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BLACK HOLES AS GEOMETRIC DISTORTIONAL EXTREMA

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Summary

The work is a non-conventional mathematically-geometric approach to describing “black-hole” structures. A comprehensive description or model of the universe at the fundamental level which improves on the Newtonian r^{-4} (infinity at $r = 0$ called a singularity) gravitational force model is proposed. Matter and force concepts are to be replaced by more *ab initio* or *first principle* energy and geometric-modeling. We have produced a description of the “black hole” as a geometric-mimic, a “distorted geometry” structure, formulated from a solution of Riemann’s geometric equations (see Supplementary Information below). The model is essentially the “Curved empty space as the building material of the physical world” supposition of Clifford [1] in 1876 and 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”, facilitating and duplicating “black hole” behavior. Distorting the geometry in 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. Such a geometric description of localized warping or distorting of the spacetime manifold would seem (?) to constitute a “first-principle” model of the universe.

A historical quote from Wheeler’s work [3-5] published in 1955 reads; “In the 1950’s, one of us [4] found an interesting way to treat the concept of body in general relativity. An object can in principle be constructed out of gravitational radiation or electromagnetic radiation, or a mixture of the two, and may hold itself together by its own gravitational attraction...A collection of radiation held together in this way is

called a geon (a gravitational electromagnetic entity) and is a purely classical object....In brief, a geon is a collection of gravitational or electromagnetic energy, or a mixture of the two, held together by its own gravitational attraction, that describes *mass without mass*.”

Subsequently at *The International Congress for Logic, Methodology, and Philosophy of Science* in 1960, he [4] began by quoting William Kingdon Clifford’s [1] “Space-Theory of Matter” of 1870 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.”

Additional work in this field continues, some of which is cited in references [6-11]. The present treatment departs from these cited “geon constructional methods” in that we do not constrain the distortional descriptions to only gravitational coupling-constant produced structures.

Abstract

It is shown in the present work that the distorted-space model of matter as extended to extreme curvature limits results in characteristics mimicking those of galactic-holes. The distorted-geometry structures exhibit non-Newtonian features wherein the hole or core-region fields of the structure are energetically-repulsive (negative pressure), do not behave functionally in an r^{-4} manner and terminate at zero at the radial origin (no singularity). Of particular interest is that of r^{-6} energy-density behavior at structural radial distances near the core of the distortion, a region also displaying potential-well behavior.

Introduction

A “Curved empty space as the building material of the physical world” supposition of Clifford [1] in 1876 is the conceptual basis for this “distorted-geometry modeling” [2] [11]. We maintain and expand the geometrical perspectives inherent in the earlier work [2] and building on that work, we apply the geometric concepts to produce a distortional-geometric extremum, a “stability-based minimum-energy-density”

condition or “maximum geometrically-distorted gravitational radius” condition. Additionally, we showed in [2] that the propagation velocity in the core region of these distorted-geometry structures was approximately 1.5 times that external to the core (see Fig.1). This feature, which is present for all such structures, is equivalent to a “partial light trapping” phenomenon (a black hole core?).

A “geometric maximum-energy-density” feature, in the EM (electromagnetic) energy-density realm, was successfully exploited to geometrically explain and quantify the Fermi constant [2] and in addition a “stability-based minimum-energy-density” condition was fundamental to describing the structure of the “stable distortional-geometry electron” feature.

In this perspective, the distorted-geometry model is a departure from the classical geometry model where the Einstein Curvature tensor is the stress-energy-tensor describing the “material contents” of the energy distribution. This distorted-geometry model is rather viewed with the energy-content residing in the warping or distorting of the manifold and therefore in its geometric-tensors, and the “curved empty space” referred to above is a “localized curved or distorted space” devoid of an “external or foreign” causative matter-entity. The “distorted metrics” and the core propagation velocity are displayed for example, for the distorted-geometry electron-mimic in Fig. 1.

Fig.1 Metrics and propagation-velocity factor for the distortional electron structure; abscissa in meters.

Theoretical Modeling for Distortional Extrema and Holes

Both gravitational and electromagnetic energy-densities are capable of distorting the geometric manifold. This feature of these *distorted-space structures* is a manifestation of a composite coupling-constant between energy and geometry,

$$\kappa = \kappa_G + \kappa_{EM} = \frac{G}{c^4} + \frac{\mu_0 \left(\frac{\mu_{spin}}{\hbar c S g_e} \right)^2}{2\pi} = \frac{G}{c^4} + \frac{\alpha \hbar c}{2} \left(\frac{Q}{3 Mc^2} \right)^2 ; Q = 3 \text{ for the electron, muon and } W^- \text{ boson.} \quad (1)$$

We have used a modified coupling—constant definition by omitting the factor 8π and retaining the factor in the energy-density equations; conventionally, the coupling-constant definition would be $8\pi\kappa$.

Allowing the distorted space itself to be material in nature, we constrain the modeling by requiring that the descriptive stress-energy tensors satisfy a “constitutive relation” or an “equation-of-state” between the temporal and spatial tensor-curvature elements, namely

$$\mathbf{Td}_4 = -(\mathbf{Td}_1^1 + \mathbf{Td}_2^2 + \mathbf{Td}_3^3). \quad (2)$$

We have introduced the explicit distortional-tensor symbolism $\mathbf{Td}$ for the geometric quantities. Contrast this perspective with cosmological renditions of geometric curvature structure resulting from “matter” causation, wherein several “equations of state” relating to the “matter” variables ρ (density) and p (pressure) have been forthcoming [12] where $p = \sigma \rho$ and where σ varies from -1 to +1.

Inherent in the geometric “equation-of-state” constraint is the requirement that the descriptive stress-energy tensor, $\mathbf{Td}$, be Maxwellian in nature; the mimicking process is therefore limited to asymptotically flat-space regions of the manifold since $1/r^2$ field behavior does not adequately describe elementary-particle structural-detail [13]. The field equations, in both the EM realm and the gravitational realm ($Q = 0$), exhibit r^{-6} geometric behavior which we have interpreted as constituting a “magnetic monopole” mimic (what is a “magnetic monopole”?).

This description, equation (2), of the *distorted-space volume*, has led to the *universal structural solution*, Eq. (SI-4), (see equations (SI-1)-(SI-3) in the SI for variable definitions and for the fundamental Riemann geometric-equation-set leading to equation (SI-4));

$$\mu' = \frac{2(1-u^3)u^2}{(1u - \gamma)R0}, \quad (\text{SI-4})$$

where the metric quantity $g_{11} \equiv -e^\mu$ and $g_{44} \equiv e^\nu$; $\nu' = \left[-2 + \frac{1}{1-u^3}\right]\mu'$

and the transformed radial variable $u \equiv \frac{R0}{r}$. Riemann's geometric equations are expressed in the metric-variables μ' and ν' and the manifestation of the composite coupling-constant appears in the geometric quantities γ (equation (7)) and the geometric “transformation radius” $R0$ (equation (7)) both determined from the “distorted spatial volume” with electromagnetic and/or gravitational energy-density components.

A radial zero in the field quantity $(\mathbf{F}\mathbf{d}_{14})^2$, namely $r0 \equiv R_{s_{\text{geo}}} = R0_{\text{geo}}/u(r0)$, with $u(r0) = \gamma(\text{grav})/2 = 3.27512/2$, is the geometric manifestation of the Schwarzschild “metric-radial-zero”, the radial singularity classically interpreted as a “black-hole” radius. The core-radius is a fundamental feature of the “distorted-space” structures; it is the radial point at which the energy-density-distortion transitions from a positive shell-like value to a negative core-like value. The structures inherently illustrate r^{-4} , r^{-6} and repulsive-radial energy-density behavior (relative to the shell energy-density behavior), thereby accounting for Newtonian, weak and strong field-attributes.

In discussions of the negative energy-density core-regions of this universal (EM as well as gravitational) distorted-geometry structure, it should be emphasized that a negative energy-density gravitational feature (a repulsive gravitational force or negative pressure) is non-Newtonian. The hole or core region-fields of the structures are repulsive (relative to the extra-core, or shell, region), do not behave functionally in an r^{-4} manner and terminate at zero at the radial origin (no singularity). See Fig. 2 where the magnetic and radial field energy-densities are graphed for quantitative and qualitative purposes and Fig. 3 where the same quantities are shown in absolute values to more clearly identify the relative strengths of these energy

densities in the shell to core transition regions. Fig. 4 is constructed to complement the theoretical results exhibited in Figures 2 and 3.

Fig.2 Field-Energy-Density distribution functions (at creation) for mimicking the Sagittarius A* galactic-hole; $\mathbf{G_mag}$ is the r^{-6} magnetic-field-mimic, $\mathbf{Fd_{mag}^2}$, and $\mathbf{G_e}$ is the radial-field-mimic $\mathbf{Fd_{14}^2}$. The ordinate is linear in Joules/m³ and the abscissa is logarithmic in meters. Rsg is the Schwarzschild radius $2G \, c^{-4} Mc^2$.

Fig.3 Field-Energy-Density distribution functions (at creation) for mimicking the Sagittarius A* galactic-hole; $\mathbf{G_mag}$ is the r^{-6} magnetic-field-mimic, $\mathbf{Fd_{mag}}^2$, and $\mathbf{G_e}$ is the radial-field-mimic $\mathbf{Fd_{14}}^2$. The ordinate is logarithmic in Joules/m³ and the abscissa is logarithmic in meters. An absolute value ordinate is used to display the “negative pressure or negative energy density” core behavior. Rsg is the Schwarzschild radius $2 G c^{-4} M c^2$.

Fig.4 Mass-Energy-Density distribution-function surface-plots (two views) (linear radii and logarithmic amplitudes) for the geometric hole distortion.

Results

We are considering, in the present undertaking, the gravitational energy realm. Incorporating the symbolism utilized in [2], we write equation (3) for the “geometric-maximum-energy-density” feature, the *maximum curvature extremum* or minimum-radius-extremum, of a “geometric” gravitational-distortion. In the EM realm, the “geometric-maximum-energy-density” structure is represented by the W-boson which is understood to be the transition-mediator-particle in beta-decay, a high-energy short-lifetime fundamental-particle satisfying the Heisenberg uncertainty principle $\Delta E \Delta t = \hbar/2$.

$$\left(8\pi \kappa_{\text{grav}} (R0_{\text{Schwarzschild}})^2 \right)^{-1} \equiv \left(8\pi \kappa_{\text{boson}} (R0_{\text{boson}})^2 \right)^{-1} \quad (3)$$

$$\text{with } \kappa_{\text{boson}} = \frac{\alpha \hbar c}{2} \left(\frac{1}{m_{\text{boson}} c^2} \right)^2, R0_{\text{boson}} = \beta_{\text{boson}} \frac{\hbar c}{m_{\text{boson}} c^2}, \kappa_{\text{grav}} = G c^{-4}, \beta_{\text{boson}} = \left(\alpha \left(\frac{g_e}{2} \right)^2 \frac{2}{3} \right)^{1/3}$$

and $R0_{\text{Schwarzschild}} = 2 \kappa_{\text{grav}} M_{\text{grav}} c^2$. This equivalence relationship produces the mass-energy equation for the extremum gravitational structure,

$$(Mc^2)_{\text{grav_min}} = \sqrt[2]{\left(\frac{\kappa_{\text{boson}}}{\kappa_{\text{grav}}} \frac{1}{1.6375} \right) \frac{R0_{\text{boson}}}{2 \kappa_{\text{grav}}}} = 1.80 \cdot 10^{41} \text{ Joules} \quad (4)$$

at a radius

$$r0_{\text{grav}}(\text{min}) = 2.98 \cdot 10^{-3} \text{ meters} . \quad (5)$$

By the same modeling as for the boson, the Heisenberg lifetime would be approximately 10^{-75} seconds. The Heisenberg lifetime for the W-boson is approximately 10^{-26} seconds.

Inherent in the “structural-geometric” equations for the boson are their relations to the Fermi constant GF, a measure of the “strength of interaction” in beta decay, which can be written in “distorted geometry” form as,

$$GF_{geo} = \frac{\pi^3}{2} m_{boson} c^2 R0_{boson}^3 \cong \frac{1}{3 \kappa_{boson}} R0_{boson}^4 =$$

$$= 1.435851 \cdot 10^{-62} \text{ Joule m}^3 = GF , \quad (6)$$

the latter form of which emphasizes the “geometric-curvature” facet of the “interaction strength” quantity GF.

R0 is the *geometric* normalization radius (R0e is calculated from the fundamental-particle magnetic-field component and R0g is determined from the γ radius-ratio equation for the distorted-geometry structures).

$$R0 \equiv R0e + R0g , \quad R0e = \frac{\beta \hbar c}{m_{boson} c^2} , \quad R0g = 2 \kappa_{boson} m_{boson} c^2 ,$$

$$Rs \equiv Rse + Rsg = 2 (\kappa_{boson} + \kappa_{grav}) m_{boson} c^2 \quad \text{and} \quad \gamma \equiv \frac{2 R0}{Rs} . \quad (7)$$

Then,

$$\gamma \equiv \frac{2 (R0e + R0g)}{Rse + Rsg} = \frac{2 (0 + R0g)}{0 + Rsg} = 2 u(r0) \quad \text{and} \quad u(r0) = \frac{3.27512}{2} \quad (\text{if } r0 = Rsg = \frac{R0_{geo}}{u(r0)}).$$

For a gravitational distortion, R0e and Rse are zero.

If, in the absence of a physical structural constraint, one posits a “minimum” curvature, or a “minimum” EM-energy-density condition (which was posited for the “*electron-mimic*” and which is equivalent to a “maximum” geometric EM core-radius) as the “stability” *criterion to produce the maximum-core-radius-extremum, distorted-geometry, gravitational-entity*, one can write for the *electron-mimic*,

$$r0_{geo_max} = r0(\text{electron}) = \frac{\beta(1/2, 3)}{uB0(1/2, 3)} \frac{\hbar c}{m_e c^2} ,$$

with $\beta(S,Q) = \left[\frac{2}{3} \alpha \left(\frac{g_e}{2} S \frac{Q}{3} \right)^2 \right]^{\frac{1}{3}}$, α = fine structure constant, S is the spin quantity and g_e is the gyromagnetic ratio factor. Then,

$$r0_{\text{geo_max}} = 3.329(10)^{-14} \text{ meters.} \quad (8)$$

By using the associated EM “*geometric-energy-density minimum*” as the equivalent gravitational constraint for determining a “*maximum gravitational core-radius*”, and using equation (3) with electron characteristics substituted for boson characteristics, we produce the more classical “*HOLE-like*” structure; the “*distorted-geometry*” gravitational Schwarzschild radius is the “*hole radius*” (see the earlier development in [2] for the Fermi-constant GF where $GF_{\text{geo}} \stackrel{\text{def}}{=} \left[\text{fe } \frac{4\pi}{3} R0_{\text{boson}}^3 \right] m_{\text{boson}} c^2$; also see YouTube educational video with included citations [Largest Black Holes in the Universe](#) or Wikipedia entry, [Black hole](#)).

We construct the energy-density relationship (equations (SI-4a) in the SI for $\mathbf{Td}_4^4$), calculate the energy-density maximum for the electron and set

$$\mathbf{Td}_4^4 \text{ max (from the stable electron structure)} = \mathbf{Td}_4^4 \text{ max (for a stable gravitational hole structure).}$$

Then, using the “transformation radii $R0$ ”,

$$[8\pi \kappa_0(\text{elec}) R0(\text{elec})^2]^{-1} [\gamma(\text{elec}) \frac{2}{3\pi}] = [8\pi \kappa G(\text{hole}) R0(\text{hole})^2]^{-1} [\gamma(\text{elec}) \frac{2.85}{3\pi}] \quad (9)$$

$$\text{where } \kappa_0(\text{elec}) = \frac{\alpha \hbar c}{2} \left(\frac{Q/3}{m_e c^2} \right)^2 \text{ and } \kappa G(\text{hole}) = G c^{-4};$$

$$R0(\text{elec}) = \frac{\beta(\text{elec}) \hbar c}{m_e c^2}, \quad R0(\text{hole}) = \frac{3.275}{2} \frac{1}{\kappa G(\text{hole})} M(\text{hole}) c^2,$$

$$\text{and } \gamma(\text{elec}) = \frac{2 R0(\text{elec})}{Rs(\text{elec})} = 29.255.$$

The cofactors $\gamma(\text{elec})2/3\pi$ and $\gamma(\text{elec})2.85/3\pi$ have been introduced to account for the slight dependence of the energy-density functions $\mathbf{Td}_4^4$ max (in equations (3) and (9)) on γ : $\mathbf{Td}_4^4$ is displayed explicitly in equations (4a) in the SI.

The resultant $\text{Mc}^2(\text{hole}) = \frac{\beta(\text{elec})}{\gamma(\text{grav})} \left(\frac{1}{m_e c^2} \right)^2 \left(\frac{\hbar c}{G c^{-4}} \right)^{3/2} \frac{1}{3} \sqrt{2\pi \left(\frac{\pi}{3} \right)^{0.5} \alpha}$, where α is the fine-structure constant and

$$(\text{Mc}^2)_{\text{grav max}} \equiv \text{Mc}^2(\text{hole}) = 1.461 (10)^4 \text{ solar masses} \quad (10)$$

at a core radius

$$(\text{Schwarzschild_radius for } \mathbf{Td}_4^4) = 2 G c^{-4} \text{Mc}^2(\text{hole}) = 4.34 (10)^7 \text{ meters.} \quad (11)$$

Such a primordial distortional-hole, after $13.8(10)^9$ years of mass accretion at a rate of $3.01(10)^{-4}$ solar-masses/year, would exhibit the present mass of the “Milky Way galactic black-hole (Sagittarius A*)” at $4.154(10)^6$ solar masses [14-15] and a core (Schwarzschild)-radius of $R_{\text{sg}} = 1.23(10)^{10}$ meters; its distortional energy-density distribution functions are shown in Fig. 5. The distortional peak energy-densities are reduced over this time period from the 10^{27} range to a 10^{23} range (see Figs. 3 and 5). These extremely high energy-densities (both positive and negative $\mathbf{Td}_4^4$) integrate to a composite total energy which is the mass-energy of the structure [2]. Also illustrated in Fig. 5 is the Newtonian $1/r^4$ field energy-density (grav_r) function wherein the “distorted-geometry” function is an order of magnitude greater than the Newtonian function near the core. Functionally the “distorted-geometry-field” transitions to a repulsive core-function at R_{sg} the Schwarzschild radius. Accreted-mass and the “black hole” constitute a “field-modified energy-altered structure” as, analogously, for example, the neutron, which is unstable when free, but becomes a stable structure when in the nucleus-field-environment.

Therefore this “distortional-geometry hole-structure”, created at the “birth of the universe” (also see reference [16]), registers as a viable candidate for the structure of “black holes”.

Fig.5 Field-Energy-Density distribution functions (after $13.8(10)^9$ years of accretion) for mimicking the Sagittarius A* galactic-hole; G_{mag} is the r^{-6} magnetic-field-mimic, Fd_{mag}^2 , and G_e is the radial-field-mimic Fd_{14}^2 . The ordinate is logarithmic in Joules/m³ and the abscissa is logarithmic in meters. An absolute value ordinate is used to display the “negative pressure or negative energy density” core behavior. Rsg is the Schwarzschild radius $2 G c^{-4} Mc^2$ and “Earth-Sun” designates the earth to sun distance. Also illustrated for comparison is the classical Newtonian field energy-density function “grav_r”.

Mass-energy “black-hole” growth rates [17-21] however range from “~1 solar mass/3000 years (for the Milky Way Galaxy)” up to “~1 solar mass/20 years (for NGC 4594)”, therefore the “Milky Way Black-Hole mass-accretion rate” allows for even a “zero-mass black-hole” at creation-time. Accretion rates are in part based on distance, times and the universe-expansion model (see reference ¹³) and would be subject to revision according to the model selected. The average accreted-hole mass-energy, as calculated from the present-day Universe model is approximately $6.2(10)^{55}$ Joules ($1/2 \times$ mass-energy of NGC 4594). This calculation puts the “galaxy black holes” at 0.17% of the Universe mass-energy if there are 10^{11} to 10^{12}

galaxies. If the “TON 618 hole” mass-energy $(1.19(10)^{70}$ Joules) is used to calculate the total “hole mass-energy”, (average $\equiv \frac{1}{2}$ TON 618 mass-energy), at 10^{12} galaxies, the holes constitute 11 % of the total Universe mass-energy. Therefore, “dark gravitational hole entities” might be responsible for most of the posited dark-mass-energy.

This “DG Black hole”, distorted-geometry primordial gravitational-structure, a “geometric-energy-density minimum” structure (DG_Hole $\equiv 2.63(10)^{51}$ Joules), along with the “geometric maximum-energy-density” structure, constitute the extrema, the mass-energy bounds of the gravitational-structure particle-spectrum, a range from $1.80(10)^{41}$ Joules to $2.63(10)^{51}$ Joules. The extrema for electromagnetic structures range from $8.19(10)^{-14}$ Joules for the electron to $1.29(10)^{-8}$ Joules for the W-boson. The distorted-geometry model, and its “gravitational-mass-energy spectrum” at the maximum energy-density extremum, incorporates the transitory short-lived character (not stable) of a “mediator structure”, a gravitational mimic of the electromagnetic W-boson structure.

Production numbers at creation depend on the “Universe-Creation-Model” utilized (see [16]), and the mass-energy distribution function. Here we tailor the Planckian “thermodynamically-constructed” black-body radiation-emission function to produce a mass-energy-creation, emission and energy-distribution function. We incorporate this “Mass-energy Black-Body” function to describe the “Universe-mass-energy” structure and its mass-energy emission (at creation) distribution.

The “Universe-mass-energy” $\equiv U_0 \equiv 5.38(10)^{70}$ Joules and the “mass-energy ratio” for “Milky-Way gravitational-hole” production is $\equiv Bu(x = DG_Hole/U_0) / DG_Hole = 2.25(10)^{11}$, posited as “the number of hole-seeded galaxies”, generated with the Planckian-like mass-energy distribution-function $Bu(x)$;

$$\begin{aligned}
 Bu(x) &\equiv \frac{1}{C_0} U_0 [x^N (e^x - 1)^{-1}] f_{BB}(x) \text{ with } x \equiv \frac{\text{mass energy}}{U_0}, \quad N = 1.4 \\
 \text{and} \quad C_0 &= \int_0^\infty [x^N (e^x - 1)^{-1}] f_{BB}(x) dx = 1.72 \text{ with } f_{BB}(x) = 1. \\
 Bu_2(x) &\equiv \frac{15}{\pi^4} U_0 [x^3 (e^x - 1)^{-1}] \text{ with } x \equiv \frac{\text{mass energy}}{U_0}, \quad N = 3 \dots \text{Planck's Law} .
 \end{aligned} \tag{12}$$

For $N = 1.35$ and $C0 = 1.69$, $Bu(x = DG_Hole / U0) / DG_Hole = 2.11(10)^{12}$ galaxies. The black body mass-limitation function $f_{BB} = 1$ in this calculation. The “thermodynamic” Planckian functions $Bu(x)$ and $Bu2(x)$ exhibit no energy-emission limit.

The Distorted-Geometry Black-Body Planckian distribution-function, $Bu(x)$ with $N = 1.4$, and the classical black-body Planckian radiation-emission distribution-function, $Bu2(x)$ are displayed in Fig.6. Because the Universe, primordially modeled as a black-body, is at an extreme temperature, the galaxy DG-Hole-energy appears in the “ u^{N-1} mass-energy range” and is off-scale in the Figure.

Fig.6 Black-Body energy distribution functions; DG-Bu (mass-energy) and Planckian-Bu2 (radiation energy), are expressed in Joules on the logarithmic ordinate scale as a function of mass-energy (Joules) on the logarithmic abscissa. For the classical Planck-distribution, $N = 3$ and for the posited Universe-energy distribution ($2.25 (10)^{11}$ hole-seeded galaxies), $N = 1.4$. The integral function $C0$ is 1.72 for the Universe-energy distribution and the classical black-body Planckian radiation-energy distribution integral is $\pi^4/15$. $U0$ is the “Universe mass-energy”.

The mass-energy ratio, “Bu (DG_Hole)) mass-energy-to-hole mass-energy”, is postulated to be the number of “hole-seeded-galaxies” and equal to 10^{11} to 10^{12} (references [22, 23]). The density of “dark-

matter” in the universe, posited as necessary in the presently accepted Universe-model, is not accounted for in this purely “gravitational-mass-energy spectrum” although a “black body” is considered “dark”.

However these distribution functions do not describe the “Universe as a Black-Body” entity in that the mass-energies exceed the “Universe-Energy” itself; it is a “continuous-energy distribution function” as opposed to a “discrete-energy distribution function”. In the absence of a known experimental mass-energy distribution function, we have posited a modified Planckian distribution function by incorporating the classical 3-dimensional “density of states” function, $f_{BB}(x) = (x - 1)^2$, thereby terminating the Distorted-Geometry Black-Body Planckian distribution function at the “Universe-Energy” U_0 ;

$$B_u(x) \equiv \frac{1}{C_0} U_0 [x^N (e^x - 1)^{-1} f_{BB}(x)] \text{ with } x \equiv \frac{\text{mass energy}}{U_0}, \quad N = 1.46,$$

$$f_{BB}(x) = (x - 1)^2 \quad \text{and} \quad C_0 = \int_0^1 [x^N (e^x - 1)^{-1}] f_{BB}(x) dx = 0.137. \quad (13)$$

$$B_{u2}(x) \equiv \frac{15}{\pi^4} U_0 [x^3 (e^x - 1)^{-1} f_{BB}(x)] \text{ with } x \equiv \frac{\text{mass energy}}{U_0}, \quad N = 3 \dots \text{Geo_Planck's Law}.$$

This distribution function, equation (13), (see Fig.7) produces $1.96 (10)^{11}$ as the number of hole-seeded galaxies, that is $B_u(x = DG_Hole / U_0) / DG_Hole = 1.96(10)^{11}$.

Fig.7 Modified Black-Body energy distribution functions; Universe-Bu (mass-energy) and Geo_Planckian-Bu2 (radiation energy) are expressed in Joules on the logarithmic ordinate scale as a function of mass-energy (Joules) on the logarithmic abscissa. For the classical Planck-distribution, $N = 3$ and for the posited Universe-energy distribution $(1.96(10))^{11}$ hole-seeded galaxies), $N = 1.46$. The integral function C0 is 0.137 for the Universe-energy distribution and the classical black-body Planckian radiation-energy distribution integral is 0.0258. U_0 is the “Universe mass-energy”.

Finally, for hole-like-structure elucidation, it is of interest to examine the ratio of the $1/r^6$ tensor-component to the $1/r^4$ tensor-component in the construction of the geometric fields. To further illustrate the structural character of the “distortional-geometry mimics”, we compare at “near-core radial regions” the geometrostatic field quantities $\mathbf{Fd}_{14}^2$ and $\mathbf{Fd}_{\text{mag}}^2$. For both gravitational and electromagnetic distortions, the magnetic field component, $\mathbf{Fd}_{\text{mag}}^2$, is non-zero at the “radial field zero”, $\mathbf{Fd}_{14}^2 = \mathbf{0}$, or “core radius”. This field feature would seem responsible for accretion-disk and galaxy-matter rotational-distribution behavior. Actually, the $\mathbf{Fd}_{14}^2$ fields contain r^{-6} elements of a magnitude comparable to the magnetic-field strengths $\mathbf{Fd}_{\text{mag}}^2$ (see equations (Si-6) in SI), resulting in a significant departure from the classical

Newtonian r^{-4} (or r^{-6}) behavior. The fields exhibit potential-well behavior as they radially transition to repulsion at the hole-core radius.

Discussion

It has been shown in the present work that the distorted-space model of matter, as extended to extreme curvature-limits, results in characteristics mimicking those of galactic-black-holes. The distorted-geometry structures exhibit non-Newtonian features wherein the hole or core-region fields of the structures are gravitationally-repulsive, do not behave functionally in an r^{-4} manner and terminate at zero at the radial origin (no singularity) while exhibiting a propagation velocity in the core region approximately 1.5 times that external to the core (light trapping or black hole behavior). Of particular interest is that of r^{-6} energy-density behavior at structural radial distances near the core of the distortion, a region also displaying potential-well behavior.

References

- [1]. Clifford, W. On the Space Theory of Matter. *Proc. Of the Cambridge philosophical society*. **2**, 157 (1876).
- [2]. Koehler, D. Geometric-Distortions and Physical Structure Modeling. *Indian J. Phys.* **87**, 1029 (2013).
- [3] Ciufolini, I. and Wheeler, J. A., Gravitation and Inertia, USA, Princeton University Press, 1996.
- [4] Wheeler J. A., Phys. Rev., vol. 97, p.511, 1955.
- [5] Wheeler J. A., “Logic, Methodology, and Philosophy of Science”, Proc. 1960 International Congress, USA, Stanford University Press, p.361, 1962.
- [6] Anderson, P.R.; Brill, D.R. Phys.Rev. 1997, D56 4824-33
- [7] Perry, G.P.; Cooperstock, F.I. Class.Quant.Grav. 1999, 16 1889
- [8] Sones, R.A. Quantum Geons, (2018) [arXiv:gr-qc/0506011](https://arxiv.org/abs/gr-qc/0506011)
- [9] Stevens, K.A.; Schleich, K.; Witt, D.M. Class.Quant.Grav. 2009, 26:075012
- [10] Vollick, D.N. *Class.Quant.Grav.* 2010, 27:169701
- [11] Louko, J. J. Phys.: Conf. Ser. 2010, 222:012038
- [12]. Linder, E. V. *First Principles of Cosmology*. Addison Wesley, England (1997).
- [13]. Tolman, R. *Relativity, Thermodynamics and Cosmology*. Dover, NY, 248 (1987).
- [14]. Abuter, R. et al., A geometric distance measurement to the Galactic center. *Astronomy & Astrophysics*. L10, **625** (2019).
- [15]. Lu, R. Detection of Intrinsic Source Structure at ~ 3 Schwarzschild Radii with Millimeter-VLBI Observations of SAGITTARIUS A*. *Astrophysical Journal*. **60**, 859 (2018).

- [16]. Koehler, D. Radiation-Absorption and Geometric-Distortion and Physical-Structure Modeling. *IEEE Transactions on Plasma Science*. **45**, 3306 (2017).
- [17]. Rees, M.J., Volonteri, M., Karas, V., Matt, G. Massive black holes: formation and evolution. *Proceedings of the International Astronomical Union*. 51-58 **238** (2007). doi:[10.1017/S1743921307004681](https://doi.org/10.1017/S1743921307004681).
- [18]. Vesperini, E., et al. Unified Field Theory and the Hierarchical Universe. *The Astrophysical Journal Letters* **713**(1) L41-L44 (2010). doi: 10.1088/2041-8205/713/
- [19]. Zwart, S., et al. Formation of massive black holes through runaway collisions in dense young star clusters. *Nature*. **428** (6984), 724–726 (2004). doi:[10.1038/nature02448](https://doi.org/10.1038/nature02448)
- [20]. O'Leary, R., et al. Binary mergers and growth of black holes in dense star clusters. *The Astrophysical Journal*. **637** (2): 937–951 (2006). doi:[10.1086/498446](https://doi.org/10.1086/498446).
- [21]. Kormendy, J., et al. Hubble Space Telescope Spectroscopic Evidence for a $1 \times 10^9 M_{\odot}$ Black Hole in NGC 4594. *The Astrophysical Journal*. **473** (2): L91–L94 (1996). doi:10.1086/310399.
- [22]. Conselice, C. J., et al, The Evolution of Galaxy Number Density at $z < 8$ and its Implications. *The Astrophysical Journal*. **830** (2): (2016). doi: 10.3847/0004-637X/830/2/83.
- [23]. Lauer, T.R. New Horizons Observations of the Cosmic Optical Background. *The Astrophysical Journal*. **906** (2) (2021) doi: 103847/1538-4357/abc881. <https://arxiv.org/abs/2011.03052>
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SI Supplementary Information

Supplementary Equations

BLACK HOLES AS GEOMETRIC DISTORTIONAL EXTREMA

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For the presently described spherically symmetric Maxwellian case, ϕ , the electrostatic potential, is a function of r alone, and the Maxwellian electromagnetic tensor and the associated field tensor $\mathbf{F}_{1\mu}$ can be constructed according to equation (SI-1), where the only surviving field tensor components are (following the symbolism and development of Tolman [SI-1]):

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

$$\mathbf{F}_{21} = -\mathbf{F}_{12}, \mathbf{F}_{13} = -\mathbf{F}_{31} \quad \text{and} \quad \mathbf{F}_{14} = -\mathbf{F}_{41}, \quad \text{i.e.}$$

$$\mathbf{T}^{\mu\nu} = -\mathbf{g}^{\nu\beta} \mathbf{F}^{\mu\alpha} \mathbf{F}_{\beta\alpha} + \frac{1}{4} \mathbf{g}^{\mu\nu} \mathbf{F}^{\alpha\beta} \mathbf{F}_{\alpha\beta} \quad \text{or} \quad \mathbf{T}^{\mu\mu} = -\mathbf{g}^{\mu\mu} \mathbf{F}^{\mu\alpha} \mathbf{F}_{\mu\alpha} + \frac{1}{4} \mathbf{g}^{\mu\mu} \mathbf{F}^{\alpha\beta} \mathbf{F}_{\alpha\beta}, \quad (\text{SI-1})$$

then

$$\mathbf{T}_4^4 = \frac{(\mathbf{F}_{12}\mathbf{F}^{12} + \mathbf{F}_{13}\mathbf{F}^{13} - \mathbf{F}_{14}\mathbf{F}^{14})}{2}, \quad \mathbf{T}_1^1 = \frac{(-\mathbf{F}_{12}\mathbf{F}^{12} - \mathbf{F}_{13}\mathbf{F}^{13} - \mathbf{F}_{14}\mathbf{F}^{14})}{2},$$

$$\mathbf{T}_2^2 = \frac{(-\mathbf{F}_{12}\mathbf{F}^{12} + \mathbf{F}_{13}\mathbf{F}^{13} + \mathbf{F}_{14}\mathbf{F}^{14})}{2} \quad \text{and} \quad \mathbf{T}_3^3 = \frac{(\mathbf{F}_{12}\mathbf{F}^{12} - \mathbf{F}_{13}\mathbf{F}^{13} + \mathbf{F}_{14}\mathbf{F}^{14})}{2}.$$

The resultant field quantities are

$$(\mathbf{F}_{14})^2 = -(\mathbf{T}_4^4 + \mathbf{T}_1^1) \mathbf{g}_{11} \mathbf{g}_{44} = (\mathbf{T}_2^2 + \mathbf{T}_3^3) \mathbf{g}_{11} \mathbf{g}_{44},$$

$$(\mathbf{F}_{12})^2 = -(\mathbf{T}_2^2 + \mathbf{T}_1^1) \mathbf{g}_{11} \mathbf{g}_{11} \quad \text{and} \quad (\mathbf{F}_{13})^2 = -(\mathbf{T}_3^3 + \mathbf{T}_1^1) \mathbf{g}_{11} \mathbf{g}_{11}.$$

Therefore, we see that the static-spherically-symmetric Maxwellian tensors exhibit the same stress and energy relationship as the geometric tensors [SI-1],

$$\mathbf{T}_4^4 = -(\mathbf{T}_1^1 + \mathbf{T}_2^2 + \mathbf{T}_3^3). \quad (\text{SI-2})$$

The present geometric-modeling endeavor, with its Maxwellian-tensor-form mimicking-component, has produced the fundamental and limiting agent for the currently-studied distorted geometry, namely a particular constraining functional relationship between the geometry-defining tensors (for an empty-space geometry, all of the components of the energy-momentum tensor are zero). In using this simple equation-of-state, equation (SI-2), as a restricting distortional-model tensor relationship, we thereby elicit the metric-defining differential equations for such a family of geometric distortions.

The geometric-energy-density or field equations, after using solution Eq. (SI-4), are repeated here (from [SI_2]); also see [SI_1];

STRUCTURAL EQUATIONS

The calculational treatment employs the isotropic coordinate description of equation (SI-1) and utilized by Tolman [SI-1], where the system of equations represented by equation (SI-1), is shown more explicitly in equation (SI-3) in mixed tensor form;

$$8\pi\kappa T_1^1 = -e^{-\mu} \left[\frac{\mu'^2}{4} + \frac{\dot{\mu}\dot{v}'}{2} + \frac{\mu' + v'}{r} \right] + e^{-v} \left[\ddot{\mu} + \frac{3}{4}\dot{\mu}^2 - \frac{\dot{\mu}\dot{v}}{2} \right], \quad (\text{SI-3})$$

$$8\pi\kappa T_2^2 = -e^{-\mu} \left[\frac{\mu''}{2} + \frac{v''}{2} + \frac{v'^2}{4} + \frac{\mu' + v'}{2r} \right] + e^{-v} \left[\ddot{\mu} + \frac{3}{4}\dot{\mu}^2 - \frac{\dot{\mu}\dot{v}}{2} \right] = 8\pi\kappa T_3^3,$$

$$8\pi\kappa T_4^4 = -e^{-\mu} \left[\mu'' + \frac{\mu'^2}{4} + \frac{2\mu'}{r} \right] + e^{-v} \left[\frac{3}{4}\dot{\mu}^2 \right],$$

$$8\pi\kappa T_4^1 = + e^{-\mu} \left[\dot{\mu}' - \frac{\dot{\mu}\dot{v}'}{2} \right],$$

$$8\pi\kappa T_1^4 = -e^{-v} \left[\dot{\mu}' - \frac{\dot{\mu}\dot{v}'}{2} \right].$$

Metric coupling, that is terms such as $\mu'v'$, are apparent in the fundamental curvature equations. The usual notation, where primes denote differentiation with respect to the radial coordinate r and dots denote differentiation with respect to the time coordinate t , is employed. We are considering the static case (where total differentiation replaces partial differentiation) as was also used for Schwarzschild's (gravitational) interior and exterior solutions for the model of an incompressible perfect-fluid sphere of constant density surrounded by empty space [SI-1]. In that work a zero-pressure surface-condition and matching and normalization of the interior and exterior metrics at the sphere radius were used as boundary conditions. Tolman [SI-1] has shown that the energy of a “quasi-static isolated system” can be expressed as “an integral extending only over the occupied space”, which we will allow to extend to infinity, and where the total energy of such a sphere is therefore expressed as

$$U(\text{sphere total}) = \int_0^\infty (T_4^4 - T_1^1 - T_2^2 - T_3^3) \sqrt{(-g_{11})^3 g_{44}} 4\pi r^2 dr = M_{\text{sphere}} c^2.$$

This mass-energy representation will be used throughout in calculating the distortional mass-energies. The distortional-tensor energy-density amplitudes manifested in these presently calculated geometric representations are both negative and positive, that is, there are both negative energy-density [SI-2] and positive energy-density regions internal to the distortions. However, the modeled distortions for the mimicked elementary particles all exhibit positive mass-energies. Since geometric distortional fields arise

from the same energy-density tensors, the negative energy-density geometric regions are also sources of negative energy-density field quantities.

$$\mu' = \frac{2(1-u^3)u^2}{(1u - \gamma)R0} , \quad u \equiv \frac{R0}{r} , \quad (\text{SI}_4)$$

(R0 is the normalizing radius after mimicking EM and gravitational forces)

$$1u = -u \left[\frac{3}{7}u^6 - \frac{3}{4}u^3 + 1 \right] ,$$

$$8\pi\kappa \mathbf{Td}_1^1 = -e^{-\mu} \frac{1}{(1u - \gamma)} \left(\frac{u^2}{R0} \right)^2 \left[2u^2 + (3u^3 - 1) \frac{1 - u^3}{(1u - \gamma)} \right] ,$$

$$8\pi\kappa \mathbf{Td}_2^2 = e^{-\mu} \frac{1}{(1u - \gamma)} \left(\frac{u^2}{R0} \right)^2 \left[4u^2 + (3u^3 - 1) \frac{(1 - u^3)^2}{(1u - \gamma)} \right] ,$$

$$8\pi\kappa \mathbf{Td}_4^4 = -8\pi\kappa (\mathbf{Td}_1^1 + 2\mathbf{Td}_2^2) \quad \text{since} \quad \mathbf{Td}_3^3 = \mathbf{Td}_2^2$$

or

$$\mathbf{Td}_4^4 = e^{-\mu} \frac{1}{8\pi\kappa(1u - \gamma)} \left(\frac{u^2}{R0} \right)^2 \left[-6u^2 - (3u^3 - 1) \frac{(2u^3 - 1)(u^3 - 1)}{(1u - \gamma)} \right] \quad (\text{SI-4a})$$

and

$$8\pi\kappa (\mathbf{Td}_2^2 + \mathbf{Td}_1^1) = e^{-\mu} \frac{1}{(1u - \gamma)} \left(\frac{u^2}{R0} \right)^2 \left[2u^2 - (3u^3 - 1) \frac{(1 - u^3)u^3}{(1u - \gamma)} \right] \quad (\text{SI-5})$$

leading to

$$(\mathbf{Fd}_{14})^2 = -g_{11}g_{44}(\mathbf{Td}_4^4 + \mathbf{Td}_1^1) = g_{11}g_{44}(2\mathbf{Td}_2^2) \quad \text{and}$$

$$(\mathbf{Fd}_{14})^2(r \rightarrow \infty) \stackrel{\text{def}}{=} \left(\frac{Rs}{2} \right)^2 \frac{2}{8\pi\kappa} \frac{1}{r^4} = \frac{Rs^2}{2} \frac{1}{8\pi\kappa} \frac{1}{r^4} \stackrel{\text{def}}{=} \left(\frac{q}{4\pi\epsilon_0 r^2} \right)^2 \frac{\epsilon_0}{2} .$$

$$(\mathbf{Fd}_{12})^2 + (\mathbf{Fd}_{13})^2 = 2g_{11}g_{11} \left(\frac{\mathbf{Td}_4^4 - \mathbf{Td}_1^1}{2} \right) \stackrel{\text{def}}{=} \mathbf{Fd}_{\text{mag}}^2 =$$

$$= -2 g_{11} g_{11} (\mathbf{Td}_1^1 + \mathbf{Td}_2^2) \quad \text{and}$$

$$(\mathbf{Fd}_{12})^2 + (\mathbf{Fd}_{13})^2 (r \rightarrow \infty) = 2 R_s R_0^3 \frac{1}{8\pi\kappa} \frac{1}{r^6} \stackrel{\text{def}}{=}$$

$$\stackrel{\text{def}}{=} \frac{\mu_0}{2} \left(\frac{\mu_{spin}}{2\pi} \right)^2 \frac{1}{r^6} \quad (\text{SI-6})$$

where

$$\mu_{spin} \stackrel{\text{def}}{=} \left(\frac{g_e Q e}{2 3M} \right) S \hbar \quad \text{and} \quad g_e = 2.00231930436 \quad (\text{for the electron}).$$

The **Td** and **Fd** symbolism is used for the “distorted geometry” tensor quantities. The field equations, in both the EM realm and the gravitational realm ($Q = 0$), exhibit r^{-6} geometric behavior which we have interpreted as constituting a “magnetic monopole” mimic (what is a “magnetic monopole”?).

References

- [SI-1]. Tolman, R. *Relativity, Thermodynamics and Cosmology*. Dover, NY, 248 (1987).
[SI-2]. Koehler, D. Geometric-Distortions and Physical Structure Modeling. *Indian J. Phys.* **87**, 1029 (2013).