Folded Time Creation of Residual Masses in Vector Electrodynamics.

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Abstract

The flatspace nullification of the Einstein tensor curvature for the elementary continuous source (active radial particle or field) and sink (passive radial particle or field) maintains the conceptual equivalence of collinear active and passive energy-momentum densities of energy-matter carriers in General Relativity (GR). The Ricci scalar curvature of the (astro)electron’s material space is related to residual positive energies of negative active and positive passive mass densities, while electromagnetic (EM) active and passive imaginary masses produce the traceless energy density in the electron’s Lagrangian. One four-potential in geometrical sink-source identities universally forms gravitational and electromagnetic fields of the complex mass current. EM vector equalities balance anti-collinear four flows of active and passive imaginary masses (or electric charges). Similar GR vector equalities correspond to the inseparable coupling of twin unlike active mass densities beside twin passive time-converted fields due to folded time symmetry, \( dt = | \pm idx^4/c | \), in the Minkowski four-interval for real (inertial) matter. Folded pseudo-coordinates \( \pm x^o \equiv \pm ix^4 \) for unlike twin masses, called comasses, provide creation of material bodies with collinear active (source) and passive (sink) four-flows with real energy-momentum for residual gravitation and inertia of EM charges. Couples of unlike twin masses can ‘radiate-absorb’ paired vector waves (confined tensor gravitons) with zero-balanced Poynting flows under real-time gravitational interactions in the two-body system. Such paired gravitational waves cannot be screened by third bodies or intercepted by interferometers.

1 Geometrization of the nonlocal carrier of mass-energy

The Standard Model has not yet explained the origin of inertial mass and has failed to incorporate Einstein’s General Relativity into the \( SU(3) \times SU(2) \times U(1) \) gauge scheme. Breaking of Lagrangian chiral symmetry has been already justified by Quantum Chromodynamics for \( 10^{-15} \) m scales and it is not clear what further measurements of space beyond the current \( 10^{-18} \) m limit might change for this mass forming symmetry. The goal of this article is to revisit algebraic and geometrical conditions for the residual creation of the Ricci curvature of GR energy spaces from the traceless electromagnetic (EM) vacuum \( \Pi \) of \( U(1) \) gauge fields. Our algebra equally employs both imaginary coordinate branches, \( \pm ix^4 \equiv \pm x^o \), of folded world pseudo-geometry for single time physical reality with \( dt = | \pm dx^o |/c > 0 \). Such pseudo-geometry might
originated after the spontaneous coordinate folding of regular 4D geometry for zero-balanced imaginary electromagnetic (iEM) mass four-flows. Two mirror pseudotimes, $\pm x^o/c$, for the GR four-interval can describe spatial coupling of unlike GR charge densities, $\rho^+ = -\rho^-$, with folded (collinear) energy-momentums for active (distributed source-particle or conventional field) and passive (distributed sink-particle or inertial conventional particle) fractions of gesamt (= whole) energy carriers in folded time practice. The global fluctuation of vacuum 4D geometry into the real world pseudo-geometry with one partially folded coordinate, Big Bang or Big Fold with $[-x^o_{BB}; +x^1_{BB}] \rightarrow 2[0, |ix^1_{BB}|] = 2[0, cT_{BB}]$, might created collinear (residual) energy-momentums and angular momentums vectors from anti-collinear (zero-balanced) source and sink vacuum iEM mass flows. A steady or accelerated relaxation of such a positive energy fluctuation to flat zero-energy vacuum with regular geometry can drive world matter dynamics under decreasing rest-mass densities and the decreasing length $cT \equiv |x^o| \rightarrow 0$ of the global vacuum fluctuation. Relaxation shrinking, $c(T) \equiv d| \pm x^o| < 0$, of two folded pseudotimes $\pm x^o$ defines the positive time arrow $dt = | \pm dx^o/c| = dU_T > 0$ for the increasing Universe age $T_U = T_{BF} - T > 0$. Einstein’s tensor gravitation for coupled unlike masses with folded time symmetry (FTS) at two pseudotimes $\pm x^o/c$ corresponds to paired vector interactions and can be unified with Maxwell’s electrodynamics for (continuous) carriers of active and passive complex masses.

Before the 1897 discovery of the electron, Thompson \[2\] proposed to relate the conventional electric field energy $E \equiv (1/8\pi) \int_0^\infty (-e_o/r^2)^2 4\pi r^2 dr = e_o^2/2a$ of the charged sphere to corpuscle’s mass (or electron’s rest-mass $m_o = 0.51$ GeV at $2a = 2.8 \times 10^{-15}$ m). He later decided to call the celebrated term $4E/3$ as the electromagnetic part of the inertial mass ($c=1$ unless otherwise stated). However, the Lorentz transformations of the symmetrical EM energy-momentum tensor, $T^{\alpha\nu} = T^{\nu\alpha} = [T^{\alpha\nu}(1 + v^2) + vT^{\alpha\nu} + vT^{\nu\alpha}]/(1-v^2) \approx (4T^{\alpha\nu}/3)v$, cannot coincide with the transformations of four-vectors for moving scalar masses. This blocked coherent theoretical attempts to reconcile Thompson’s electromagnetic mass with the Lorentz invariant dynamics of the inertial mass $m_o$. Moreover, there are no reports that electrons exhibited radial inhomogeneities up to experimentally achieved $10^{-18} m$ scales. Therefore, both theory and practice deny the Thompson radius for the EM content of inertia. From where does the inertial mass-energy $m_o \neq 0$ come from if not EM fields or their invariant scalar constructions?

We support Thompson’s fundamental guess about the electromagnetic origin of mechanical masses through Sakharov’s hypothesis of gravitation as a residual electromagnetic phenomenon \[3\]. For a vector EM-type unification of two fundamental forces, a joint (forming-up) four-potential for gravitational, $W_{\mu}$, and electromagnetic, $A_{\mu} = \text{const} \times W_{\mu}$, classical fields should be justified. We start this program from the Einstein-Grossmann ‘Entwurf’ flatspace generalization \[4\] of the Minkowski interval and employ this original metric approach for further geometrization of the continuous source-particle (fluctuating $r^{-4}$ radial formation for particle-wave matter or energy) together with its continuous sink-particle in non-empty (material) energy space. We find that one universal four-potential $W_{\mu}$ can form the Maxwell EM field and the Einstein GR metric field, when the balanced Einstein tensor curvature, $G_{\mu}^\nu \equiv g^{\mu\nu}R_{\omega\nu} - \delta_{\mu}^\nu R/2 = 0$, describes joint geometrization of the elementary continuous source-particle (active charge-energy) and continuous sink-particle (passive charge-energy). Then the Ricci scalar density $R = g^{\mu\nu}R_{\mu\nu}$ of curved 4D space-time of the elementary carrier with flat 3D subspace depends on the local active and passive energy densities of this carrier of distributed energies. The local metric tensor $g^{\mu\nu}$ in pseudo-Riemannian geometry of the $r^{-4}$ nonlocal carrier of energy depends on its spatial integral or the GR energy-charge \[5\].

The energy-momentum $P_{\mu} \equiv m_p u_{\mu} \equiv m_p g_{\mu\nu}dx^\nu/ds = K_{\mu} + G_{\mu}P_\nu$ of an Einstein-Grossmann
non-rotating material point (an infinitesimal volume of matter $\Delta V \to 0$) with passive-inertial mass $m_p$ and the positive kinetic energy $K \equiv m_p/\sqrt{1-v^2}$ complies with the four-component gravitational potential, $G_\mu \equiv (G_o,G_i)$, for the probe (passive-inertial) charge-energy, $P_\mu/c^2 = m_p \sqrt{g_{oo}/\sqrt{1-v_i v^i}} > 0$, in pseudo-Riemannian space-time with strict spatial flatness, where

$$ds^2 \equiv g_{\mu\nu}dx^\mu dx^\nu = \left(\frac{dx^0 + G_i dx^i}{1 - G_o}\right)^2 - \gamma_{ij} dx^i dx^j,$$

$g^{oo} = (1 - G_o)^2 = \delta^{ij} G_j G_j$, $g^{oo} = g^{oo} = \delta^{ij}$, $g_{oo} = (1 - G_o)^{-2}$, $g_{oi} = G_i/(1 - G_o)^2$, $g_{ij} = -\delta_{ij} + G_j G_j (1 - G_o)^{-2}$, $v_i = \gamma_{ij} dx^i/d\tau$, $d\tau^2 = ds^2 + \gamma_{ij} dx^i dx^j$, $\gamma_{ij} \equiv g_{ao} g_{oj} g_{oo} - g_{ij} = \delta_{ij}$, and $\sqrt{-g} = \sqrt{g_{oo}} \mathbb{I}$. Such ‘Entwurf’ flatspace geometrization of the $r^{-4}$ continuous particle aside with the $r^{-2}$ Newtonian field ‘simplifies’ the Einstein-Grossmann tensor formalism for every elementary continuous carrier of active and passive energy densities through nullification of their energy-momentum components in the Einstein tensor curvature,

$$\begin{cases}
G^\mu_o = g^{\mu\nu} R_{\nu\nu} = g^{\mu\nu} R_{\nu\nu} + g^{ij} R_{\nu\omega} = \delta^{ij}(G_j R_{\nu\nu} - R_{\nu\omega}) = 0 \\
G^0_0 \equiv g^{0\nu} R_{\nu\nu} - (R/2) = (g^{oo} R_{oo} - g^{ij} R_{ij})/2 = [(1 - G_o)^2 R_{oo} + \delta^{ij}(R_{ij} - G_i G_j)]/2 = 0 \\
(2)
\end{cases}
$$

with $R_{oo} = g_{oo} R/2$, $\delta^{ij} R_{ij} = g^{oo} g_{oo} R/2$, and $\sum_1^\infty u_\mu u_\nu G^\nu_0 = 0$.

In our energy-to-energy reading of Einstein-Grossmann’s metric gravitation, a Newtonian force $(\mathbf{r} G/\gamma^2)(-P^\mu_o/c^2)(P^\nu_o/c^2)$, exerted to the positive passive-inertial charge, $P^\mu_o/c^2 > 0$, takes place due its attraction by the active (negative) gravitational charge $(-P^\mu_o/c^2) < 0$, which also possesses the positive active self-energy $(-P^\mu_o/c^2)(-\gamma^2) > 0$. Our ultimate goal is to explain the origin of negative and positive GR charges with collinear energy-momentums in terms of residual parts of vacuum (balanced, anti-collinear) imaginary mass four-flows. We develop pure geometrical approach to the electron’s active and passive complex masses with EM imaginary counter-flows (balanced densities) and GR real co-flows (residual, imbalanced densities). We discuss the residual EM origin of the electron’s GR four-momentum and the Ricci curvature in the Einstein-Grossmann metric gravitation (2) with flat space. Our curved pseudo-metric (1) with Euclidean 3D submetric yields $g^{oo} = \delta^{ij} G_i = \delta^{ij} g_{oo}/g_{oo}$, $R_{oo} = G_i R_{oo}$, and $R/2 = g^{oo} R_{oo} = g^{oo} R_{oo} + g^{ij} G_i R_{oo} = (1 - G_o)^2 R_{oo} = R_{oo}/g_{oo}$. Therefore, the conceptual nullification of the Einstein curvature for the gesamt carrier of active and passive positive energies corresponds to $R_{oo} = g_{oo} R/2$ and $\delta^{ij} R_{ij} = g^{oo} g_{oo} R/2$. These solutions are displayed in (2) after the Einstein geometrization rule $G^\mu_o = 0$ for an elementary continuous carrier of active and passive GR energies. A covariant contraction of four ‘time’ components of the Einstein curvature with the carrier four-velocity $u_\mu$, provides energy, $u_\mu G^\mu_o \equiv u^\nu R_{\nu\nu} - u_{o}(R/2) \equiv (g_{oo} u^0 - u_o) R/2 \equiv 0$, and four-momentum, $u_\mu u_\nu G^\nu_0 \equiv 0$, equalities for elementary energy spaces with $R \neq 0$. The joint dynamical equation $\sum_1^\infty u_\mu u_\nu G^\nu_0 = 0$ for all overlapping elementary carriers of radial mass-energies is also displaced in (2) as a consequence of the complete (particle + field) geometrization $G^\mu_o = 0$ for every gesamt radial carrier.

In static cases with $G_o = -r_0/r$ and $G_i = 0$, the GR radial source generates a negative interaction potential $W_o(r) = -c^2 \ln(1 + r_o r^{-1})$ due to its active (negative) gravitational charge $m_a \sqrt{g_{oo}/\sqrt{1 - v_i v^i}} \equiv (-P_o/c^2) < 0$ with the negative mass scalar, $m_a = -m_p < 0$. Such a negative active gravitational charge with the negative active mass can attract positive passive-inertial charges through vector forces only due to mass-$x^0$ symmetry hidden in single
time reality of positive energies. In other words, our goal is to find justifications for new physical options with reversed pseudo-coordinates, $\pm x^0$, and unlike masses beside $CPX^0$ vector forces when parity (P) is associated with charges (C) or masses (M) at different pseudo-coordinates $\pm x^0$, rather than at real time. FTS relations $m^+ dx^0 = m^- d(-x^0)$ for twin coupled unlike masses (comasses, for brief) keeps the positive time rate $dt = |\pm dx^0|$ under the pseudo-inversion $x^0 \rightarrow -x^0$ which does not reverse the real world motion of observed carriers of energy. The static radial potential $W_o$ with the energy-driven scale $r_o \equiv GP_o > 0$ can describe both a radial astrodensity, $\rho_a = -\nabla^2 W_o(r)/4\pi Gc^2 < 0$ of the active gravitational charge ($-P_o/c^2 < 0$), and the passive-inertial mass-energy density, $\rho_p = (\nabla W_o)^2/4\pi Gc^2 > 0$, of the passive gravitational charge $P_o/c^2 > 0$. Similar to electrodynamics, negative active GR charge density $\rho_a$ gains positive self-energy $\rho_a(-c^2) = \mu_a > 0$ in the negative self-potential $(-c^2) = -1$ for the negative charge. This constant self-potential is free from self-forces because $\nabla(-c^2) \equiv 0$. Active and passive energy densities equally contribute $[5]$ to the local Ricci scalar $Rc^2 = \kappa[\rho_a(-c^2) + \rho_p(+c^2)] = \kappa(\mu_a + \mu_p) = 2\kappa\mu_a = 2\kappa\mu_p > 0$, where $\kappa \equiv 8\pi G/c^2 = 1.86 \times 10^{-26} m/kg$. Our goal is to infer how the Ricci curvature $R$ in flatspace relativism (2) for real active and passive masses (and unlike GR charges) can match complex active and passive mass flows with zero contributions of imaginary masses into inertia and gravitation. Then electric charges can be associated with imaginary masses in the FTS pseudo-geometrical unification of classical GR+iEM fields of complex masses (or complex charges with real, residual self-energies).

Energy-momentum densities of the unified continuous carrier of complex GR+iEM masses should obey the universal transformation laws. Therefore, GR four-vector equalities $u^\mu u^\nu G_{\mu\nu} \equiv 0$ for gravito-mechanical mass-energy densities of the gesamt radial carrier request similar four-vector equalities for iEM densities of a distributed electric charge and its field. In what follows, we rely on the passive self-energy of a continuous imaginary electric charge (sink) and on the active self-energy of iEM field (source), with the exact local balance of sink and source count-flows for their inertia-free imaginary masses or electric charges. Basic geometrical identities for radial fields with the universal four-potential $W_\mu$ (and its complex gauge transformations) will be derived for the continuous carrier of GR+iEM masses independently from values of their real (inertial) or imaginary (electrical) parts. These forming-up identities associate Maxwell’s equations-equalities with imaginary masses, while associating Newton-Poisson’s gravitation equation with real (inertial) masses. Zero divergence (or strong local conservation) of complex mass four-flows with arbitrary fluctuations and wave modulations can shed some light from these geometrical identities on the particle-wave duality for nonlocal classical matter.

By balancing anticollinear active and passive iEM four-flows of the bi-fractional (continuous source-particle and continuous sink-particle) radial electron, we should reserve physical options for the residual imbalance of its real mass four-flows. The latter should maintain a collinear transport of the positive energy, $(-P_o/c^2)(-c^2) = (-\int d\pi 4\pi r^2(\nabla^2 W_o)/(4\pi Gc^2)(-c^2) > 0$, of the active (negative) GR charge-source and the positive energy of the passive-inertial (positive) GR charge-sink, $P_o/c^2 = \int 4\pi r^2 dr(\nabla W_o)^2/(4\pi Gc^2) > 0$. Residual or collinear source and sink energy-momentums ‘here’ require two more Machian partners ‘there’ for balanced (zero sum) creation of real energy from void nothingness. Such a partnership should explain the creation of active masses with positive GR energies simultaneously with equal positive energies of passive masses. This mutual partnership can indeed be justified for single time reality of radial mass-energy densities under pseudo-geometrical folding of 4D vacuum geometry of traceless EM energy spaces. We assign mirror $\pm x^0$ branches in folded pseudo-geometry to spatially coinciding Machian partners ‘here’ and ‘there’. Then a mirror partner ‘there’ (with positive source’s mass) can belong to the
same spatial structure of the elementary energy carrier ‘here’. The unlike twin masses (comasses $m^\pm$) get identical (folded) time dynamics and attractive cross-branch forces in $MPX^o$ vector interactions.

Folded time symmetry of the world pseudo-geometry suggests to read the GR mass-vs-energy relation $P_\mu P^\mu = (\pm m_o)^2(\pm c^2)$ equally with both algebraic signs next to the inertial mass $m_o$, with equal active, $(-m_o)(-c^2)$, and passive, $m_oc^2$, rest-frame energies. What benefits can the folded Lagrangian with the cross-branch symmetry $m^+dx^o \equiv m^-(-dx^o)$ provide for the mass creation mechanism of inertia-free electric charges? Geometrical folding of the zero-sum vacuum 4D fields with anti-collinear four-momentums enables cross-branch pairing of twin comasses with their local coupling and twin non-zero energy. This imbalanced or residual inertial mass-energy is positive under the positive time arrow. Briefly, a short fold of zero-sum anti-collinear vectors (in void balance of vacuum states or imaginary mass counter-flows) results in a residual four-vector (observed energy-momentum in pseudo-metric reality) next to the vacuum parts of charged matter. Interactions of two imaginary electric charges result in real forces, exerted on real (inertial) masses-energies. Again, real EM forces and real EM energies can be observed exclusively through dynamics of real GR masses of complex GR+iEM masses (or complex charges). Vacuum electric charges without inertial rest-masses (pure imaginary masses) were never observed in physical reality.

2 Locally balanced active and passive imaginary mass flows

There is no satisfactory mathematical approach to the diverging field energy of the Coulomb point charge in the classical theory of fields. We assign imaginary densities to both the active (source, yang) radial charge and the passive (sink, ying) radial charge or conventional electric field that keeps real interaction forces between active, $(iq)^*$, and passive, $iq$, electric charges. To be more specific, we accept that the equilibrium radial electron possesses the active charge distribution, $i^*\rho(r) = i^*(-e_o)r_o/4\pi r^2(r + r_o)^2 = i^*\nabla d/4\pi$, and has the imaginary self-potential $i\Lambda_e = const$ for real self-energy generation. Then, the local balance of active (source) and passive (sink) real EM energy densities can be achieved for the radial (astro)electron in full analogy with the Equivalence Principle for active and passive GR mass-energies. We replace, due to the exact solution to static Maxwell’s equations [5], the operator particle density $\delta(r - R_e)$ with the steady particle density $n(r - R_e) = r_o/4\pi(r - R_e)^2(|r - R_e| + r_o)^2$ around the center of spherical symmetry at $R_e$.

Thompson’s squared electric field energy does not contribute to the collinear (residual, inertial) imbalance at any scale $r_o$ for the radial electron because this passive charge self-energy is strictly balanced by the active, divergence electric field or active charge self-energy. Due to the extension of the Principle of Equivalence on balanced active and passive EM self-energies, one can rigorously consider extremely small half-charge scales $r_o \equiv GP_o \approx Gm_o \equiv r_e = 7 \times 10^{-58}m$ for the imaginary density $i\rho(r)$ of the elementary passive electric charge (passive imaginary mass) and the post-Coulomb interaction potential, $i^*\Lambda_e(r) = i^*(-e_o/r_e)W_o(r) = i^*(-e_o/r_e)\ln(1 + r_o/r_e)$ of the active electric charge. This inhomogeneous imaginary potential for real interactions with other passive imaginary charges is not a uniform self-potential $i^*\Lambda_e$. The latter nullifies local self-forces ($i^*\nabla \Lambda_e \equiv 0$) without additional Poincaré pressures for stabilization of the elementary passive charge density $i\rho(r)$. The constant self-potential $i^*\Lambda_e$ transforms, in fact, the passive ele-
mentary charge density $i\rho(r)$ into the real self-energy density $i\rho(r)\times i^*\Lambda_e = \rho(r)\Lambda_e = e(r)d(r)/4\pi$.

The self-potential magnitude, $\Lambda_e \equiv (-e_o)/r_e$, for the radial (astro)electron can be defined from the Maxwell static field solution $id_r = ie_r r_e/r_o = -i(r_e/r_o)\partial_r A_o(r) = i(-e_o)/r(r + r_o)$ due to the balanced active and passive electric field energies, with $(-e_o)\Lambda_e = \int dr 4\pi r^2 \rho(r)\Lambda_e = \int d\rho^{\mu\nu} dr 4\pi r^2 \rho(r)A_o(r)$.

Once static post-Newton and post-Coulomb potentials of active GR and EM charges are proportional to each other, $W_o/A_o = Gm_o/e_o = \text{const}$, then one can use identical covariant transformations for gravitational and electromagnetic four-potentials, $W_{\mu}(-\xi^2) = -(r_e u_\mu/r_o)ln[1 + (r_o/\sqrt{-\xi^2})]$ and $i^*A_{\mu}(-\xi^2) = i^*(e_o/r_o)W_{\mu}(-\xi^2) = -i^*(e_o u_\mu/r_o)ln[1 + (r_e/\sqrt{-\xi^2})]$, respectively, with $-\xi^2 = -\xi_o \xi^\mu = -x_\mu x^\mu + (u_\mu x^\mu)^2 \Rightarrow r^2$ for $u^\mu = (1, 0, 0, 0)$, $\xi^\mu = x^\mu - u^\mu(u_\nu x^\nu)$, $u_\mu u^\mu = 1$, $u_\mu \xi^\mu = 0$, $\nabla^\mu(-\xi^2)/2 = -x^\mu + u^\mu(u_\nu x^\nu)$. Recall that the radial scale $r_o = GP_o = Gm_o u_o = r_e u_o$ is defined by the variable energy component of four-vector $P_\mu = m_o g_{\mu\nu} u^\nu$, with $m_o \equiv +\sqrt{P_\mu P^\mu}$.

The Hilbert gravitational action $S = -\int \sqrt{-g}d^3xd\rho/2\kappa$ for the geometrized (astro)carrier in non-empty space depends on the active (continuous source) and passive (continuous sink) contributions into the Ricci scalar density $R = \kappa (\mu_o + \kappa \rho_p > 0$ for curved space-time under strict spatial flatness (when $\sqrt{-g} = \sqrt{g_{oo}}$). Such an active+passive Ricci structure may originate, in principle, as a residual real part of complex active and passive masses in the unified GR+iEM action $S_z = \int \sqrt{-g}d^3xdx^o(iZ^* + iZ)/2\kappa$ for distributions of active, $iZ^*$, and passive, $iZ$, complex densities of the gesamt (astro)carrier of elementary energies. We associate the active complex charge distribution with the continuous source (including its fluctuations and wave modulations) and the passive complex charge distribution with the continuous sink (which should reiterate source’s vector flows in the Lagrange equations of motion). In this way we generalize the real Ricci term, $R/\kappa = \mu_o + \mu_p = -(iZ^* + iZ)/\kappa$, in the Hilbert action on the sum of complex active $(iZ)^*$ and passive $iZ$ Lagrange densities above and below the origin the unfolded coordinate $dx^o$ in regular 4D geometry,

$$S_z = \int_{-\infty}^{\infty} dx^3 \left[ \int_0^T \sqrt{-gdx^0} \left( \frac{-Z^* + Z}{2\kappa} \right) + \int_{-T}^0 \sqrt{-gdx^0} \left( \frac{-Z^* + Z}{2\kappa} \right) \right] \equiv S_z^+ + S_z^- \quad (3)$$

Now we can set the complex scalar density $iZ^* = i^*e^{i\gamma}f_{\mu\nu}f^{\mu\nu}M/m_o$ for the active (source) fraction of matter and $iZ = ie^{-i\gamma}f_{\mu\nu}f^{\mu\nu}M/m_o$ for passive (sink) matter of the whole (gesamt) particle-source + particle-sink carrier. Hereinafter antisymmetrical tensor intensities, $f_{\mu\nu} \equiv (\nabla_\mu W_\nu - \nabla_\nu W_\mu)_{\mu\nu}$ and $f^{\mu\nu} \equiv g^{\mu\nu}g^{\lambda\kappa}f_{\lambda\kappa}$, and the contravariant potential $W_\mu = g^{\mu\nu}W_\nu$ are defined through the dimensionless four-potential $W_\mu$. The real parameter $M$ is an arbitrary magnitude of the complex GR+iEM charge composition, while $M \sin \gamma = m_o = 8\pi r_e/\kappa$ is its real GR or mechanical part part.

At first we drop for a moment the ‘unphysical’ negative branch $x^o < 0$ in the elementary action (3) for complex mass densities in 4D space. The reduced action with only one positive branch for such transition in question to 3D+1T pseudo-geometry with unfolded physical time, when $dt = +dx^o/c$ and

$$S_z^+ = -\int_{-\infty}^{\infty} dx^3 \int_0^T i\sqrt{g_{oo}}dt \frac{M}{16\pi r_e} \left( e^{i\gamma}f_{\mu\nu}f^{\mu\nu} - e^{-i\gamma}f_{\mu\nu}f^{\mu\nu} \right) \quad (4),$$

employs the incomplete Lagrangian without FTS options for positive and negative (real) masses. Equal contributions to the active matter density (with $e^{i\gamma}$) and the passive matter density (with
$e^{-i\gamma}$ should not be subtracted in (4) before the Lagrange variations for dynamical equations. Evaluations of covariant derivatives, $\nabla_\nu W^\mu = -r_o \xi_\nu u^\mu / u_o(\sqrt{-\xi^2} + r_o)(-\xi^2)$, can be achieved under the Lorentz condition $\nabla_\mu W^\mu = 0$ (when $r_o = \text{const}$ for the steady radial electron without GR energy changes due to waves or fluctuations). Notice that $\nabla^\mu W^\mu \neq 0$ or $\xi^\mu u^\mu \neq 0$ even for $\xi_\mu W^\mu = \xi_\mu u^\mu = 0$.

The imbalance factor $\gamma$ will be related to the residual inertia mechanism for complex EM charges, with extremely small real GR parts for one elementary electric charge associated with $\gamma \ll 1$ and $m_p = m_o = r_e / G \ll M$. The electron’s energy-driven scale $r_o$ can vary under time-depending interactions together with variations of the gravito-mechanical energy content $P_o$. The mass-driven scale $r_e = Gm_o$ may depend only on cosmological parameters, like the (diminishing) world length of the folded pseudo-coordinate $cT = x_{BB} - cT_U$.

The residual inertia factor $\gamma \equiv \gamma(T) \approx \text{const}$ imbalances complex densities of the active distributed particle (continuous source or classical field), $iMe^{i\gamma}$, and the passive distributed particle (continuous sink or inertial classical body), $iMe^{-i\gamma}$, of the elementary continuous carrier. One can associate equal active and passive imaginary parameters $\text{Im}(iMe^{i\gamma}) = M\cos\gamma$ and $\text{Im}(iMe^{-i\gamma}) = M\cos(-\gamma)$, respectively, with active and passive EM masses of an electrically charged carrier. Real parts, $\text{Re}(iMe^{i\gamma}) \equiv m_a$ and $\text{Re}(iMe^{-i\gamma}) \equiv m_p$, can be associated with active (source) and passive (sink) GR masses, respectively, with $(-m_a) = m_p = M\sin\gamma = m_o > 0$. Variations of the action (4) with respect to the four-potentiel $W_\mu$ ought to produce, in principle, eight Euler-Lagrange equations for imaginary and real mass four-flows. Lagrange equations for the imaginary EM mass densities from (4) maintain the mutual local balance of anti-collinear active and passive EM four-flows in terms of vector identities for equal active and passive imaginary masses or imaginary charges, $i^* q_o \equiv i^* M\cos\gamma \sqrt G$ and $iq_p \equiv iM\cos(-\gamma) \sqrt G$, respectively,

$$\frac{-i^* q_o \nabla_\nu f^{\mu\nu}}{\sqrt G 4\pi r_e} = \frac{iq_p \nabla_\nu f^{\mu\nu}}{\sqrt G 4\pi r_e} = \frac{iq_p}{\sqrt G}(nu^\mu + l^\mu) \equiv \frac{-i^* q_o}{\sqrt G}(nu^\mu + l^\mu),$$

with $q_o = q_p = q_o$ and $M^2 = (q_o^2 / G) + m_o^2$.

Here we first equalized the covariant derivatives for local counter-flows of active and passive imaginary mass (or iEM charge) densities. Then we set the passive four-current through the steady (equilibrium) four-flow $nu^\mu$ of the radial particle density $n$ and the four-flow $l^\mu$ of unspecified particle’s fluctuation or wave modulations. The passive four-current locally balances (reiterates) the active one. The local density $l^\mu$ vanishes under the local Lorentz condition $\nabla_\mu A^\mu = \text{const}\nabla_\mu W^\mu = 0$ for steady radial states, that corresponds to the spatial scale conservation, $r_o = GP_o = \text{const}$, in the unified EM and GR four-potentiel $W^\mu$. The radial particle flow $nu^\mu$ for $r_o = \text{const}$ and $\xi_\mu W^\mu = 0$ of the steady elementary source can be specified through the following evaluations of covariant derivatives,

$$n(\sqrt{-\xi^2})u^\mu \equiv \frac{1}{4\pi r_e} \nabla_\nu[\nabla^\mu W_\nu(\sqrt{-\xi^2}) - \nabla^\nu W_\mu(\sqrt{-\xi^2})] = \nabla_\nu \left[ \frac{(\xi^\mu u^\nu - \xi^\nu u^\mu)r_o}{4\pi r_e u_o(\sqrt{-\xi^2} + r_o)\xi^2} \right]$$

$$= \frac{u^\mu}{4\pi(\sqrt{-\xi^2} + r_o)\xi^2} = \frac{(\sqrt{-\xi^2} + 2r_o)u^\mu}{4\pi(\sqrt{-\xi^2} + r_o)^2\xi^2} = \frac{r_o}{4\pi(\sqrt{-\xi^2} + r_o)^2(-\xi^2)}u^\mu. \tag{6}$$

The particle’s density $n(-\xi^2)$ matches the electric charge density $(-e_o)n(r) = (-e_o)r_o / 4\pi(r + r_o)^2r^2$ and the inertial mass-energy density $\mu_p(r) = m_o c^2 n(r)$ in the electron’s rest frame.\[\]
where $\sqrt{-\xi^2} = r$. The post-Coulomb field intensity, $f'^{\mu\nu} = u^o x^i/(r + r_o)r^2 = u^o d^i$, is coherently derived from $f^{\mu\nu} \equiv (\xi^\mu u^\nu - \xi^\nu u^\mu)r_e/(-\xi^2 + r_o)\xi^2$ in this static limit with $4\pi n(r) = \nabla d^i$. The passive imaginary counter-flow is identical to the active flow in (5) and, therefore, the left-hand side covariant derivative in (5) for active tensor fields can be identically interpreted thorough the source flows $nu^\mu$ for radial density $n$ particle and $l^\mu$ (for fluctuations). Passive and active four-flows are bound (yin-yang) identical entities in this approach, while their tensor fields can be shifted, $f_\mu^{\nu\alpha} - f_\alpha^{\nu\mu} = \tilde{f}^{\nu\mu} \neq 0$, by non-trivial (wave) solutions of $\nabla_\nu \tilde{f}^{\mu\nu} = 0$.

The continuous source or sink structures can differ from the radial particle structure $n(\sqrt{-\xi^2})$ due to fluctuations, outward and inward radial waves, or inhomogeneous modulations of $n(\sqrt{-\xi^2})$. Time varying interactions with real energy exchanges or radiation energy losses/gains result in variations of the equilibrium radial scale $r_o = P_o/G$ and in violations of the Lorentz steady-state condition $\nabla_\mu W^\mu = 0$. The equations (5) are source-sink equalities for iEM mass four-flows or electric four-currents. They incorporated the unspecified four-flow densities $l^\mu$ for all non-equilibrium and non-stationary modifications of steady radial structures with the Lorentz condition. The identical active and passive four-flow structures in (5), with the strong scalar conservation $\nabla_\mu (nu^\mu + l^\mu) \equiv 0$ for fluctuating matter of continuous sources or sinks, replicates the particle-wave duality of the quantum carrier of elementary energy.

The four-flow equalities (5) were derived only for imaginary (EM) masses or electric charges. These equalities incorporate the Maxwell-Lorentz equations for the steady elementary charge when $q_\mu l^\mu \equiv 0$. The point electron model, where $(-e_o)n^\mu = \nabla_\nu (-e_o r_e^{-1} f^{\mu\nu})/4\pi, e_o r_e^{-1} f^{\mu\nu} \equiv F^{\mu\nu}$, and $(-e_o)l^\mu \equiv 0$, can also be deduced from (5) after the operator simplification of the continuous source density, $n(r) \Rightarrow \delta(r)$. The non-empty space equalities (5) for fluctuating and radiating elementary carriers of active plus passive continuous charges generalize Maxwell’s equations for electric currents and their fields, including waves. The strict equivalence of active and passive electric charges (or imaginary EM masses) in the Lagrange equations for the imaginary EM densities (5) yields the following vector, tensor, and scalar identities,

$$
\begin{align*}
&\begin{cases}
nu^\mu + l^\mu \equiv \nabla_\nu f^{\mu\nu}/4\pi r_e \\
\nabla_\lambda f^{\mu\nu} + \nabla_\nu f^{\lambda\mu} + \nabla_\mu f_{\nu\lambda} \equiv 0 \\
\nabla_\mu nu^\mu \equiv -\nabla_\mu l^\mu,
\end{cases} \\
&\end{align*}
$$

for the forming-up dimensionless densities of active/passive fractions of continuous carriers. These elementary geometrical structures should be properly loaded with active/passive EM and GR charges.

The geometrical flow conservation-identity, $\nabla_\mu nu^\mu \equiv -\nabla_\mu l^\mu$, for mutual transformations of the non-steady radial particle and inhomogeneous spatial modulations addresses the particle-wave duality of the continuous electron, for example. Any wave modulation of the radial particle should be considered within its infinite material space. Such non-empty space physics of nonlocal elementary matter-energy admits distant influences of overlapping continuous particles. There are no free space regions for the local dimensionless identities (7) of nonlocal elementary carriers of energy. Therefore, classical field waves are material space modulations. They can be associated with one or another rest-mass carrier of energy and with timeless switching between nonlocal radial hosts. Electrodynamic equations for a statistical ensemble of $k$ overlapping continuous sources and their EM fields are followed from (7) and (5) as the local superposition of elementary densities of imaginary EM mass flows or electric currents. How can these imaginary vector flows of continuous electric charges be related to real mass flows of elementary inertial carriers?
3 Folded time symmetry for the residual EM origin of inertia and gravitation

If an inertial carrier of energies with real passive/active masses $M \sin \gamma = m_p = -m_a$ and distributed densities $m_{(p/a)} r_o/4\pi r^2(r + r_o)^2$ had no a mechanical counter partner, then self-translations or self-rotations of such an infinite material distribution might violate conservation laws or not make much sense in terms of self-references. Mach proposed to consider motion of a passive mechanical mass with respect to ‘the rest of the Universe’ or to nullify inertia without this ‘rest’. Matter ‘there’ determines inertia ‘here’ in the formal interpretation of Mach’s qualitative analysis. We follow this 1904 eureka for counter-motion of inertial masses in order to justify mirror time dynamics for locally converted real masses in folded pseudo-geometry of the Universe. The twin unlike masses (comasses) obey identical space translations-rotations and identical events under the joint physical time arrow. Pseudo-metric folding of two anti-collinear and zero-sum iEM mass-flows can result in the finite and real energy-momentum sum of collinear (folded) four-vectors. The Machian-type mechanism for the positive mass-energy $m_o$ creation (for the positive time rate $dt = |\pm idx^4| > 0$) takes place due to a partial fluctuation folding of an infinite forth coordinate $x^4$ in vacuum 4D geometry. This geometrical fluctuation transfers two balanced imaginary mass counter-currents with traceless (zero-sum) densities into real mass-energy currents in observable reality with folded time pseudo-geometry. Such a pure geometrical creation of non-zero four-vectors in folded-time spaces with inertial energies still obeys Machian counter-motion with opposite four-momentums and opposite angular momentums for unbroken vacuum geometry. Inertia and gravitation of every folded geometrical formation (the rest-mass carrier of real folded four-momentums and folded angular momentums) is defined by its GR charge $P_o = r_e u_o / G = m_o \sqrt{g_{oo}} / \sqrt{1 - u_i u^i}$ in flatspace Machian relativism (2). Therefore, inertia and gravitation of real energy bodies depend on spatial distributions of other ‘distant’ nonlocal bodies in full agreement with Mach’s ideas. Moreover, initial residual creation of positive translational and rotational mechanical energies is also related to Mach’s quest for mutual relativism of observed, inertial matter.

The EM counter-flows (5) of equal active (source-particle) and passive (sink-particle) imaginary masses (i.e. electric charges) are balanced. These iEM mass flows would never be observed in physical reality unless imaginary masses gain real residual parts for inertial collisions with real energy-momentum and angular momentum exchanges. Recall again that electric charges without inertial masses were not found in practice. Utilization of real EM energies is possible due to their transformation into mechanical energies with further collision exchanges between real rest-mass bodies. The key question is how can the imaginary vacuum mass-flows (5) with identically balanced source and sink four-vectors gain a residual four-momentum imbalance without violation of the mathematical equalities (7) for geometrical flows of active/passive material structures? To answer briefly, FTS of real world pseudo-geometry with the single time arrow, $dt = |\pm idx^4| > 0$ for folded pseudo-coordinates $\pm idx^4$, can provide the Machian-type cross-balance for inseparable coupled unlike masses and their fields without violation of the dimensionless identities (7). The folded time pseudo-geometry stands behind the residual GR mass creation from inertialless EM imaginary masses and enables observable practice with real EM and GR energies.

Let us return to the point that the imbalance $\gamma$ in the reduced ‘physical’ action (4) should describe real parts of active and passive complex masses. The one branch action (4) exhibits positive Ricci curvature, $R = \kappa (-c^2) \rho_a + c^2 \kappa \rho_p = \kappa \mu_a + \kappa \mu_p > 0$, for the positive passive-inertial $\rho_p = \mu_p / c^2 > 0$ and negative active, $\rho_a = -\mu_a / c^2 = -\mu_p / c^2 < 0$, mass densities. In other words,
the residual Ricci imbalance of complex GR+iEM masses in (4) should result in the negative active mass, $m_a = -m_o < 0$, of the source (active charge or the classical field) and the positive passive-inertial mass $m_p = m_o > 0$ of the sink (passive charge or the classical particle). Such a carrier of unlike active and passive masses with equal positive energies does possess imbalanced or collinear mass-energy four-flows according to the conceptual source/sink equalities (7). The challenge is to explain the origin of the negative active mass next to the positive passive-inertial mass of real-time bodies or gesamt carriers of source and sink fractions of distributed energy.

First we make direct evaluations of the Lagrange density in (4) for steady radial carriers (with the Lorentz conservation $\nabla \cdot W^\mu = 0$) and compare this action for complex GR+iEM masses with the gravitation action $S = -\int \sqrt{g_{oo}} d\Omega R/2\kappa$ for the electrically neutral radial carrier of gravito-mechanical energy,

$$-i\sqrt{g_{oo}}M(e^{i\gamma} - e^{-i\gamma}) f_{\mu\nu} f^{\mu\nu} = -i\sqrt{g_{oo}}M(e^{i\gamma} - e^{-i\gamma}) r_o^2 (\xi_\mu u_\nu - \xi_\nu u_\mu)(\xi^\mu u^\nu - \xi^\nu u^\mu)$$

$$\frac{1}{16\pi r_e} u_o^2 (\sqrt{-\xi^2} + r_o)^2 (-\xi^2)^2$$

$$= \frac{i(e^{i\gamma} - e^{-i\gamma}) \sqrt{g_{oo}} M n}{2 u_o} \Rightarrow -\frac{\sqrt{g_{oo}} R}{2\kappa}. \quad (8)$$

From here, the Ricci scalar density in the vector equalities $u^\nu u_\mu G^\mu_\nu \equiv 0$ with the steady radial carrier corresponds to the classical relativistic Lagrangian, $\sqrt{-g} R/2\kappa = (M sin\gamma)n\sqrt{g_{oo}}/u_o = m_o n \sqrt{1 - u_i u^i}$, for the inertial rest-mass $m_o = m_p = M sin\gamma$. Evaluations of the energy-momentum tensor $T^\nu_\mu$ for the complex GR+iEM active charge (source) and passive charge (sink) count only real, residual gravito-mechanical densities,

$$T^\nu_\mu \equiv \nabla_\mu W^\rho \frac{\partial (i^* Z^\nu + i Z)}{\partial (\nabla^\nu W^\rho)} - \delta^\nu_\mu (i^* Z^\nu + i Z) = \frac{(e^{i\gamma} - e^{-i\gamma}) m_o n}{2i sin\gamma u_o} \left( \delta^\nu_\mu - \frac{2\xi^\mu \xi^\nu}{\xi^2} \right), \quad (9)$$

with exclusively GR (real) components and the positive GR trace $T^\mu_\mu = R/\kappa > 0$.

The Euler-Lagrange formalism for the ‘physical’ time-branch action (4) cannot result in a required variational balance for equal and finite collinear four-momentums of negative active, $m_a = -m_o = -r_e/G$, and positive passive, $m_p = m_o = -m_a$, masses because of their non-vanishing active and passive mass four-flows,

$$I^\mu \equiv I^a_\mu + I^p_\mu \equiv m_p (nu^\mu + l^\mu) + \nabla_\nu \left( \frac{(-m_a) f^{\mu\nu}}{4\pi r_e} \right) \equiv 2m_o (nu^\mu + l^\mu) \equiv 2\nabla_\nu \left( \frac{m_o f^{\mu\nu}}{4\pi r_e} \right) \neq 0, \quad (10)$$

due to (7). Equalities in (10) manifest equal collinear GR densities for mechanical and gravitational energy flows. Lunar Laser Ranging could test, in principle, this equivalence for dynamical mechanical and gravitational four-vectors. According to (10), any variations of the gravitational active field energy of the Moon should coincide with variations of its passive-inertial, particle’s energy in Earth’s and Sun’s fields.

The classical variational formalism for Lagrange dynamics demands (from (10) with $m_a = -m_p$ and $I^a_\mu = I^p_\mu$) to keep the negative pseudo-time branch in the geometrical action (3). Then, space-time dynamics of geometrized mass flows with imbalanced real masses can correspond FTS Lagrange dynamics in single time physical reality. The positive and negative $x^o$ coordinate branches in (3) provide a new physical opportunity to relate active and passive masses to the opposite coordinate rates $\pm dx^o$ and to read the GR mass-energy equality $P_\mu P^\mu = (\pm m_o)^2$ with both algebraic signs. Folded time symmetry of residual masses is hidden for real-time observers.
of (vector) gravitational forces. Nonetheless, the Euler-Lagrange variational balance from the complete geometrical action (3),

\[ I^\mu( +x^o) + I^\mu( -x^o) \equiv \left( m_p^+(nu^\mu + l^\mu) + \nabla_\mu \frac{(-m_a^+)f^{\mu\nu}}{4\pi r_e} \right) \left( m_p^-(nu^\mu + l^\mu) - \nabla_\mu \frac{(-m_a^-)f^{\mu\nu}}{4\pi r_e} \right) \equiv 2(m_p^+ + m_p^-)(nu^\mu + l^\mu) = 0, (11) \]

analytically reveals twin unlike active and twin unlike passive masses in one continuous carrier of active and passive GR energies. Here equal cross-branch masses \( m_a^+(+x^o) = m_p^-(+x^o) = -m_o < 0 \) and \( m_a^-(-x^o) = m_p^+(+x^o) = m_o > 0 \) in rectangular brackets maintain hidden active - passive gravito-mechanical partnerships under the strict equalities (7) for active (source) and passive (sink) fractions of the gesamt GR energy. The inseparable folded unlike active masses \( m_a^+(+x^o) = -M\sin\gamma \) and \( m_a^-(-x^o) = -M\sin(-\gamma) \) cross generate Maxwell-type fields in the same 3D space but under reverse coordinate rates, \( \mp dx^o \), respectively. Therefore, passive-inertial mechanical flows are cross-balanced by active EM-type gravitational field flows. This inverted partnership for identical Lagrange dynamics (11) in folded time gravitation clarifies negative active charge-sources under positive passive-inertial charge-sinks. A conversion of the folded forth coordinate, \(+x^4 \rightarrow -x^4\), inverts source (active, yang) and sink (passive, ying) notions in the Lagrangian, but keeps the same physical time and observable space-time dynamics of inertial matter. Folded time symmetry for the Lagrangian maintains both creation of residual (inertial) four-momentums for one way translations of real matter and residual (inertial) angular momentums for one way rotations. In fact, FTS pseudo-geometry of the 1908 Minkowski four-interval for any inertial masses justified independent chiral options for left and right rotations of matter in all modern theories, including Quantum Chromodynamics.

Again, the observable four-current (10) of collinear and equal mechanical and gravitational energy-momentums matches Coulomb-type cross-branch interactions of active and passive unlike masses in FTS reality with MPX\(^o\) symmetrical forces. An increase of the mechanical energy-momentum of the inertial particle is always accompanied by equal increase of its gravitational field energy-momentum. Einstein’s Principle of Equivalence of active and passive gravitational charges (positive GR energies in our reading) is well known. This Principle for imbalanced (residual) GR four-momentums originates from strictly balanced imaginary mass flows in EM vacuum with regular 4D geometry. Broken vacuum geometry (folded pseudo-geometry) transfers zero-sum counter-vectors into equal co-vectors which obey the GR Principle of Equivalence. Contrary to four cross-balanced active and passive GR mass-energy co-flows in (11), imaginary EM active and passive mass counter-flows are directly balanced (without the cross-branch cooperation) in the EM equalities (5). Therefore, the Lagrange variational balance can be achieved for independent motion of unlike electric charges (imaginary masses) that admits their spatial split (observed in practice). The similar spatial split is impossible for real unlike comasses, accompanying each separated electric charge, because the GR vector balance (11) requires FTS dynamics with mirror local coupling of negative and positive active/passive mass densities.

One can imagine a hydrodynamic thought experiment in order to visualize how two unlike comasses can coexist in the same spatial structure of an observed body or a gesamt carrier of elementary energies. The attraction of sink-ends of hoses pumping water from a tank (one side of the universe) and the repulsion of other source-ends of these hoses pumping this water into another tank (second side of the universe with so far the same time parameter) may shed some light on paired unlike comasses in folded time reality. If the time parameter would be reversed
for the second tank, then identical attractions of sink-ends could be simultaneously achieved in both sides of this tank-universe (which can be folded due to identical dynamics of folded hoses with equal attractions of their ends).

Equalities (10) for collinear source-particle and sink-particle energy-momentums are compatible with the inward Newtonian field with negative Gauss flux around the active (negative) mass. The folded pseudo-balances (11) can take place in real time world only due to identical cross-branch cancellations of two active and two passive mass four-flows. The gravitational two-body attraction can be interpreted as paired FTS Coulomb-type interactions of unlike active and passive comasses. Spatial split of unlike electric charges still holds paired residual comasses for each electric charge. The electron (or another charged object) carries only one unpaired imaginary mass (or electric charge) but twin unlike real comasses with their inseparable coupling. One can combine the imaginary mass flow equalities (5) for electrodynamics with residual mass flow equalities (11) for real time computations of electromagnetic and gravitational fields of the world current density ensemble of continuous overlapping particles (vector flows \( n_ku^\mu \)) of charged radial structures and their arbitrary fluctuation \( l_k^\mu \),

\[
\begin{cases}
(i/\sqrt{G}) \sum_1^\infty q_k(\mu u^\mu + l^\mu) & \equiv -\frac{1}{4\pi G} \nabla_\nu \left( (i/\sqrt{G}) \sum_1^\infty f^\mu_\nu q_k/|m_k| \right) * \\
\sum_1^\infty 2|m_k|(\mu u^\mu + l^\mu) & (i/4\pi G)[\nabla_\lambda(\sum_1^\infty f^\mu_\nu q_k/|m_k|) + \nabla_\nu(\sum_1^\infty f^\mu_\lambda q_k/|m_k|) + \nabla_\mu(\sum_1^\infty f^\mu_\lambda q_k/|m_k|)] \\
\left( \sum_1^\infty 2f^\mu_\nu \right) & \left( \sum_1^\infty 2f^\mu_\nu \right) + \nabla_\mu(\sum_1^\infty 2f^\mu_\nu) \\
\left( \sum_1^\infty 2|m_k|\mu u^\mu \right) & \equiv -\nabla_\mu \left( \sum_1^\infty 2|m_k|\mu u^\mu \right)
\end{cases}
\]

Here \( i^\nu q_k \) are active electric charges, \( iq_k \) are passive electric charges, and \(|m_k| \equiv |m_k^\pm(\pm \varepsilon^o)| \) are elementary rest mass scalars for active and passive twin comasses, with \(|m_k^\pm(\pm \varepsilon^o) + m_k^\mp(\pm \varepsilon^o)| = 2|m_k|dt > 0 \) and \( k = 1, 2, \ldots, \infty \). Two unlike comasses of the elementary mechanical current cross-generate the doubled real time gravitational field \( 2f^\mu_\nu(x, t) \) intensity beside the single EM field intensity from one unpaired charge \( iq_k \). All fields and covariant derivatives in the FTS equalities (12) are functions of physical time, with \( \nabla_\mu a = \nabla_i a_i \) and \( \partial/\partial t = \partial/|\partial x^\varepsilon| \), rather than one of two pseudo-coordinates \( \pm \varepsilon^o \). Contrary to the vector pseudo-balance of real mass currents, imaginary mass currents are balanced in (12) in a line with the geometrical identities (7). The imaginary electric charges do not contribute to the real residual masses \( m_k \) and, therefore, to gravitation and inertia of complex charges with local coupling of real unlike comasses.

The real-time equalities (12) for identical active and passive overlapping mass densities can be interpreted through net Maxwell and Newton fields, \( F^\mu_\nu(x, t) = -\sum_k f^\mu_\nu(x, t)q_k/G|m_k| \) and \( G^\mu_\nu(x, t) = -\sum_k f^\mu_\nu(x, t), \) respectively, verses net electric and mechanical current densities \( J^\mu_q(x, t) = \sum_k q_k(nu^\mu + l^\mu) \) and \( J^\mu_m(x, t) = \sum_k m_k(nu^\mu + l^\mu) \), respectively. The strong conservation laws \( \nabla_\mu J^\mu_q(x, t) \equiv 0 \) and \( \nabla_\mu J^\mu_m(x, t) \equiv 0 \) for these world current densities are followed from the equations-equalities (12) in the conventional form of the classical theory of real-time fields,

\[
\begin{cases}
4\pi J^\mu_q(x, t) = \nabla_\nu F^\mu_\nu(x, t) \equiv \sum_1^\infty \nabla_\nu f^\mu_\nu(x, t)q_k/r_{ek} \\
4\pi G J^\mu_m(x, t) = -\nabla_\nu G^\mu_\nu(x, t) \equiv -\sum_1^\infty \nabla_\nu f^\mu_\nu(x, t).
\end{cases}
\]

The forming-up potential, \( W_\mu \), in the dimensionless geometrical field \( f^\mu_\nu \) of every elementary energy carrier \( k \) with the radial scale \( r_{ek} = Gm_k \) keeps basic identities (7) under complex gauge
transformations, $W'_\mu \rightarrow W_\mu + (C_1 + iC_2) \partial_\mu \chi$. Such a complex gauge composition of gravitational and electromagnetic four-potentials, $W_\mu$ and $iA = i\text{const} \times W'_\mu$, respectively, addresses the Lagrange dynamics where overlapping nonlocal carriers of complex mass-charges may have mutual transformations of electromagnetic and gravito-mechanical energies.

Now we look at wave solutions $\tilde{W}_\mu = C_\mu \exp(k_\nu x^\nu)$ in (5) or (11) in order to discuss these solutions for FTS physics of real time relations (12)-(13). All waves ‘propagate’ within the non-local source+sink carrier and can modulate its steady radial density $n(r) = r_o/4\pi r^2(r + r_o)^2$. Transverse wave modulations do not contribute to (identical) active and passive four-currents, because $\nabla f^{\mu \nu} = 0$, and these waves can exist independently within source or sink fractions of the gesamt energy carrier. For example, the radial sink-particle fraction of such a distributed carrier may exist without waves when the source-particle (classical field) fraction possesses transverse wave modulations. In general, our non-empty space paradigm for nonlocal continuous carriers admits also longitude periodic modulations of active (source) and passive (sink) carrier’s fractions, providing they have equal four-vector currents. FTS or chiral symmetry of real world matter can strike out longitude wave modulations from direct observations. Therefore, the unphysical empty space wave theory for only one field of one energy carrier can be completed by particle’s waves in non-empty space physics. Here one can infer the particle-wave duality for the distributed elementary carrier of nonlocal energy-matter and chiral wave doublets (within the infinite carrier) under folded time observations. Two pseudo-coordinates restore causality for ‘advanced’ EM waves and their real-time equivalence with retarded EM waves.

A EM field of any electric charge is accompanied by twin GR fields of two comasses. One vector electromagnetic wave (the photon) is associated in the real-time equation (12) with two paired vector gravitational waves. Therefore, the spin 1 EM wave of the accelerated electron is accompanied by paired vector cowaves (of twin unlike comasses) with net spin 2 in unfolded 4D geometry. Paired emitted gravitational waves of active comasses at mirror branches $\pm x^0$ cross-interact with twin passive comasses during one elementary interaction process. There are no physical options to split unlike twin comasses and there are no physical options in folded time reality to split zero net energy-momentum and zero net spin of two paired vector waves. Such a doublet of vector gravitational waves may be called a zero tensor graviton or a null-particle. A positive momentum of cross-waves in one null-particle is accompanied by the net positively directed momentum of emitting active comasses in agreement with (11). Similarly, passive comasses gain net negatively directed momentum by cross-absorbing the gravitational wave doublet (one graviton). The same observation rule applies to angular momentum exchanges - two gravitating bodies gain opposite spin 2 elementary impacts from every graviton despite of its confinement for third bodies and direct observations.

In the FTS description of single-time reality, the unbroken EM vacuum of balanced imaginary masses has unfolded 4D geometry with equal active (source-particle) and passive (sink-particle) four flows. Real time dynamics for complex GR+iEM masses corresponds to folded pseudo-geometry of real twin unlike masses. Their twin consolidation enables residual inertia and observations of vacuum EM energies. Wave solutions of (12)-(13) possess non-vanishing Poynting flux in folded time reality only for unpaired EM modulations of complex continuous masses. The strict local coupling of positive and negative twin comasses corresponds to the strict confinement of their paired vector waves (zero tensor gravitons or null-particles) addressed by these comasses exclusively to one or another gravitational partner. There are no real-time options to screen gravitons between two gravitating bodies or to borrow addressed energy of confined gravitons by third bodies or by interferometers. At the same time, FTS cowaves with the
cross-balanced Poyting vector cross-interact with twin comasses and provide energy-momentum and information exchanges between (inert and living) material bodies. Quantitative results of these FTS exchanges of null-particles can be predicted, computed, and observed in practice as mutual chiral interactions.

Cross-branch gravitational energy-momentum and angular momentum exchanges of the radiating two-body system with four active and four passive comasses can be evaluated through electromagnetic wave solutions with \( q^2 \to (2r_o)^2/G \approx 4Gm^2 \) for the non-relativistic limit. There is no outward gravitational energy flow from binary stars, for example, under their evolution toward one elementary radial object with the equilibrium density \( r_+/(4\pi r^2(r + r_+)^2 \) of the coalesced steady state, where \( r_+ = r_{o1} + r_{o2} \). There are no thermo-gravitomechanical energy losses under space-time-energy self-organizations of gravitating bodies through zero-tensor gravitons or null-particles. Only EM radiation losses can take place due to local transformation of gravitational waves into heat \( Q \) within accelerated thermodynamical bodies. Due to the real-time equalities (12), one can apply the known [7] EM wave solution, \( dI/d\Omega = (4Gm^2) \times a^4 \omega^6 \sin^2 \theta(1 + \sin^2 \theta)^2/\pi c^5 = d\dot{Q}/d\Omega \), to the angular self-heating (of neutron stars) by paired vector waves (confined null-particles) under mutual circular rotation of two equal inertial masses \( m \). The coherent application of this EM wave solution of (12) to confined gravitational waves corresponds to the binary system energy conservation (due to heat power accumulation) and to the period decay approximation, \( dP/dt = -(48\pi/5c^5) \times (4\pi Gm/P)^{5/3} \), for the non-relativistic binary pulsar PSR B1913+16 [8].

### 4 Conclusions

The strict balance of EM imagine mass counter-currents and the residual FTS imbalance of GR real mass-energy co-currents in (12)-(13) mean that the main part of EM and GR energies of electrons, for example, belongs to unfolded 4D geometry of vacuum. Practical utilization of these huge vacuum energies is given in single-time reality with folded pseudo-geometry through real energy-momentum exchanges between inertial masses. Energy-momentum changes of rest-mass carriers stand in practice behind all observations and measurements. Real inertial masses with positive GR energies do not deny real Coulomb-Lorentz forces between imaginary masses or real energies of electric charges. The point is that EM interactions can be observed only through the inertial dynamics of residual GR mass-energies. Real EM energies of pure imaginary vacuum masses (charges) cannot be traced in physical reality. Neither imaginary nor real mass flow densities are measured directly in integral energy-momentum exchanges of inertial carriers with discrete (quantized) amounts of energies. Proper understanding of balanced vacuum mass counter-flows and their residual folds with broken (pseudo) geometry might facilitate geometry-controlled methods for Tesla-type extraction of mechanical energy from EM vacuum. The proposed approach to waves as periodic modulations of material densities within continuous overlapping carriers of elementary radial active and passive energy-charges can be useful for physical interpretation of the world nonlocality in classical terms, as well as for other FTS phenomena like radiation self-acceleration, which was not satisfactorily unexplained by the point particle model.

Static pseudo-metric folding of 4D vacuum masses under the constant cosmological length \( T \) of the folded \( x^0 \) coordinate would hold static 3D distributions for elementary mass-energies. What drives the coordinate fold variations \(| \pm dx^0 | \equiv dt \) as the running time rate \( dt \neq 0 \)? There is no well developed theory for the origin of time and its arrow. We may note in the FTS
geometrical approach that the main difference between coordinates $x^i$ and $x^o$ in the 4D action (3) is the finite length interval $2T$ of the pseudo-coordinate $x^o$. It might not be illogical to infer that the folded length $T$ is not a constant parameter for the broken vacuum geometry. The real world energy-matter spontaneously appeared due to the Big Bang Fold of zero-energy vacuum states. And partial breaking of 4D vacuum geometry due to a finite interval $[-cT_{BB}; cT_{BB}]$ folding can be assigned to any of four initially equal coordinates. Such a geometrical fluctuation resulted in residual rest-mass energy creation in infinite 3D space, rather than in one Big Bang center. The fluctuation rest-mass density should return to the initial, zero-balanced vacuum energy state. Therefore, particles’ rest-masses should monotonously decay together with the relaxation decrease of the non-equilibrium coordinate folding, $T = |± x^o| → 0$. The running age of the Universe, $T_U = T_{BB} - T > 0$ and $dT_U = dt > 0$, should be restricted by the initial Big Bang Fold, $T_U^{max} = T_{BB}$, because inertial matter should disappear together with time without breaking of geometry at the global unfolding point $T = 0$.

A nonlinear relaxation, $T → 0$, of the global pseudo-geometry folding can result in accelerated or decelerated physical time for evolution of observed matter toward its disappearance. The (nonlinear) cosmological decay of all overlapping GR energy-charges can interpret the Hubble red shift thought the GR red shift for light coming from the more dense material Universe in the early epochs of the global geometrical folding. The so called accelerated repulsion of galaxies by unspecified dark energy could be modeled by nonlinear relaxation of non-equilibrium pseudo-geometry toward regular 4D geometry of vacuum imaginary masses. Several independent cosmological folds of the forth coordinate $x^4$ can be considered for coexisting 3D realities with, for example, shifted electron’s and muon’s rest-masses. Many other geometrical options for observed matter-energy can be also discussed for nonlocal FTS reality. Unless an experiment against sink/source elementary identities (7) and global currents-vs-fields equalities (12)-(13) is found and justified, residual gravitation of complex masses from folded 4D geometry of EM vacuum could stay in the unification portfolio beside 5D and higher dimension interpretations of charged matter.

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