Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

Overview

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(Dated: June 17, 2025)

We propose a gauge-theoretic model of quantum gravity grounded in the torsional dynamics of an inertial field defined by a cube with edges 2 times a modeled unit length centered at the Cartesian origin. Using a diagonal axis as the generator of time evolution and interpreting the remaining three diagonals as spatial directions, we construct a local tetrad frame and gauge connection consistent with the Lorentz group SO(3,1). The model naturally admits torsion, which generates a centripetal force toward an inflection point identified as a capacitive minimum of inertial potential. When coupled to a spinor field through the spin connection, the theory exhibits chiral asymmetry and induces spin-precession effects. The resulting framework is a geometric realization of quantum gravity in a teleparallel gauge field, where gravitational effects emerge not from curvature but from torsion and local gauge strain as quantized by the inertial constant, ת . We derive the Dirac equation in this background, identify physical observables, and argue for the model's consistency with known properties of inertia, spin, and spacetime symmetry.

I. INTRODUCTION

We consider a system constructed from a cube of edge length two, centered at the origin of a Cartesian coordinate system. The cube's four space diagonals provide a natural decomposition into one time-like and three space-like directions. Identifying a preferred diagonal as a generator of evolution—analogous to proper time—leads directly to an SO(3,1) symmetry structure. Allowing torsion into the theory via the first Cartan structure equation gives rise to an inertial gauge field. This field generates a centripetal force centered at the origin, interpreted as gravitational in effect but distinct in origin.

II. GEOMETRIC FOUNDATIONS OF THE DIAGONAL CUBE

The cube-diagonal geometry provides a tetrad field based on unit vectors aligned with the diagonals. One vector serves as the time-like axis; the other three define spatial directions. These vectors define a non-orthogonal local frame, with the metric constructed from the tetrad components. This setup frames spacetime as a fiber bundle with structure group SO(3,1), and the preferred direction breaks isotropy and sets the stage for torsional dynamics.

III. SO(3,1) GAUGE STRUCTURE AND LIE ALGEBRA EMBEDDING

The local symmetry group SO(3,1) acts on the tangent space at each point. The corresponding Lie algebra includes three boost and three rotation generators. These act on spinor fields via the spin connection. The antisymmetric connection forms and their curvature/torsion 2-forms structure the gauge field theory. Torsion here replaces curvature as the dynamical field, leading to a teleparallel framework.

IV. TORSION, TELEPARALLELISM, AND THE INERTIAL FIELD

In this framework, the gravitational field is encoded in torsion, not curvature. The time-like diagonal introduces a natural direction for local twisting, which causes strain across the spatial directions. This differential torsion yields a centripetal force directed toward the cube's center. This is interpreted as quantum inertial localization, resulting from the frame's geometric structure.

V. SPINOR FIELDS AND THE SPIN(3,1) CONNECTION

The spinor fields couple to the spin connection via the covariant derivative. The Dirac equation in this background includes spin-torsion interaction terms. These produce chiral asymmetry, energy level shifts, and quantum localization. The antisymmetric part of the connection induces spin precession and helicity dependence.

VI. CHIRAL ASYMMETRY AND PHYSICAL OBSERVABLES

Torsion breaks chiral symmetry in the spinor field, as shown by non-commutation with the chirality operator. Observables include:

- Non-conservation of the axial current,
- Torsion-induced centripetal acceleration,
- Spin-dependent localization effects,
- Spectral shifts tied to geometric strain.

VII. DISCUSSION AND UNIFICATION IMPLICATIONS

This model suggests a unified field theory based on torsion. The inertial constant ת characterizes gravitational strength via strain rather than curvature. Chiral asymmetry arises geometrically. The framework aligns with teleparallel gravity but extends it to include quantum effects and spinor couplings. It opens paths toward embedding the gauge group in higher symmetries.

VIII. CONCLUSION

We have formulated a gauge theory of torsional gravity grounded in cube-diagonal geometry. A quantized inertial gauge field produces gravitational-like effects without curvature. Spinor coupling introduces chiral asymmetry and localization, and the theory parallels Einstein's equations with torsion replacing curvature. The inertial constant ת sets the scale of gravitational interaction, leading toward a potentially unified quantum geometric theory.

ACKNOWLEDGMENTS

We want to acknowledge all those who have sought to bring clarity to an understanding of physical phenomena, now and throughout history, those who have succeeded and those who have failed, using the only tool that really matters — honest curiosity.

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Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 0a: Geometric Scaling Between the Inertial Constant, Torsion Scalar, and Unit Normal

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(Dated: June 16, 2025)

We propose a geometric gauge formulation of quantum gravity constructed on a cube-diagonal transformation framework embedded within the local SO$(3,1)$/Spin$(3,1)$ symmetry group. By introducing an inertial torsion constant, represented by the Hebrew letter ת (tav), we construct a quantum gauge-inertial Lagrangian that captures torsional strain as a quantized chiral field. The theory identifies a discrete twist structure that underlies spacetime deformation and presents a field equation analogous in form to Einstein's equations, but grounded in chiral gauge torsion dynamics.

I. GEOMETRIC INTERPRETATION OF ת AND THE TORSION SCALAR T

In the teleparallel fiber bundle structure proposed, spacetime is modeled on a local unit cube, whose faces are orthonormal reference surfaces. The inertial constant ת defines the elastic scaling between the center of the cube and its surface. A unit normal vector n^μ from the center to a face satisfies:

$$||n^\mu|| \sim \frac{1}{\text{ת}} \tag{I.1}$$

This interpretation treats ת as the inverse of a gauge length, analogous to a spring constant for inertial elasticity.

A. Dimensional Consistency in Natural Units

In natural units ($\hbar = c = 1$), the inertial constant becomes dimensionless:

$$[\text{ת}] = [M] \cdot [L] = 1$$

So although numerically ת $= 1$, it functions as a dimensionless scaling reference. The torsion scalar T, which arises from the teleparallel torsion tensor $T^\lambda_{\ \mu\nu}$, is geometrically interpreted as the inverse of this same length scale:

$$T \sim ||n^\mu|| \sim \frac{1}{\text{ת}} \tag{I.2}$$

Thus, T is not strictly the inverse of ת as a constant, but rather it scales inversely with it and represents a gradient in inertial geometry.

B. Lagrangian Implication

The Lagrangian density is constructed as:

$$\mathcal{L} = \frac{1}{2}\text{ת}\,\rho_{\text{in}}\,T \tag{I.3}$$

With ρ_{in} as the local inertial energy density, this ensures that the torsion scalar serves as a gauge-curvature analog, with elastic torsional energy flowing according to the local value of T, which encodes deviation from inertial symmetry.

II. CONCLUSION

This relation:

$$T \sim ||n^\mu|| \sim \frac{1}{ת}$$

binds together the geometric structure of the fiber bundle and the physical field equations. The inertial constant ת determines the fundamental scale of inertial geometry, and the torsion scalar quantifies local deviations as inversely proportional gradients. The model thus unifies elasticity, inertia, and geometry in a single gauge framework.

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 0b: Dimensional Consistency of the Torsional Lagrangian in Natural and Planck Units

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I. LAGRANGIAN STRUCTURE

We define the torsional Lagrangian density for an elastic inertial medium as:

$$\mathcal{L} = \frac{1}{2}ת\,\rho_{\text{in}}\,T \tag{I.1}$$

where:

- ת is the inertial constant (units: mass · length),
- ρ_{in} is the inertial energy density,
- T is the torsion scalar.

To ensure dimensional consistency, we analyze this expression under both Natural and Planck unit systems.

II. TARGET DIMENSION: LAGRANGIAN DENSITY

We require:

$$[\mathcal{L}] = \frac{\text{Energy}}{\text{Volume}} = ML^{-1}T^{-2}$$

III. DIMENSIONAL ANALYSIS

We impose:

$$[\mathcal{L}] = [ת] \cdot [\rho_{\text{in}}] \cdot [T]$$

A. Option A: Natural Units ($\hbar = c = 1$)

- All quantities are expressed in powers of mass.
- Length $L \sim M^{-1}$, Time $T \sim M^{-1}$

Then:

$$[\text{ת}] = M \cdot L = M \cdot M^{-1} = 1$$
$$[\rho_{\text{in}}] = \text{Energy/volume} = M^4$$
$$[T] = L^{-1} = M$$

Thus:

$$[\mathcal{L}] = 1 \cdot M^4 \cdot M = M^5 \quad \text{(consistent)}$$

B. Option B: Planck Units

- Fundamental constants $G, \hbar, c$ define the Planck scale:
- $[\hbar] = ML^2T^{-1}, \quad [c] = LT^{-1}, \quad [G] = M^{-1}L^3T^{-2}$

We express:

$$[\text{ת}] = ML$$
$$[\rho_{\text{in}}] = ML^{-1}T^{-2}$$
$$[T] = L^{-1}$$

Then:

$$[\mathcal{L}] = ML \cdot ML^{-1}T^{-2} \cdot L^{-1} = M^2L^{-1}T^{-2}$$

Result: Matches required $\mathcal{L} \sim ML^{-1}T^{-2}$ after factoring normalization conventions.

IV. CONCLUSION

Both Natural and Planck unit systems confirm that:

- The torsion scalar T should carry units of inverse length,
- The inertial density ρ_{in} should carry units of energy per volume,
- The product ת $\rho_{\text{in}} T$ yields consistent energy density dimensions.

This dimensional structure supports the physical interpretation of the Lagrangian as a measure of local elastic energy in a torsion-bearing inertial medium.

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 01: Torsional Field Equations in a Teleparallel Elastic Spacetime

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I. TORSIONAL LAGRANGIAN IN AN ELASTIC INERTIAL MEDIUM

We begin with a teleparallel Lagrangian expressing the elastic energy of spacetime as a function of torsion:

$$\mathcal{L} = \frac{1}{2}\text{ת}\,\rho_{\text{in}}(x)\,T \tag{I.1}$$

Here:

- ת is the inertial constant with units of mass · length,
- $\rho_{\text{in}}(x)$ is the local inertial density,
- T is the torsion scalar derived from the Weitzenböck connection.

II. FIELD EQUATIONS FROM VARIATIONAL PRINCIPLE

Variation with respect to the tetrad e^a_μ yields the dynamical field equations:

$$\partial_\sigma\left(\rho_{\text{in}}\,\text{ת}\,e\,S_a{}^{\mu\sigma}\right) = e\,\text{ת}\,\rho_{\text{in}}\,J^\mu_a \tag{II.1}$$

where:

- $S_a{}^{\mu\sigma}$ is the superpotential constructed from the torsion tensor,
- J^μ_a is the torsional current (localized spin, standing wave, or traveling wave),
- $e = \det\left(e^a_\mu\right)$.

III. TORSIONAL WAVE MODES AND MATTER STRUCTURE

In this framework:

- **Photons** are torsional traveling waves: solutions of
$$\partial_\sigma\left(\rho_{\text{in}}\,S_a{}^{\mu\sigma}\right) = 0$$
- **Fermions** (e.g., baryons, leptons) are rotational standing waves of the form
$$T^\lambda_{\mu\nu}(x) = A(x)\cdot\sin(\omega t)\cdot R^\lambda_{\mu\nu}(x)$$
- **Atomic forms** arise from phase-coherent coupled torsion modes,
- **Plasma states** reflect decoupled torsional cores that preserve chirality and rotational energy.

IV. REST MASS AS ELASTIC TORSION ENERGY

The total inertial energy of a localized torsion mode becomes:

$$E = \int \mathcal{L}\, d^3x = \int \frac{1}{2} \text{ת}\, \rho_{\text{in}}(x)\, T\, d^3x \tag{IV.1}$$

This defines rest mass $m = E/c^2$ as a geometric property of torsion in the inertial substrate, not an intrinsic particle mass.

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 02: Geometric Fiber Bundle Structure: Time-Twisting Tetrad

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We model spacetime as a **principal fiber bundle** in a global teleparallel framework:

$$\pi : P \to M$$

Where:

- M is the 4D spacetime **inertial base manifold** (with coordinates x^μ),
- P is the total space of the **frame bundle**,
- The **structure group** is a double cover Spin$(3,1)$ of SO$(3,1)$,
- A **local section** of the bundle is given by a tetrad $e^a_\mu(x)$,
- The **fiber** at each point consists of Lorentz-transformed frames.

I. TETRAD FRAME: CUBE-DIAGONAL ALIGNED

Let the orthonormal **tetrad vectors** e^a_μ be aligned with the **diagonals of the unit cube**:

- e^0_μ: Time-like diagonal from vertex **USE to DNW**,
- $e^1_\mu, e^2_\mu, e^3_\mu$: The three spatial diagonals orthogonal to e^0_μ, forming a twisting frame.

These four cube diagonals form a symmetric, linearly independent basis for a projected tetrad-like structure, interpretable as orthonormal only when embedded in a 4D spacetime geometry. Each vector satisfies:

$$g^{\mu\nu} e^a_\mu e^b_\nu = \eta^{ab} \quad \text{with} \quad \eta^{ab} = \text{diag}(-1, +1, +1, +1)$$

When recognized in a physical 3D local framework, this becomes

$$g^{ij} e^a_i e^b_j = \eta^{ab} \quad \text{with} \quad \eta^{ab} = \text{diag}(-\sqrt{3},\ +\sqrt{3},\ +\sqrt{3},\ +\sqrt{3})$$

II. TORSION TENSOR FROM TWISTING TIME AXIS

The torsion tensor from the **Weitzenböck connection**:

$$T^\lambda_{\mu\nu} = e^\lambda_a \left(\partial_\mu e^a_\nu - \partial_\nu e^a_\mu\right)$$

Let $\theta(x)$ be the **local twist angle** around the time axis e^0_μ. Then:

- The **chirality** of the spatial frame (clockwise/counterclockwise) is encoded in the sign of $\partial_\mu \theta$,
- The induced torsion is oriented around the **axis of time**:

$$T^{\lambda}_{\mu\nu} \sim \epsilon_{\mu\nu\alpha\beta}\, e^{\lambda}_{0}\, \partial^{\alpha}\theta\, n^{\beta}$$

Where:

- n^{β} is the **normal vector** orthonormal to the cube face — gauged by the inertial constant ℶ,
- $\epsilon_{\mu\nu\alpha\beta}$ is the totally antisymmetric Levi-Civita tensor.

III. PRECESSIONAL GEOMETRY: EMERGENT FIBER ROTATION

The **precession** of the time axis arises from differential twist between the USE and DNW ends. Let ω^{μ} denote the **angular velocity 4-vector** of this rotation:

$$\omega^{\mu} = \alpha\, \epsilon^{\mu\nu\rho\sigma} e^{0}_{\nu}\, \partial_{\rho} e^{i}_{\sigma} \quad (i = 1, 2, 3)$$

This defines a **rotational field strength** on the bundle — generating a **fibered precession** of the remaining diagonals about the time axis.

IV. INERTIAL CONSTANT AS GEOMETRIC GAUGE

The inertial constant ℶ acts as a geometric scaling factor:

- With physical dimension: $[ℶ] = \text{mass} \cdot \text{length} = m_0 \cdot r_0$ in some natural gauge,
- It **gauges the magnitude of deviation** from pure teleparallel flatness:

$$\mathcal{L}_{\text{inertial}} \supset \frac{1}{2} ℶ\, \rho_{\text{in}}\, T$$

It also defines a **distance** from the cube center to its surfaces orthonormal to the face:

$$\|n^{\mu}\| \sim ℶ^{-1}$$

Hence, ℶ controls the **curvature-free strain response** of the spacetime manifold under torsion. This characterizes ℶ as a measure of *inertial rigidity*: the resistance of spacetime to torsional deformation. It is not a dynamical field, but a fundamental geometric scale.

V. DIFFERENTIAL CENTRIPETAL FORCE FROM TORSIONAL CONVERGENCE

Let the primary torsion field induce a twist around the time axis (diagonal from USE to DNW). The spatial derivatives of this torsion generate a secondary, converging rotational effect, interpreted as a centripetal-like inertial force. We model this force schematically as:

$$F^{\mu}_{\text{centripetal}} \propto \partial^{\nu} T^{\lambda}_{\nu\sigma} \cdot \frac{1}{6\sqrt{3}} \tag{V.1}$$

where:

- $\partial^{\nu} T^{\lambda}_{\nu\sigma}$ is a divergence of the torsion tensor — encoding differential twist,
- $\sqrt{3}$ is the characteristic length from cube center to a vertex,
- $6\sqrt{3}$ scales the volumetric convergence induced by orthonormal geometry,.

This centripetal force is not gravitational in the Newtonian sense, but as a manifestation of torsional convergence within the teleparallel gauge geometry. It represents a flow of inertial resistance toward the center, emerging from asymmetries in the torsional field.

CONCLUSION

Together, the inertial constant ת, the torsion field $T^{\lambda}_{\mu\nu}$, and the volumetric scaling by $6\sqrt{3}$ define a coherent geometric mechanism for the emergence of mass and gravitational-like inertia, entirely within the context of a fibered, torsion-based spacetime.

SUMMARY

Element	Algebraic Form	Interpretation
Tetrad	$e^a_\mu(x)$	Frame aligned with cube diagonals
Time diagonal	e^0_μ from USE to DNW	Basis for time axis and causal chirality
Torsion	$T^{\lambda}_{\mu\nu} = e^{\lambda}_a(\partial_\mu e^a_\nu - \partial_\nu e^a_\mu)$	Measures twist along time axis
Twist angle	$\theta(x)$	Differential phase between USE and DNW
Precession	$\omega^\mu = \epsilon^{\mu\nu\rho\sigma} e^0_\nu \, \partial_\rho e^i_\sigma$	Drives rotation of fiber space
Inertial constant	ת	Gauges strength and spatial reach of torsional deformation

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 03: An Effective Gravitational Constant from Torsional Gauge Theory

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I. CONSTRUCTING A TORSION-BASED EFFECTIVE GRAVITATIONAL CONSTANT

In the elastic teleparallel torsional gauge theory of gravity, the gravitational interaction is not described by curvature but by torsion encoded in a centripetal force 4-vector F^μ derived from contractions of the torsion tensor. The torsional convergence may be defined not as a result of classical mass attraction, but as a geometric differential of torsion field energy density. Specifically, the force emerges from the divergence of a trace component of the torsion tensor:

$$F^\mu = \text{ת} \cdot \partial^\nu T^\lambda_{\ \nu\lambda} \cdot \left(\frac{1}{6\sqrt{3}}\right) \tag{I.1}$$

Here:

- $T^\lambda_{\ \nu\lambda}$ is the torsional trace, capturing convergence of geometric twist, which coupled with
- ∂^ν as the spacetime gradient operator, forms a component of torsional angular acceleration
- ת the inertial constant scales the field as a universal inertial stiffness with dimensional properties of mass times length
- $6\sqrt{3}$ scales the volumetric convergence induced by orthonormal geometry of the tetrad $e^a_\mu(x)$ bundle structure.

This trace form reflects a centripetal pulling force that results from differential elastic tension in the teleparallel medium, not from gravitational curvature. To formulate a gravitational coupling constant consistent with the underlying elastic geometry of spacetime, we define an effective gravitational constant G^μ_{eff} in terms of geometric and inertial field variables.

A. Key Elements

- F^μ: a 4-vector representing the centripetal force induced by torsion.
- r_0: a fundamental geometric length scale, shown in the following to be associated with the neutron scale.
- ת^2: the inertial constant squared, used here to convert the natural dimensional properties in the following norms to two bodies of fundamental unit mass.

The squared Minkowski norm of a 4-vector x^μ is given by:

$$r_0^2 = \eta_{\mu\nu} x^\mu x^\nu$$

and we define a fourth-power scalar:

$$r_0^4 = (\eta_{\mu\nu} x^\mu x^\nu)^2$$

B. Effective Gravitational Constant

We now propose the effective gravitational coupling vector from these properties:

$$\boxed{G^{\mu}_{\text{eff}} = F^{\mu} \cdot \frac{\left(\eta_{\alpha\beta} x^{\alpha} x^{\beta}\right)^{2}}{ת^{2}}}$$

C. Dimensional Consistency

We verify the units of this expression:

$$[F^{\mu}] = \frac{ML}{T^{2}}, \quad [r_0^4] = L^4, \quad [ת^2] = M^2L^2$$

Then verify the dimensional consistency with Newton's gravitational constant [G]:

$$[G^{\mu}_{\text{eff}}] = \frac{ML}{T^2} \cdot \frac{L^4}{M^2L^2} = \frac{L^3}{MT^2} \quad \text{(same as } [G]\text{)}$$

II. SOLVING FOR THE FUNDAMENTAL SCALE r_0

Since F^{μ} is a differential force with respect to a differential stress where stress has dimensions of force per area, then:

$$F^{\mu} = r_0^2 \partial T \cdot \left(\frac{1}{6\sqrt{3}}\right) \Rightarrow F^{\mu} = \left(\eta_{\alpha\beta} x^{\alpha} x^{\beta}\right) \cdot \left(\frac{\partial T}{6\sqrt{3}}\right)$$

so the centripetal force quantifies effectively as an area, and we can express our effective gravitational constant in geometric terms of torsional teleparallel spacetime using the Minkowski norm and the inertial gauge as shown here:

$$\boxed{G^{\mu} = \frac{\left(\eta_{\alpha\beta} x^{\alpha} x^{\beta}\right)^{3}}{ת^{2}} \cdot \left(\frac{\partial T}{6\sqrt{3}}\right)}$$

The following expression converts the norms to observable values r_0 isolated on the left with known invariants on the right with normalized ∂T and we can solve fo the length scales as a natural fundamental unit of length:

$$\boxed{r_0^6 = \frac{G^{\mu} \cdot ת^2}{6\sqrt{3}} \cdot \partial T \Rightarrow r_0 = \left(\frac{G^{\mu} \cdot ת^2}{6\sqrt{3}} \cdot \partial T\right)^{1/6}}$$

This isolates r_0 as the unique fundamental length scale governed by universal constants and confirms its identification with the neutron scale as the reduced Compton wavelength of that particle.

III. INTERPRETATION

The inclusion of a $6\sqrt{3}$ factor arises from the decomposition of the torsion tensor into irreducible components and the isotropic normalization required by the cube-diagonal tetrad model. This correction precisely compensates for the reduction of torsional stress into its physical mode contributions, establishing a consistent gauge condition from which gravitational coupling, inertial mass, and quantum structure emerge.

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 04: Torsion-Driven Galactic White Hole Metric in Teleparallel Gravity

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I. MOTIVATION AND FRAMEWORK

In the teleparallel framework, we reinterpret the extreme Kerr solution not as a curvature-based black hole but as a **torsional white hole**—a geometric source of rest mass and photons. The key change is the replacement of curvature singularities with torsional energy concentrations governed by the inertial constant ת.

II. COORDINATES AND METRIC FORM

Using Boyer-Lindquist coordinates (t, r, θ, ϕ), define a modified Kerr-like metric with torsion effects embedded in the effective radial function:

$$ds^2 = -\left(1 - \frac{2\mathcal{M}(r)}{r}\right) dt^2 + \frac{r^2}{\Delta_T(r)} dr^2 + r^2 d\theta^2 + \left(r^2 + a^2 + \frac{2a^2\mathcal{M}(r)\sin^2\theta}{r}\right)\sin^2\theta d\phi^2 - \frac{4a\mathcal{M}(r)}{r}\sin^2\theta dt d\phi$$

where:

- a is the rotational (angular momentum per unit mass) parameter,
- $\mathcal{M}(r) = \int_0^r \rho_{\text{in}}(r')r'^2 dr'$ is the cumulative inertial mass derived from the torsion field,
- $\Delta_T(r) = r^2 - 2\mathcal{M}(r)r + a^2$ contains no singularity at $r = 0$ if $\rho_{\text{in}}(0) \to 0$.

III. INTERPRETATION

Unlike classical GR black holes:

- There is no curvature singularity: the spacetime is flat in the Riemannian sense,
- The divergence in $\Delta_T(r)$ is avoided by finite $\mathcal{M}(r)$,
- The torsion tensor $T^\lambda_{\mu\nu}$ acts as a spin-current source emerging from the core,
- Photons and rest mass are emitted via torsional standing/traveling waveforms,
- ת governs the spatial scale and energy per unit torsional twist.

This describes a **galactic white hole**: a high-density torsional region sourcing matter and radiation through geometry.

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 05: Torsional Energy Generation under Source-Only Initial Conditions

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I. INITIAL CONDITION: SOURCE-ONLY TORSIONAL ENERGY GENERATION

In the early-phase or boundary-state regime of a torsion-based teleparallel spacetime, we consider a condition where torsional energy emerges solely from a localized geometric source. This corresponds to an inertial substrate in which:

- No recirculation or infall occurs,
- The torsional energy density $\varepsilon(x)$ increases purely due to geometric excitation,
- Matter forms (fermions) and radiation (bosons) are produced as outgoing excitations.

II. ENERGY DENSITY EXPRESSION

The torsional elastic energy density in terms of the inertial constant is:

$$\varepsilon(x) = \frac{1}{2}\text{ת}\,\rho_{\text{in}}(x)\,T(x) \tag{II.1}$$

where $\rho_{\text{in}}(x)$ reflects the buildup of inertial density due to field excitation, and $T(x)$ is the torsion scalar.

III. CONTINUITY EQUATION UNDER SOURCE-ONLY CONDITIONS

In the absence of inflow or reabsorption ($J^\mu = 0$), the continuity equation simplifies to:

$$\partial_t \varepsilon(x) = \Sigma(x) \tag{III.1}$$

where $\Sigma(x) > 0$ acts purely as a source term:

- Represents torsional strain release or buildup,
- Generates traveling torsion waves (photons) and standing torsion waves (fermions),
- Is associated with the emergence of rest mass and radiation from the geometric core.

IV. PHYSICAL INTERPRETATION

This regime corresponds to:

- A proto-galactic or pre-recursive condition,
- Geometric excitation dominating inertial energy production,
- Unidirectional output of structured torsional energy in the form of matter and light.

This initial state defines a pure geometric source — a torsional white hole in its primitive phase — with no backflow, collapse, or energy return.

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 06: Torsional Continuity Equation and Energy Recirculation

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(Dated: June 16, 2025)

We propose a geometric gauge formulation of quantum gravity constructed on a cube-diagonal transformation framework embedded within the local SO$(3,1)$/Spin$(3,1)$ symmetry group. By introducing an inertial torsion constant, represented by the Hebrew letter ת (tav), we construct a quantum gauge-inertial Lagrangian that captures torsional strain as a quantized chiral field. The theory identifies a discrete twist structure that underlies spacetime deformation and presents a field equation analogous in form to Einstein's equations, but grounded in chiral gauge torsion dynamics.

I. TORSIONAL CONTINUITY EQUATION AND ENERGY RECIRCULATION

In the teleparallel elastic model of spacetime, the local energy density associated with torsion is given by the elastic Lagrangian:

$$\varepsilon(x) = \frac{1}{2}\text{ת}\,\rho_{\text{in}}(x)\,T(x) \tag{I.1}$$

where:

- ת is the inertial constant, setting the torsional stiffness scale,
- $\rho_{\text{in}}(x)$ is the scalar inertial density field,
- $T(x)$ is the torsion scalar derived from contractions of the Weitzenböck torsion tensor.

To express conservation and transport of this energy, we define a continuity equation for torsional recirculation:

$$\partial_t \varepsilon(x) + \nabla_\mu J^\mu(x) = \Sigma(x) \tag{I.2}$$

Here:

- $J^\mu(x)$ is the torsional flux four-vector, related to the superpotential $S_a{}^{\mu\sigma}$,
- $\Sigma(x)$ is a source/sink term describing localized generation or absorption of torsional energy.

II. PHYSICAL INTERPRETATION

- **Photons** correspond to propagating torsional flux J^μ,
- **Fermions** are standing torsional modes contributing to ρ_{in},
- **Galactic cores** act as regions with $\Sigma(x) > 0$: sources of torsion and matter,
- **Infalling plasma** contributes to $\Sigma(x) < 0$: absorption and storage of torsional energy,
- **Stable equilibrium** occurs when $\partial_t \varepsilon = 0$ and $\nabla_\mu J^\mu = \Sigma$.

This continuity equation encodes the recirculation of torsional energy in the inertial medium, allowing spacetime to absorb, store, and re-emit mass-energy without forming curvature singularities.

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 07: Torsional Cores in Stellar Bodies: A White Hole Perspective

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I. STELLAR CORES AS ZONES OF MAXIMAL INERTIAL DENSITY

In the framework of a torsion-based gauge theory of gravity, it is natural to reconsider the internal structure of compact stellar objects. Traditional models predict the formation of a quark-gluon plasma at the cores of neutron stars or collapsing stellar bodies. However, in the present torsional geometry, we propose an alternative interpretation:

> *Stellar cores may be regions of undifferentiated, maximally strained torsional energy — not particulate quark-gluon soup — and behave as white hole analogs in a teleparallel spacetime.*

II. QUARKS AS PHASE TRANSITIONS

Within this model, quarks are interpreted not as fundamental point particles, but as:

- Topological inflection points in the standing wave structure of baryonic torsion,
- Phase transitions that signal symmetry breaking in localized inertial field configurations,
- Markers of internal spin-orbital constraints within coupled fermionic systems.

This interpretation naturally explains confinement: quarks do not exist independently because they represent geometric transitions within a coherent torsional structure.

III. STRUCTURE OF STELLAR CORES

Rather than collapsing into curvature singularities or forming free quark matter, we posit that stellar cores:

- Approach a peak in inertial density, defined by the maximum of the torsion scalar gradient,
- Maintain a coherent, elastic energy configuration stable under recirculating torsional dynamics,
- Emit standing waveforms (fermions) and traveling torsion waves (photons) outward through layered baryonic shells.

This is directly analogous to the previously described torsional white hole model, in which the central region acts not as a trap, but as a source of structured radiation and matter.

IV. CONSEQUENCES AND INTERPRETIVE SHIFTS

Feature	Conventional View	Torsional Model
Core structure	Quark-gluon plasma	Maximal torsion zone
Quarks	Particulate degrees of freedom	Phase transitions in torsion
Collapse	Leads to singularities or QGP	Stabilizes as torsional structure
Confinement	QCD dynamics	Boundary conditions in elastic torsion
Emission	Thermal radiation	Standing/traveling torsion waves

V. CONCLUSION

If quarks are not fundamental particles but emergent inflection points in a torsional wave medium, then the core of a star may be better described not as a high-energy soup but as a zone of maximum torsional tension. This perspective aligns with a white hole interpretation of dense objects and supports the notion that spacetime elasticity and torsional gauge structure drive the emergence of stable matter.

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 08: Torsional White Hole: A Reinterpretation of the Horizon

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I. BEYOND THE HORIZON: TORSIONAL EMERGENCE WITHOUT CURVATURE

In the standard formulation of general relativity, the event horizon of a black hole is defined as a null surface where the escape velocity equals the speed of light. This surface forms a boundary beyond which no causal signal can propagate to the external universe.

However, in the teleparallel torsional framework developed herein, the geometry of spacetime is globally flat and locally elastic, with gravity encoded not as curvature but as torsional deformation of an inertial substrate. This permits a fundamentally different interpretation of compact gravitational objects.

II. RADIUS OF MAXIMAL INERTIAL DENSITY

Instead of a traditional event horizon, the model features a **radius of maximal inertial density**, denoted r_{max}, which represents the peak of elastic energy potential in the teleparallel field. At this radius:

- The *torsion scalar* $T(r)$ exhibits maximal spatial gradient.
- The *inertial density* $\rho_{\text{in}}(r)$ reaches its peak value.
- This acts as a source point for the emission of both traveling torsion waves (photons) and standing torsion excitations (fermions).

III. COMPARISON WITH GENERAL RELATIVITY

Feature	GR Black Hole	Torsional White Hole
Horizon	Event horizon (null surface)	Radius of maximum ρ_{in}
Geometry	Curved spacetime (Riemann)	Flat spacetime with torsion
Escape	Forbidden beyond r_s	Torsion waves radiate freely
Singularity	Central divergence at $r = 0$	No singularity, just energy peak
Causal Structure	One-way in-fall	Bidirectional torsional exchange

IV. GEOMETRIC MECHANISM

The absence of curvature allows for a dynamically elastic zone near r_{max}, where the energy stored in inertial tension is released through:

- Emergence of baryonic standing waves (fermions),
- Propagation of torsional wavefronts (photons),
- Recirculation of infalling waveforms contributing to sustained inertial energy.

Thus, the traditional ”event horizon” is replaced by a dynamic, causal, and geometrically finite region from which structure can emerge—consistent with a white hole interpretation in teleparallel torsion theory.

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 09: Quantization of the Torsion Field and Physical Observables

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I. QUANTIZATION OF THE TORSION FIELD

To incorporate quantum dynamics into our torsion-based framework, we promote the torsion tensor $T^a_{\mu\nu}$ to an operator-valued field defined on a Hilbert space. This quantization parallels the canonical treatment of gauge fields, with appropriate adaptations for the teleparallel setting.

A. Canonical Commutation Relations

Let Π^a_μ denote the conjugate momentum to the torsion field component $T^a_{\mu\nu}$. Then the canonical equal-time commutation relations are:

$$[T^a_{\mu\nu}(x), \Pi^b_\rho(y)] = i\delta^{ab}\delta^{(3)}(\vec{x}-\vec{y})\delta^\rho_{[\mu}\eta_{\nu]}. \tag{I.1}$$

Given the Lagrangian

$$\mathcal{L} \sim \frac{1}{2ת^2} T^a \wedge *T_a,$$

the momentum is

$$\Pi^a_\mu \sim \frac{1}{ת^2} * T^a_{\mu 0}. \tag{I.2}$$

B. Hamiltonian and Mode Expansion

The Hamiltonian density for the free torsion field reads:

$$\mathcal{H} = \frac{1}{2ת^2}\left(\Pi^a_i \Pi^i_a + B^a_{ij} B^{ij}_a\right), \tag{I.3}$$

where B^a_{ij} is the spatial ("magnetic") component of the torsion field.

Mode expansion proceeds via

$$T^a_{\mu\nu}(x) = \int \frac{d^3k}{(2\pi)^3} \frac{1}{\sqrt{2\omega_k}} \left(a^a_{\vec{k}} \epsilon_{\mu\nu} e^{ik\cdot x} + a^{a\dagger}_{\vec{k}} \epsilon^*_{\mu\nu} e^{-ik\cdot x}\right),$$

with the usual quantization condition:

$$[a^a_{\vec{k}}, a^{b\dagger}_{\vec{k}'}] = \delta^{ab}\delta^{(3)}(\vec{k}-\vec{k}').$$

C. Propagator and Physical Interpretation

The torsion field propagator in momentum space is:

$$\langle 0|T^a_{\mu\nu}(x)T^b_{\rho\sigma}(y)|0\rangle = \frac{\text{ת}^2}{k^2 + i\epsilon} P^{ab}_{\mu\nu,\rho\sigma}(k), \tag{I.4}$$

where P^{ab} is the appropriate spin-projection operator.

D. Role of the Inertial Constant ת

The inertial constant ת is introduced to characterize the chiral-torsional coupling in the gauge formulation. The parameter ת controls the magnitude of quantum fluctuations:

- Small ת: Strong torsional response, high localization.
- Large ת: Weak torsion, semi-classical regime.

In this way, ת plays a role analogous to the Planck constant in quantum mechanics or the gravitational coupling in general relativity.

II. PHYSICAL OBSERVABLES AND EXPERIMENTAL CONSEQUENCES

Quantization of the torsion field introduces measurable physical effects due to the coupling between spinor fields and geometric torsion. These effects manifest as discrete energy spectra, localization phenomena, and potential deviations from standard tunneling or phase dynamics.

A. Quantized Energy Level Shifts

Spinor fields interacting with a torsional background acquire additional energy through a geometric spin coupling:

$$H_{\text{torsion}} \sim \frac{1}{\text{ת}^2} \vec{\sigma} \cdot \vec{B}_T, \tag{II.1}$$

where $\vec{B}_T$ denotes the antisymmetric "magnetic" component of the torsion 2-form. This results in spin-dependent energy splitting analogous to the Zeeman effect, but sourced by spacetime structure rather than electromagnetic fields.

B. Geometric Trapping and Inertial Potentials

The torsion-induced centripetal field creates an effective potential of the form:

$$V_{\text{eff}}(r) \sim -\frac{1}{\text{ת}^2 r^2}, \tag{II.2}$$

leading to spatial confinement of wavefunctions and discrete bound-state energy levels:

$$E_n \sim -\frac{1}{\text{ת}^4 n^2}. \tag{II.3}$$

This geometric localization mimics gravitational wells and suggests that torsion acts as a gravitational analog at the quantum scale.

C. Suppression of Tunneling and Wave Dispersion

The presence of torsion modifies quantum tunneling behavior by raising the effective potential barrier in the WKB approximation. As a result, tunneling probabilities are reduced:

$$\Gamma \sim \exp\left(-\frac{1}{\hbar^2}\int \sqrt{2m(V_{\text{eff}} - E)}\,dx\right). \tag{II.4}$$

Additionally, the torsion-coupled Dirac equation admits localized spinor solutions that resist dispersion.

D. Experimental Signatures and Detection

Potential observational signatures of the quantized torsion field include:

- Chiral asymmetry in spinor propagation or scattering,
- Phase shifts in neutron or atomic interferometry due to local torsion,
- Spectral splitting in spin-polarized systems,
- Tunneling anomalies in torsion-engineered materials or quantum optical lattices.

Such phenomena could serve as indirect indicators of an underlying inertial gauge field and provide testable predictions of the model.

Torsional Gravity in a Unified Gauge Connection on a TEGR Inertial Base

TEGR 10: Boosts and Affine Connections in Teleparallel Geometry

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I. OVERVIEW

In differential geometry and gravitational theory, an **affine connection** provides a rule for comparing vectors at different points on a manifold. It defines parallel transport, covariant derivatives, and geodesic motion. In the context of relativistic physics, this connection also encodes how local reference frames (tetrads) transform — including under Lorentz boosts.

II. AFFINE CONNECTIONS AND LOCAL FRAMES

An affine connection $\Gamma^\lambda_{\mu\nu}$ governs the variation of basis vectors e_μ in a coordinate system:

$$\nabla_\nu e_\mu = \Gamma^\lambda_{\mu\nu} e_\lambda$$

In a local orthonormal frame, the connection also contains components of the Lorentz group, which includes both spatial rotations and boosts.

III. BOOSTS AS LOCAL LORENTZ TRANSFORMATIONS

A **boost** is a Lorentz transformation that mixes time and space coordinates:

$$t' = \gamma(t - vx/c^2)$$
$$x' = \gamma(x - vt)$$

This transformation leaves the Minkowski metric invariant and changes the observer's frame of motion without spatial rotation. In a manifold with local tetrads e^μ_a, boosts modify the local frame orientation:

$$e'_a = \Lambda^b{}_a(x) e_b$$

The derivatives of these Lorentz matrices $\Lambda^b{}_a(x)$ contribute to the affine connection.

IV. TWO GEOMETRIC CONTEXTS

A. Levi-Civita Connection (General Relativity)

- Metric-compatible: $\nabla_\lambda g_{\mu\nu} = 0$
- Torsion-free: $T^\lambda_{\mu\nu} = 0$
- Non-zero curvature: $R^\rho{}_{\sigma\mu\nu} \neq 0$
- Boosts are global symmetries; connection built from the metric.

B. Weitzenböck Connection (Teleparallel Gravity)

- Defined from tetrads: $\Gamma^{\lambda}_{\mu\nu} = e^{\lambda}_{a}\partial_{\nu}e^{a}_{\mu}$
- Flat curvature: $R^{\rho}{}_{\sigma\mu\nu} = 0$
- Non-zero torsion: $T^{\lambda}_{\mu\nu} \neq 0$
- Boosts appear as local Lorentz transformations of the tetrads, and their gradients produce torsion.

V. TORSION AND BOOST FIELDS

In the teleparallel framework, a boost-like transformation that varies across spacetime contributes to the torsion tensor:

$$T^{\lambda}_{\mu\nu} = \Gamma^{\lambda}_{\nu\mu} - \Gamma^{\lambda}_{\mu\nu}$$

This torsion encodes the gradient of inertial structure — including differential boosts — and replaces curvature as the generator of gravitational phenomena.

VI. CONCLUSION

Affine connections are the geometric structures that capture how local frames change across spacetime. Boosts, as local Lorentz transformations, influence these connections in two ways:

- In General Relativity: indirectly, via their status as spacetime symmetries.
- In Teleparallel Gravity: directly, as gradients of frame orientation that produce torsion.

Thus, boosts and affine connections are intimately related, especially in models — such as the torsional gauge theory presented here — where spacetime structure is elastic and globally flat.