) for the BOSONIC-mediator structure,

illustrating the ‘Strong-repulsive-force (is this gluon behavior?), Weak-force and Electric-force” components. The ordinate in Joules/meter^3 is displayed in logarithmic form and the abscissa, the structural-radii r2, in meters in logarithmic values.

From the “energy-emission dynamics” model in ref. [15], and using the “corrected form” of equations 11-21 (ref.[15] corrected in ref.[16]), we can model and calculate the “lifetime” of this boson-mediator structure as

$$\text{t(lifetime)} \stackrel{\text{def}}{=} \text{tf} = \frac{1}{c}\left(\frac{3\,U0}{4\pi\rho}\right)^{1/3} = \frac{R_{boson}}{c} \stackrel{\text{def}}{=} \frac{1}{c}\, R0_W = 1.387\ 10^{-27}\ \text{seconds}\,, \quad (5)$$

where U0 is the mass-energy of the “energy-emitting” body with a constant density ρ. The tf (lifetime) is approximately π/9 *Heisenberg time-interval , thereby satisfying the “transient-time requirement” for a “virtual” mediator-structure; the W^-boson “Heisenberg-lifetime” is $\Delta t \geq \hbar/(2\ U_{boson}) = 4.1(10)^{-27}$ seconds. The transition lifetime for the “DG” W-boson provides an explicit form for energy-transitions of “distorted-geometry” structures and supports the “constant-density” “mathematical-structure” of equation (5).

Environmental fields [17,18] not included in the structural modeling would influence this “lifetime” as, for example, the stability behavior of a neutron in or out of the presence of nuclear fields. This “energy emission” model is elaborated in the following section for the “electromagnetic-radiation-emission mediator”.

5. Calculational Method for the Neutrino structure

The “extremum” equation (1) can be rearranged to accentuate the geometric-structural elements giving rise to the “strength of interaction” quantity GF as follows;

$$\mathbf{Fd_{mag}}^{\mathbf{2}}\, r^6\pi^4 = \frac{1}{8\pi\kappa} 2\ \mathrm{Rs}\ \mathrm{R0}^3\ \pi^4 = \frac{\pi^3}{2}\, m_w c^2\, R0_w{}^3 =$$

$$\equiv \mathrm{GF(distorted\ geometry)} \qquad \text{or}$$

$$\frac{Q_w}{3\ m_w c^2} S_w \frac{ge_w}{2} = \left(\frac{3\ GF}{\alpha(\pi\hbar c)^3}\right)^{0,5} . \qquad (6)$$

We see then that the magnetic descriptors theoretically and mathematically allow for solutions describing extremum-structures other than the boson. Since the neutrino is dynamically fundamental to beta decay and the weak magnetic-field interaction, we ascribe to a neutrino structure, the extremum- magnetic characterization where, for example, using a neutrino mass [19-22] at 0.02 eV, an electric charge (≠0) is calculated at Q (neutrino) = $1.49(10)^{-12}$ (compared to Q =3 for the electron or boson (see equation (2a)) or Q (neutrino) = $7.46(10)^{-11}$ for a neutrino mass at 1.0 eV; such a charged neutrino structural description is presently not part of conventional (Q = 0) modeling, which however is experimentally not verifiable.

A structural configuration describing a “stable energy-density mimic of the electron” is described as

$$\frac{Q_{neutrino}}{3\,(M_{neutrino}c^2)^{6/5}}\left(S\,\frac{ge}{2}\right)^{2/5} = \frac{Q_{electron}}{3\,(M_{electron}c^2)^{6/5}}\left(\frac{1}{2}\frac{2}{2}\right)^{2/5} . \qquad (7)$$

Such a "stable" structure would exhibit a charge Q at $3.87(10)^{-9}$ for a neutrino mass-energy of 0.02 eV or $Q = 4.24(10)^{-7}$ for a neutrino mass-energy of 1.0 eV.

6. Calculational Method for the muon mediator structure

Electromagnetic "energy emitting structures" are classically modelled as arising from the energy-density quantities **EM_e** or $\mathbf{Fd_{14}}^{\mathbf{2}}$. We therefore write analogously to Eqn.(1),

$$\mathbf{Fd_{14}}^{\mathbf{2}}\, r^4 = \frac{Rs^2}{2}\frac{1}{8\pi\kappa} = M_{muon}c^2\frac{Rs}{8\pi} = \frac{2}{8\pi}\,\kappa_{EM}\,(M_{muon}\,c^2)^2 \;, \qquad (7a)$$

or

$$\frac{2}{8\pi}\,\kappa_{EM}\,(M_{muon}\,c^2)^2 = \frac{1}{8\pi}\,\alpha\,\hbar c \equiv GF_{EM}(\text{distorted geometry}) =$$

$$= 0.917957\;10^{-29}\ \text{Joule meters}^3\ \ (\text{independent of } M_{muon}).$$

7. Calculational Method for energy-transition dynamics and the photon structure

In reference [15], we modelled "energy emitting structures" via a "black body construct" realized at the mass-level of a "fundamental particle" with a mass-energy = Universe-mass-energy. Here we posit such a "radiation-energy emitting" structure to describe photon emission dynamics, an energy-transition process. The "Planckian (Stefan-Boltzmann emitting body) power and energy distribution function" is integrated over the infinite energy spectrum and modelled as a spherical entity with radius R;

$$\mathrm{P(Planckian\ thermodynamics)} = \frac{\mathrm{dU}}{\mathrm{dt}} = -(\sigma \mathrm{T}^4)\,\mathrm{A(r)} \quad \text{and} \quad \mathrm{A(r)} = 4\pi\,\mathrm{R}^2. \qquad (8)$$

With

$$\mathrm{U} = \text{the distortional mass energy @ constant density}(?) = \rho\,,$$

$$\rho_{\mathrm{geo\_boson}} \stackrel{\mathrm{def}}{=} \rho\mathrm{GF(DG)} = \frac{\mathrm{u0B}^3}{\mathrm{GF}}\left(\mathrm{MW}\,\frac{\pi}{2}\right)^2 = 1.687(10)^{47}\,\frac{\mathrm{J}}{\mathrm{m}^3}$$

and

$$\mathrm{Temp}_{\mathrm{geo\_boson}} = \left(\rho\mathrm{GF}\,\frac{\mathrm{c}}{\sigma}\right)^{1/4} = 5.46\,(10)^{15}\,K\,,$$

then

$$\frac{\mathrm{dU}}{\mathrm{dt}} = -\mathrm{c}(4\pi\rho)^{\frac{1}{3}}(3\mathrm{U})^{\frac{2}{3}} \quad \text{and}$$

$$\mathrm{U(t)} = -\frac{4\pi\rho}{3}\,(\mathrm{c\,t})^3 + \mathrm{U0}\,. \qquad (9)$$

Using the radial-zero value, u0B, of the $\mathbf{Fd_{mag}}^2$ function, converts the normalization radius $R0_W$ to its geometric value, r = ro since u0B ≡ $R0_W$/ro.

A final extinction time, wherein all of the structural energy has been depleted and converted to photon-energy, is reached at

$$tf = \frac{1}{c}\left(\frac{3\ U0}{4\pi\rho}\right)^{1/3} = \frac{R}{c}, \qquad (10)$$

thereby producing a propagating directional photon (multi-particle production allowed) with a time-width tf and inherited blackbody and DG features; we assume a photon with velocity = c and exhibiting the "thermodynamic" body descriptors; "thermodynamic radiation" being understood as "EM radiation" at velocity c. The use of an "explosive" adjective to describe this dynamic feature is better appreciated when examining the enormous energy-densities (10^{48} Joules/ meter^3) or pressures (Pascals) within these "DG particle structures" (compare to a "stick of dynamite" at ~ 10^9 Pascals).

The extinction-time result can be interpreted as a "photonic-structural-descriptor" where tf ≡ 1/ν and R ≡ ƛ/4;

$$\lambda\,\nu = c\,; \qquad (11)$$

the thermodynamic variable c has an electromagnetic "velocity of propagation" meaning. Electric charge features are not inherent to this development since "black bodies" have been modelled from thermodynamics and statistical mechanics theory although the charged boson-body characteristics in the form of the mass-energy density ρ, the total mass-energy U and the geometric radius feature R have been utilized; i.e. a simple conceptual model wherein "explosion-or energy-transition information" propagates physically throughout the exploding entity. The maximum-curvature DG-concept, from weak-force beta-decay modelling, produces a maximum energy limit at $R_{min} = R0_W$, a charge-induced, magnetic-field-$\left(\mathbf{Td}_1^1 + \mathbf{Td}_2^2\right)$, r^{-6}, induced limit and therefore probably not the same limit as for $\left(\mathbf{Td}_1^1\right)$, r^{-4}, forces. In fact, the ratio of r^{-6} azimuthally-directed energy-densities to r^{-4} radially-directed energy-densities is

$$\frac{\mathbf{Fd_{mag}}^2}{\mathbf{Fd_{14}}^2} = \frac{8}{3}\left(\hbar c\, S \frac{Q}{3Mc^2}\right)^2 \frac{1}{r^2} = \frac{8}{3}\left(\hbar c\, \frac{1}{mW\, c^2}\right)^2 \frac{1}{r^2} = 372 \ @\ r = 0.5\ R0_W\,. \quad (12)$$

The "material properties" of the "distorted-space" are sufficiently significant in the azimuthal directions as to be responsible for the phenomenon of beta-decay, at least if the "mediator structure" is that of a W^-boson.

If one rather considers the muon-structure (an excited electron-structure (?) and a lesser-energy structure than the boson) as the black-body mediator-structure for "classical-radiation-emission", then using the photon wavelength as a measure of the "spatial curvature", we set the muon radius equal to the photon wavelength to elicit a minimum-photon-wavelength, or a maximum-curvature-photon supported by the muon-mediator structure;

$$U_{\max\_photon} = h\nu_{max}\frac{\lambda_{min}}{\mathrm{R_{min}}} = \frac{\mathrm{hc}}{\mathrm{R0}_{muon}}$$

$$= 6.275\ 10^{-10}\ \text{Joules or } 37\ \times \mathrm{W_{muon}}\ \text{mass energy},$$

where $R0_{muon}$ has been calculated from Eqn. (2a) and is $3.165(10)^{-16}$ meters. Photon energies less than $6.275(10)^{-10}$ Joules would be accommodated by the muon-mediator.

The lifetime of the muon is $2.196(10)^{-6}$ seconds which would allow for the formation of a "$\nu = 4.55(10)^{5}\ \mathrm{sec}^{-1}$ photon" (@ $1.52(10)^{-3}$meter, or the far infrared/ microwave spectral region). The Heisenberg lifetime requirement for a muonic structure would be

$\Delta t \geq \hbar/(2\ U_{muon}) = 3.12(10)^{-24}$ seconds, therefore the experimentally measured muonic lifetime of $2.196(10)^{-6}$ seconds [24] satisfies the Heisenberg requirement; the black-body muonic-structure lifetime is calculated at $4.22(10)^{-24}$ seconds which appears to approximately coincide with the Heisenberg lifetime.

Examination of the DG-structure's energy-density profile in equations $\mathbf{Fd_{mag}}^{2}$ and $\mathbf{Fd_{14}}^{2}$ in the SI, and in Figures 1 and 2, reveals the marked departure from a structural "constant-energy-density" feature and the need to use a wavelength-dependent "spectral emissivity $\varepsilon\lambda$". However the "low-emissivity" of these presently-modeled DG-structures can be understood as the reason for their stability, even though they exhibit rather short-lifetimes. For the muon considered as an "EM-mediator structure", a seemingly physically-unrealistic emissivity value would have to attach to the DG-modeled muon-structure to achieve transition-time agreement with the muon experimental lifetime. However the “force-constant” strength would seem appropriate.

The DG muon-“photon producing”-mediator fields are displayed in Fig.2;

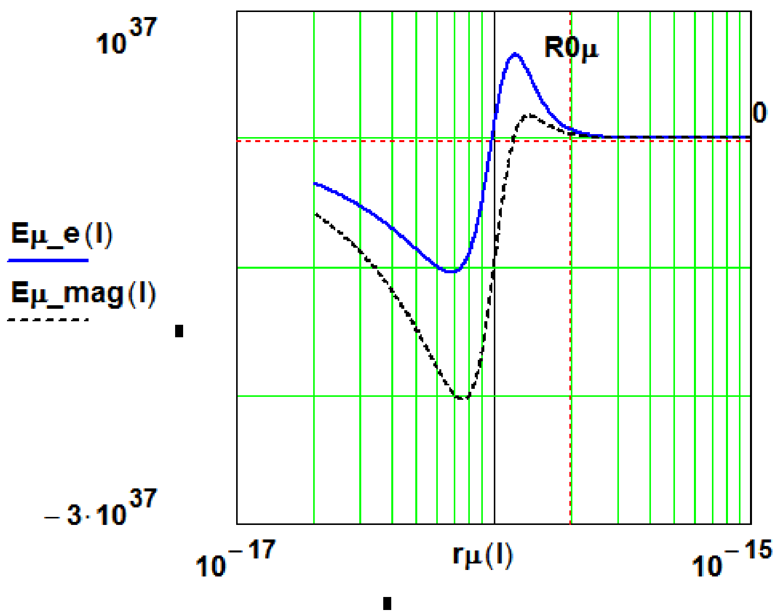

Fig.2. Distorted-Geometry Energy-Density (field) functions (**Eμ_e** for $\mathbf{Fd_{14}}^{2}$ and **Eμ_mag** for $\mathbf{Fd_{mag}}^{2}$**),** for the MUONIC-mediator structure, illustrating the ‘Strong-repulsive-force, Weak-force and Electric-force” components. The ordinate in Joules/meter^3 is displayed in logarithmic form and the abscissa, the structural radii rμ, in meters in logarithmic values. Note the energy-density reduction and the increase in radial extent compared to the W^- BOSON- character.

Although these distortional structures have been characterized at the outset as stable distortions, we have subsequently exploited the distortional form as the mediating entities in distortional transition processes, suggesting that the structural stability can be of a transient nature and sensitive to environmental "fields".

A black-body emitted, propagating, DG photonic structure is simulated and mathematically detailed, as an example, for the Lyman-alpha line @ ƛ = 121.567 nanometers (labelled R0ν), in Fig.3; the simulation is also displayed in Fig.4 to better communicate the structure of the time-varying "energy-density fields".

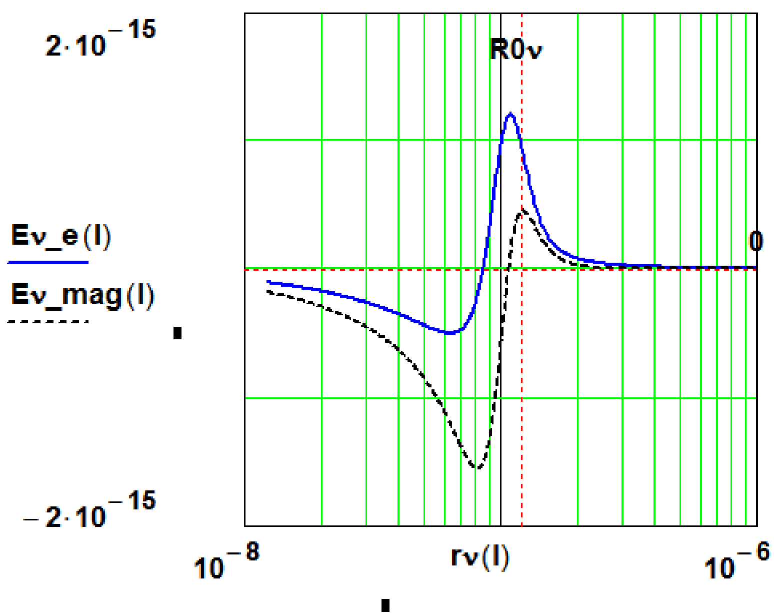

Fig.3. Distorted-Geometry-Photon Energy-Density (field) functions for the LYMAN-ALPHA_PHOTON (ƛ =121.567 10^{-9} meters = R0ν), illustrating the 'Strong-repulsive-force, Weak-force and Electric-force" components. The ordinate in Joules/meter^3 is

displayed in logarithmic form and the abscissa, the structural radii rν, in meters in logarithmic values.

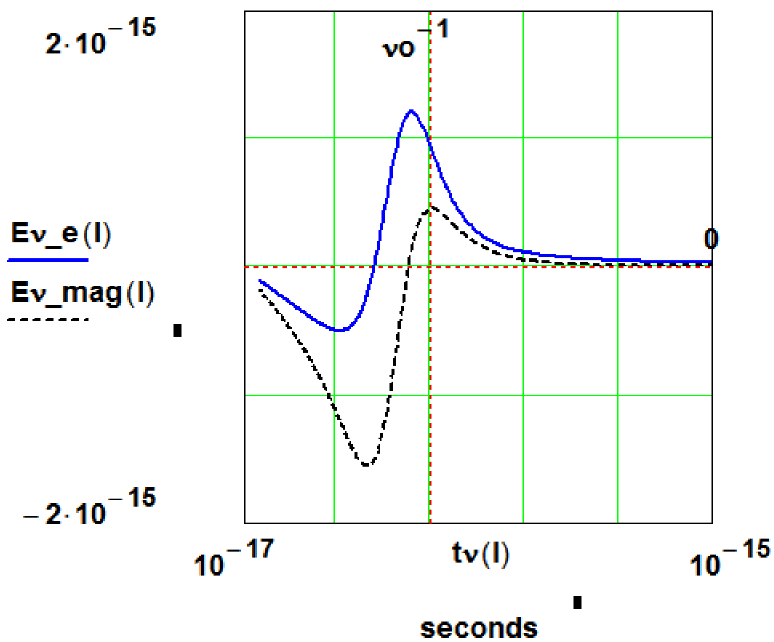

Fig.4. Distorted-Geometry-Photon Energy-Density (field) functions for the LYMAN-ALPHA_PHOTON illustrating the 'Strong-repulsive-force, Weak-force and Electric-force" components. The ordinate in Joules/meter^3 is displayed in logarithmic form and the abscissa in seconds in linear values. To emphasize the propagating energy, we have displayed the structural field character on a time scale. The actual time–extent of the photonic sphere (diameter at 2R) is double that shown in the core direction. Note the two physical-geometric facets of the Photon where Eν_e = 0 while Eν_mag = Eν_mag (max) and where Eν_e = Eν_e (max) while Eν_mag = 0, mimicking the

behavior of an EM photon. The photon-frequency νo^{-1} condition occurs at the "extra-core" Eν_mag-maximum condition.

8. Calculational Method for the Gravitational mediator

The positive-pressure (positive energy-density) quantity, $(\mathbf{Fd_{14}})^2$, evaluated at the radius(r_max) of $(\mathbf{Fd_{14}})^2$(max) , for the "HOLE_MIN" [12], gravitational structure, due to a maximum curvature, is

$$\mathbf{Fd_{14}}^2(r^{-4}\text{ component}) = \frac{\mathrm{Rs}^2}{2}\frac{1}{8\pi\,\kappa\mathrm{G}}\frac{1}{r^4} = \frac{(\kappa\mathrm{G\ Mg})^2}{4\pi\,\kappa\mathrm{G}}\frac{1}{\mathrm{r}^4} =$$

$$= \frac{(\kappa\mathrm{G\ Mg}\ c^2)^2}{4\pi\,\kappa\mathrm{G}}\frac{1}{(3.69\ 10^{-3})^{\ 4}} = 1.15\ 10^{47}\ (\mathrm{Joule/meter^3})$$

$$@\ \mathrm{r} \equiv \mathrm{r\_min} = 3.69\ 10^{-3}\ \mathrm{meters} \qquad (13)$$

and where $\kappa G = G\,c^{-4}$ and $Mg\,c^2 = \mathrm{mass_{energy}}$of HOLE MIN =

$$= 1.80\ 10^{41}\ \mathrm{Joules.}$$

The actual DG functional value at the energy-density-maximum is

$1.182\ 10^{48}\ \frac{\mathrm{Joules}}{\mathrm{meter^3}}$ @ r = r_min = $3.69\ 10^{-3}$ meters , again illustrating the magnitude of the contribution to $\mathbf{Fd_{14}}^2$ from the r^{-6} and other r^{-n} components (see Fig.5).

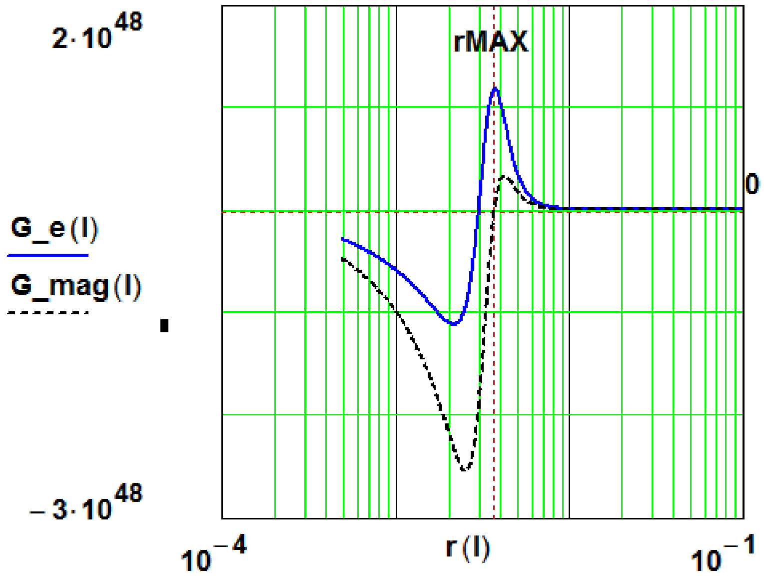

Fig.5. Distorted Geometry Gravitational Energy-Density (field) functions $\mathbf{G\_e \equiv Fd_{14}{}^2}$ and $\mathbf{G\_mag \equiv Fd_{mag}{}^2}$, (for the "HOLE-MIN" structure ≡ GRAVITATIONAL-mediator structure), illustrating a gravitationally-simulated 'Strong-grav.-force, Weak-grav.-force and grav. r^{-4}-force" components. The ordinate in Joules/meter^3 is displayed in logarithmic form and the abscissa, the structural radii r, in meters in logarithmic values.

The positive-pressure (positive energy-density) quantity, $(\mathbf{Fd_{14}})^2$**,** evaluated at the radius of $(\mathbf{Fd_{14}})^2(\max)$, for the "Milky Way Black-hole" [12] gravitational structure is

$$\mathbf{Fd_{14}}^2(r^{-4}\text{ component}) \;=\; \frac{\mathrm{Rs}^2}{2}\,\frac{1}{8\pi\,\kappa\mathrm{G}}\,\frac{1}{r^4} \;=\; \frac{(\kappa\mathrm{G}\,\mathrm{Mg}\,c^2)^2}{4\pi\,\kappa\mathrm{G}}\,\frac{1}{\mathrm{r}^4} \;=$$

$$= \frac{(\kappa G\ Mg\ c^2)^2}{4\pi\ \kappa G} \frac{1}{(1.34\ 10^{10})^4} =$$

$$= 8.70\ 10^{21}\ (\text{Joule/meter}^3)\ \ @\ r = 1.34\ 10^{10}\ \text{meters} \qquad (14)$$

and where $\kappa G = G\ c^{-4}$ and $Mg = \text{mass of Black Hole Sagittarius A} * =$

$$= 4.154\ 10^6\ \text{solar masses.}$$

The actual DG functional value at the $\mathbf{Fd_{14}}^2$ energy-density maximum is

$8.95\ 10^{22}\ \frac{\text{Joules}}{\text{meter}^3}$ $@\ r = 1.34\ 10^{10}$ meters , again illustrating the magnitude of the

contribution to $\mathbf{Fd_{14}}^2$ from the r^{-6} and other r^{-n} components (see Fig.6).

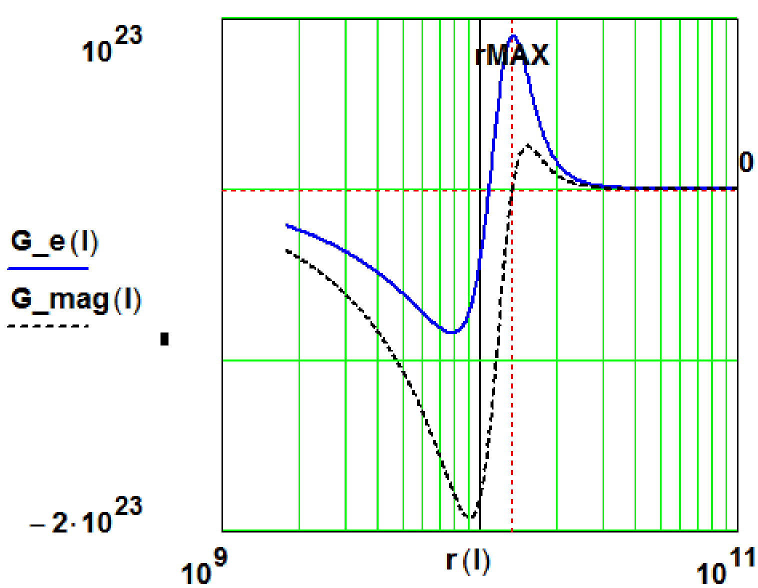

Fig.6. Distorted Geometry Gravitational Energy-Density (field) functions $\mathbf{G\_e \equiv Fd_{14}^{2}}$ and $\mathbf{G\_mag \equiv Fd_{mag}^{2}}$**,** for the MILKY WAY Black-Hole, illustrating a gravitationally-simulated 'Strong-grav.-force, Weak-grav.-force and grav. r^{-4}-force" components. The ordinate in Joules/meter^3 is displayed in logarithmic form and the abscissa, structural radii r, in meters in logarithmic values. rMAX is the value of the radius at the Black-Hole maximum of $\mathbf{G\_e \equiv Fd_{14}^{2}}$.

Similarly, the negative-pressure (negative energy-density) core-maximum (for this black-hole gravitational structure) is

$$\left(\mathbf{Fd}_{grav\ core}\right)^{\mathbf{2}}(\text{max @ r} = 9.08\ 10^{9}\text{meter}) = -1.92\ 10^{23}\ \text{Joule/meter}^{3}. \qquad (15)$$

Finally, a "gravitational representation" of the Fermi-constant, a measure of a maximum-curvature minimum-radius structure, can be calculated according to the Fermi definition (a magnetic field descriptor) as

$$\text{Gravitational interaction strength constant } \equiv \text{GG } \equiv \frac{\pi^{3}}{2}\ \text{m}_{\text{G}}\text{c}^{2}\ \text{R0}_{\text{G}}^{\ 3} =$$

$$= \frac{\pi^{3}}{2}\ \text{m}_{\text{G}}\text{c}^{2}\ (\gamma\ 2\ \text{G c}^{-4}\text{m}_{\text{G}}\ c^{2})^{3} \text{ with } \gamma = \frac{3.275}{2} \text{ and}$$

$$\text{m}_{\text{G}}c^{2} = \text{Black hole mass energy minimum [12](as a mediator structure),}$$

where

$$\mathrm{G\ c^{-4}} = \text{gravitational coupling constant} = 8.26\ 10^{-45} \frac{\text{meters}}{\text{Joule}}\ ,$$

then $$\mathrm{GG} = 3.2242\ 10^{35}\ \text{Joule meter}^3\ . \tag{16}$$

9. Conclusions

It has been shown in the present work that the distorted-space, or distorted geometry (DG), model of matter, as applied to fundamental-particle (boson, muon and gravitational) constructs, can produce structures satisfying "particle mass-energy-transition" or "mediator" dynamics. Earlier successful mimicking [12] of "Fermi-described beta decay" has been extended to a mediator description of "classical radiation-emission" and a "gravitational energy-transition mediator" entity.

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