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Research Article

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GEOMETRIC MEDIATOR STRUCTURES AND FORCE CONSTANTS

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Summary

The work is a Riemannian-geometric approach to describing "energy-transition mediator" structures. We have produced a description of the "mediator" as a geometric-mimic, a "distorted geometry" structure, formulated from a solution of Riemann's geometric equations. Clifford's[1] "Curved empty space as the building material of the physical world" supposition is the conceptual basis for this "distorted-geometry" modeling. The resulting geometric description of matter (mass-energy) mimics the classical-physics electromagnetic and gravitational-field models at large radii but departs significantly at small radii to produce a magnetic-field (spin) mimic as well as a weak-field mimic (beta decay and the Fermi constant) and a strong-field mimic without an infinity at the origin (no singularity)[2]. The structure is constituted by a core-region within which the propagation-velocity, by virtue of the distorted metrics, is greater than c and exhibits a "partial light trapping phenomenon", a "black hole". 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. 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 radiation-emission and structural modeling leads to a description of transition dynamics and photonic entities.

Introduction

Physical transition processes are presently mathematically represented in "quantum-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 this quantum-mechanical operational-mathematical rendering although an "intermediate" mediator-structure[3] is envisioned.

The intermediate mediator-structure in the beta-decay transition process, the conversion of a neutron into a proton, electron and neutrinos, 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.

We have also successfully and precisely modelled and mimicked this transition process in the "distorted-geometry" model of matter[2] 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[3] notwithstanding.

The theoretical and mathematical foundation for this undertaking is presented in the Supplementary Information section.

For the "distorted-geometry" model, precise to the mass-characterization of the W-boson,

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

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

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

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

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

The "distorted-geometry" mathematical symbols are

$$\kappa \equiv \kappa_{EM} = W\_boson\ coupling\ constant = \alpha\, \frac{\hbar c}{2}\, (m_w c^2)^{-2} = 6.93\ 10^{-13}\, \frac{\text{meters}}{\text{Joule}},$$

$\alpha = fine\ structure\ constant$,

$\hbar = Planck's constant$, $\quad c = velocity\ of\ light\ and\ m_w = boson\ mass$.

The distorted-geometry radial descriptor $R0_w = \left(\alpha\ \frac{2}{3}\right)^{1/3}\ \hbar\text{c}\ (\text{m}_\text{w}\text{c}^2)^{-1}$ $and\ Rs_W = 2\,\kappa\,\text{m}_\text{w}\text{c}^2$.

The energy-density structural nature of the 'distorted geometry" solution[2] gives rise uniquely and comprehensively to the fundamental forces 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 describes gravitational structures. The "distorted-geometry-solution (≡ *DG*)", is generated from Riemann's geometric description of a 4-dimensional spacetime manifold applied at 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 "*mass-energy*$*R0^3$ "product and which is a *magnetic energy-density weak-force maximum* and a *geometric-curvature maximum (inverse dependence)* [2], 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 *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 of the classical-differentiated force functions. We use the "BLACK-HOLE DISTORTIONAL EXTREMUM (a minimum hole mass) [4] mass-energy" for calculating the "*gravitational-interaction-strength"* constant GG. Note that the "gravitational coupling-constant $G*c^{-4}$ is ~45 orders of magnitude smaller than the "EM (electromagnetic) coupling-constant".

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

$$\mathbf{Fd_{14}}^2(r^{-4}\text{ component}) = \frac{\mathrm{Rs}^2}{2}\frac{1}{8\pi\kappa}\frac{1}{r^4} = 2.89\ 10^{45}\ \text{Joules/meter}^3\ @\ r = 2.37\ 10^{-19}\ meters,$$

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

$$(\mathbf{Fd}_{boson\ core})^2(\max\ @\ \mathrm{r} = 1.46\ 10^{-19}\text{meter}) = -2.51\ 10^{48}\ \text{Joule/meter}^3 \equiv \qquad (4)$$

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

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

These field quantities are displayed in Fig.1.

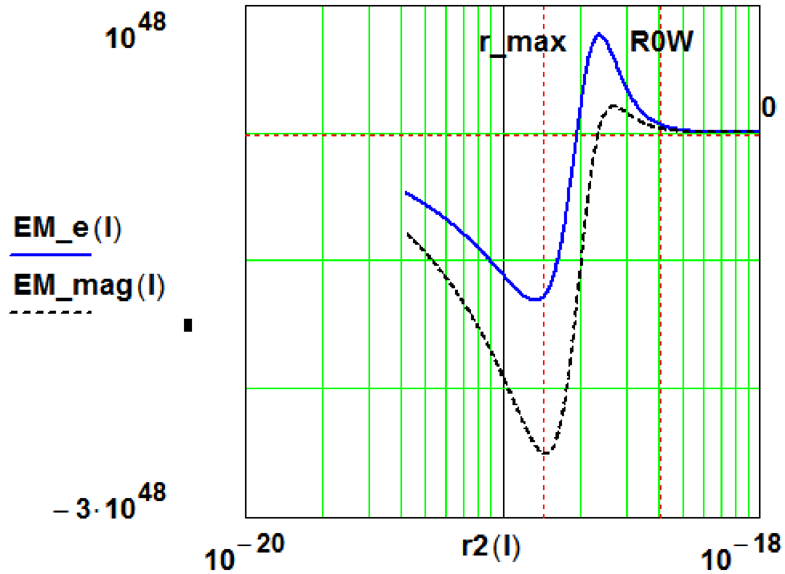

Fig.1. Distorted Geometry Electromagnetic Energy-Density (field) functions (**EM_e** for $\mathbf{Fd_{14}}^2$ and **EM_mag** for $\mathbf{Fd_{mag}}^2$) for the BOSONIC-mediator structure, illustrating the 'Strong-repulsive-force (is this gluon behavior?), Weak-force and Electric-force" components. The ordinate in Joules/meter^3 is displayed in logarithmic form and the abscissa in meters in logarithmic values.

From the "energy-emission dynamics" model in[5], and using the "corrected form" of equations 11-15 [ref.5 corrected in ref.6], we can model and calculate the "lifetime" of this boson-mediator structure as

$$t(\text{lifetime}) = \frac{1}{c}\left(\frac{3\,U0}{4\pi\rho}\right)^{1/3} = \frac{R_{boson}}{c} = \frac{1}{c}\,R0_W = 1.39\ 10^{-27}\ \text{seconds}\,, \qquad (5)$$

where U0 is the mass-energy of the "energy-emitting" body with a constant density ρ.

Environmental fields[7, 8] 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 for the "electromagnetic-radiation-emission mediator".

In reference[5], 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. 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;

$$\mathrm{P(Planckian\ thermodynamics)} = \frac{dU}{dt} = -(\sigma T^4)\, A(r) \quad \text{and} \quad A(r) = 4\pi\, R^2. \tag{6}$$

With

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

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

and

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

leading to

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

$$U(t) = -\frac{4}{3}\ \pi\rho(c\ t)^3 + U0\ . \tag{7}$$

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

$$tf = \frac{1}{c}\left(\frac{3\ U0}{4\pi\rho}\right)^{1/3} = \frac{R}{c}\,, \tag{8}$$

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

$$\mathrm{tf} \equiv 1/\nu \text{ and } \mathrm{R} \equiv \lambda\!\!\!^{-};$$

$$\lambda\,\nu = \mathrm{c}\,; \tag{9}$$

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. This time-dependent feature of the proposed photon-mediator structure is only dependent on the DG geometric-radius feature R and not on the physical mass-energy features ρ and U (a simple conceptual model wherein "explosion-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

$$\frac{\mathbf{Fd_{mag}}^2}{\mathbf{Fd_{14}}^2} = \frac{8}{3}\left(\hbar \mathrm{c}\,\mathrm{S}\frac{\mathrm{Q}}{3\mathrm{M}}\right)^2 \frac{1}{r^2} = \frac{8}{3}\left(\hbar \mathrm{c}\,\frac{1}{\mathrm{mW}}\right)^2 \frac{1}{r^2} = 372 \;\; @\, r = 0.5\, R0_W\,. \tag{10}$$

The “material properties” of the distorted-space are sufficiently significant in the azimuthal directions as to be responsible for the phenomenon of beta-decay.

We consider therefore, the muon-structure as the mediator-structure for “classical-radiation-emission”. Then

$$U_{\max\_photon} = \frac{\mathrm{hc}}{\mathrm{R_{min}}} = \frac{\mathrm{hc}}{\mathrm{R0}_{muon}} = 1.59\ 10^{-10}\ \text{Joules or } 1.23\ 10^{-2} \times W_{boson}\ \text{mass energy}.$$

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

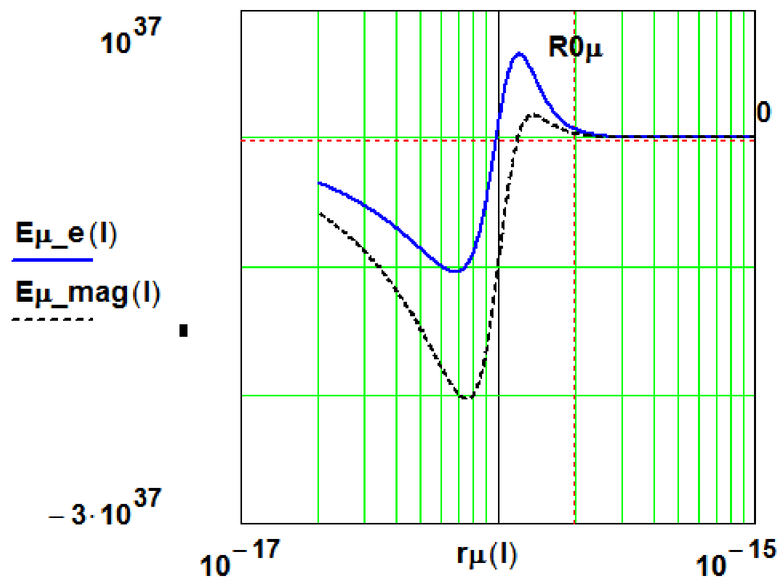

Fig.2. Distorted-Geometry Energy-Density (field) functions (**Eμ_e** for $\mathbf{Fd_{14}}^2$ and **Eμ_mag** for $\mathbf{Fd_{mag}}^2$**),** for the MUONIC-mediator structure, illustrating the ‘Strong-repulsive-force, Weak-force and Electric-force” components. The ordinate in Joules/meter^3 is displayed in logarithmic form and the abscissa 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”. As a supplementary visualizing addition to the geometric modeling we include as a Supplementary Video an animated video (simulating the muon to electron beta-decay, a higher-energy nuclear process).

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”.

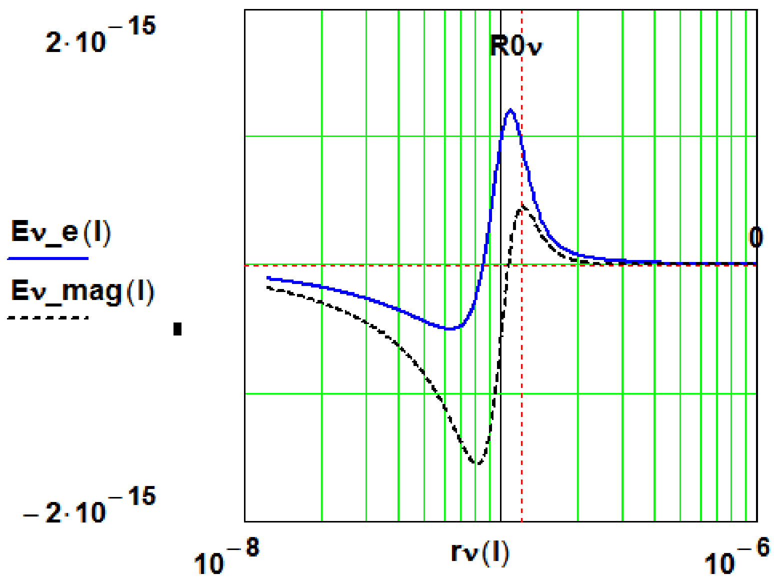

Fig.3. Distorted-Geometry-Photon Energy-Density (field) functions for the LYMAN-ALPHA_PHOTON (ƛ =121.567 10^{-9} meters = R0ν), illustrating the ‘Strong-repulsive-force, Weak-force and Electric-force” components. The ordinate in Joules/meter^{3} is displayed in logarithmic form and the abscissa in meters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

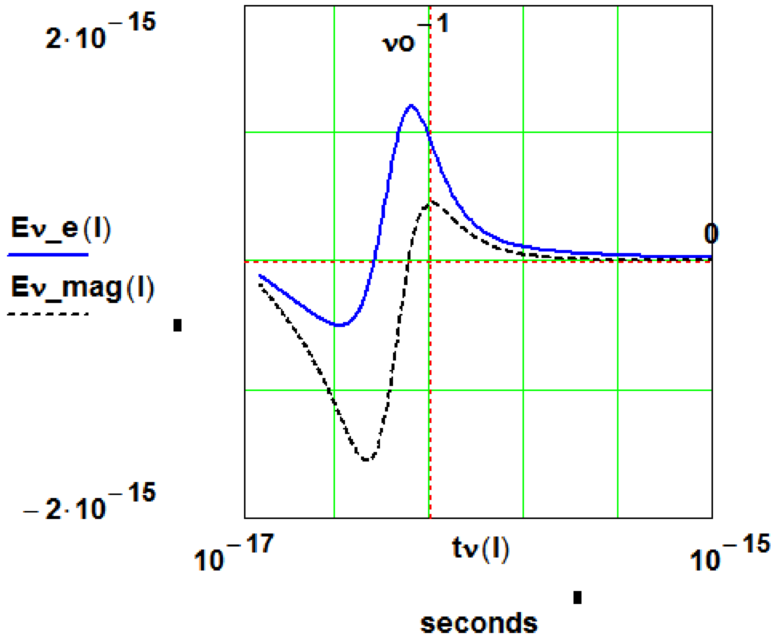

Fig.4. Distorted-Geometry-Photon Energy-Density (field) functions for the LYMAN-ALPHA_PHOTON illustrating the 'Strong-repulsive-force, Weak-force and Electric-force" components. The ordinate in Joules/meter^3 is displayed in logarithmic form and the abscissa in seconds in linear values. To emphasize 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.

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" [4], GRAVITATIONAL STRUCTURE , due to a maximum curvature, is

$$\mathbf{Fd_{14}}^2(r^{-4}\text{ component}) = \frac{Rs^2}{2}\frac{1}{8\pi\,\kappa G}\frac{1}{r^4} = \frac{(\kappa G\,Mg)^2}{4\pi\,\kappa G}\frac{1}{r^4} = \tag{11}$$

$$= \frac{(\kappa G\,Mg)^2}{4\pi\,\kappa G}\,\frac{1}{(3.69\ 10^{-3})^{\ 4}} = 1.15\ 10^{47}\ (\text{Joule/meter}^3)\ \ @\ r \equiv r\_min = 3.69\ 10^{-3}\text{ meters}$$

and where $\kappa G = G\,c^{-4}$ and Mg = mass of "hole min" $= 1.80\ 10^{41}$ Joules.

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

$1.182\ 10^{48}\ \frac{\text{Joules}}{\text{meter}^3}$ @ 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).

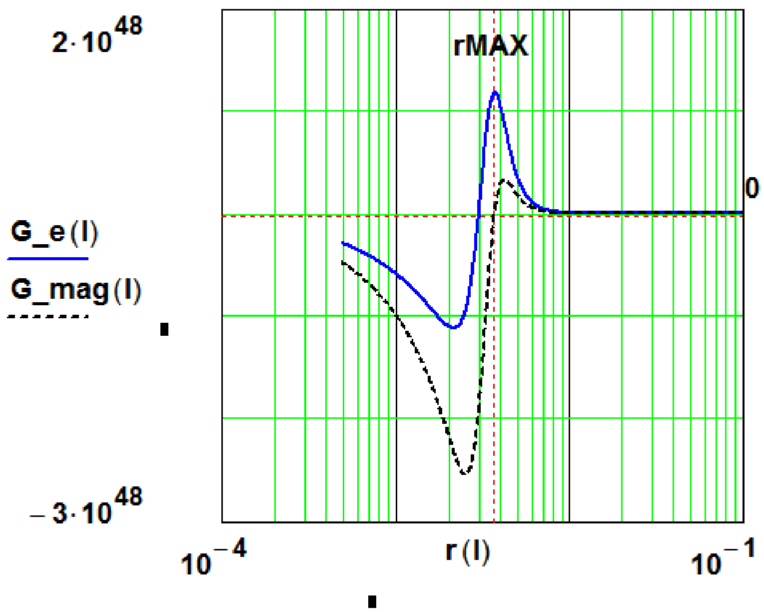

Fig.5. Distorted Geometry Gravitational Energy-Density (field) functions $\mathbf{G\_e \equiv Fd_{14}}^2$ and $\mathbf{G\_mag \equiv Fd_{mag}}^2$, (for the "HOLE-MIN" structure ≡ GRAVITATIONAL-mediator structure), illustrating a gravitationally-simulated 'Strong-grav.-force, Weak-grav.-force and grav.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

$$\mathbf{Fd_{14}}^2(r^{-4}\ \text{component}) = \frac{\text{Rs}^2}{2}\frac{1}{8\pi\,\kappa\text{G}}\frac{1}{r^4} = \frac{(\kappa\text{G Mg})^2}{4\pi\,\kappa\text{G}}\frac{1}{\text{r}^4} = \qquad (12)$$

$$= \frac{(\kappa\text{G Mg})^2}{4\pi\,\kappa\text{G}}\frac{1}{(1.34\ 10^{10})^4} = 8.70\ 10^{21}\ (\text{Joule/meter}^3)\ \ @\ \text{r} = 1.34\ 10^{10}\ \text{meters}$$

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

$= 4.154\ 10^{6}$ 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).

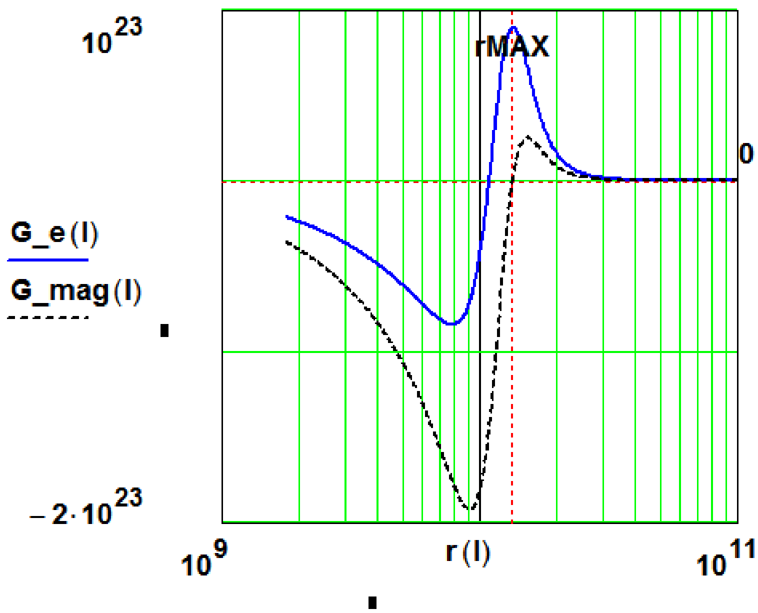

Fig.6. Distorted Geometry Gravitational Energy-Density (field) functions **G_e** $\equiv \mathbf{Fd_{14}}^2$ and **G_mag** $\equiv \mathbf{Fd_{mag}}^2$**,** for the MILKY WAY Black-Hole, illustrating a gravitationally-simulated 'Strong-grav.-force, Weak-grav.-force and grav. r^{-4}-force" components.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

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

$$\left(\mathbf{Fd}_{grav\ core}\right)^2 (\text{max @ r} = 9.08\ 10^{9}\text{meter}) = \text{-}1.92\ 10^{23}\ \text{Joule/meter}^3. \qquad (13)$$

Finally, a "gravitational representation" of the Fermi-constant, a maximum-curvature minimum-radius structure, can be calculated according to the Fermi definition as

$$Gravitational\ interaction\ strength\ constant\ \equiv GG\ \equiv \frac{\pi^3}{2}\, m_G c^2\, R0_G{}^3 =$$

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

$$m_G = Black\ hole\ mass\ minimum\ [\mathrm{SI}\ 4\,](as\ a\ mediator\ structure)\ ,\ \ where$$

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

$$GG = 3.22\ 10^{35}\ Joule\ meter^3\ . \tag{14}$$

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