

GRAVITY

*The Projection of Time onto
the Radius of Mass*

A Geometric Interpretation of Gravitation
and Cosmic Expansion

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Abstract

We propose a geometric reinterpretation of dynamics based on an invariant flow along the temporal coordinate ct , with fixed magnitude c . Motion and gravity are described as redistributions of this flow among temporal and spatial components.

Time dilation — both kinematic and gravitational — arises from the reduced projection of the flow onto the time axis when the flow tilts toward space. From the weak-field Newtonian limit we obtain the explicit radial tilt $\theta(r) = \sqrt{2GM/(c^2 r)}$, which directly yields $g = GM/r^2$ via $g = -c^2 \theta d\theta/dr$.

In vacuum, the flow accumulates exponentially (self-accumulation), giving Hubble’s law $v = Hr$ as the spatial projection of that expansion.

The combined kinematic and gravitational time dilation in GPS satellites is recovered exactly.

The framework provides a unified kinematic picture of inertial, gravitational, and cosmological phenomena without introducing forces or a cosmological constant.

Keywords

Gravity, time dilation, Hubble expansion, GPS, ct -flow, emergent gravity.

1 Introduction: From Geometric Curvature to Time Flow

Relativistic physics describes the evolution of physical systems through the geometry of spacetime, where kinematic and gravitational phenomena are encoded in the structure of the metric. In this framework, time dilation, gravitational interaction, and large-scale expansion are typically formulated within distinct, though mathematically consistent, descriptions.

In this work, we explore an alternative **geometric reinterpretation** in which these phenomena can be described in terms of an effective flow associated with the temporal coordinate ct . Rather than modifying the underlying relativistic structure, the approach provides a kinematic interpretation in which motion is represented as a redistribution of an invariant magnitude c among temporal and spatial components.¹

Within this perspective, the Minkowski metric in spherical coordinates,

$$ds^2 = -(c dt)^2 + dr^2 + r^2 d\Omega^2,$$

where $d\Omega^2 = d\theta^2 + \sin^2 \theta d\phi^2$, is taken as the underlying geometric structure, while the evolution of physical systems is described through an effective flow whose projection onto different coordinates determines observable behavior. The choice of spherical coordinates reflects the radial symmetry of the universal expansion we postulate: the fourth dimension expands uniformly in all directions, and it is in the radial coordinate r that this expansion manifests naturally.

¹The invariant magnitude $\|d\mathbf{X}/d\tau\| = c$ is exactly the standard four-velocity of a massive particle. Our “flow” is therefore a reinterpretation of that four-velocity, not a new physical field.

We propose that universal expansion can be effectively described as occurring exclusively along the temporal coordinate ct . While spatial coordinates provide the static metric stage, the ct axis represents a dynamic expansion flow emanating from the fundamental differential scale. The present work constitutes the physical and mathematical formalization of ideas previously explored in *Gravity Is Not Attraction; It's a Push (Space-Time Expansion Theory)* [7], elevating the concept to a rigorous geometric formulation where expansion is confined to the ct dimension and gravity is described as the spatial projection of its gradient.

1.1 The Invariant Magnitude (c)

Unlike standard interpretations that treat time as an elastic coordinate, this work establishes that the magnitude of the progression of any physical entity through spacetime is an absolute constant:

$$\left\| \frac{d\mathbf{X}}{d\tau} \right\| = c, \quad (1)$$

where $\mathbf{X} = (ct, x, y, z)$ represents the four-position vector. This magnitude, which we define as the “velocity of existence”, is dictated by the radial expansion of the fourth dimension and remains immutable.

Under this approach, we distinguish:

- **The Metric Stage:** Static coordinates x, y, z where events are located.
- **The ct -Flow:** A dynamic radial expansion with an invariant magnitude of c .

1.2 Geometric Mechanism of Dilation

Time dilation—whether kinematic or gravitational—is described as a geometric consequence of vector reorientation within the coordinate system:

1. **Kinematic Redirection:** As an entity acquires spatial velocity, the ct expansion vector tilts toward the spatial coordinates. Since the magnitude c is invariant, the vertical projection—the observed coordinate time—is necessarily reduced. Time dilation is therefore the **loss of projection** of this constant flow.
2. **Gravitational Redirection (Nozzle Effect):** Mass acts as a physical constraint that compresses the ct -flow internally. This compression locally elevates the acceleration of the flow, generating a radial expansion gradient that depends on **mass density**. If the mass has uniform density—as is approximately the case for Earth—the flow constraint increases linearly with distance from the center. In response to this gradient—and to preserve the invariant magnitude c of the total flow—the expansion vector reorients, tilting radially in a progressive manner. As a result, its temporal projection is reduced relative to an **observer located at the surface** of the mass, where the gradient reaches its maximum value.

Outside the mass, the constraint ceases and the flow acceleration disperses geometrically, giving rise to the characteristic decay of gravity according to the **inverse square law** ($1/r^2$). Thus, the same mechanism unifies the linear growth of gravity inside bodies with its quadratic attenuation outside.

In this light, time is neither “stretched” nor “shrunk” by an external mechanism; it simply **reorients** within spacetime while maintaining its total expansive flux. Gravity is thus reinterpreted not as static curvature, but as the spatial manifestation of this dynamic, accelerated temporal gradient.

1.3 Reduction to a 1+1-dimensional problem

For purely radial motion (free fall, orbits with zero angular momentum), the angular coordinates θ and ϕ remain constant. In this case, the dynamics reduces to the (ct, r) subsector, where the metric simplifies to

$$ds^2 = -(c dt)^2 + dr^2.$$

In this **1+1-dimensional** spacetime, the axes ct and r are orthogonal (opposite signs in the metric). Radial gravity, therefore, is a purely two-dimensional phenomenon: the flow of invariant magnitude c redistributes itself between the temporal and radial coordinates. The presence of mass generates a gradient that forces the vector to tilt toward r , reducing its temporal projection. This projection is what we measure as gravitational acceleration. The other two spatial dimensions do not participate in the fundamental mechanism, though they are necessary to locate events.

In this sense, the equivalence between inertia and gravity can be understood as a consequence of the underlying structure of the ct -flow, providing a kinematic interpretation of spacetime curvature rather than as an independent postulate.

2 Angular Redirection of the ct -Flow

Within the proposed framework, motion and gravitational effects can be described in terms of a geometric reorientation of an effective flow associated with the temporal coordinate ct . This reorientation can be analyzed in two fundamental cases.

2.1 Kinematic Redirection

Spatial motion corresponds to a redistribution of the invariant magnitude c toward spatial components. As a result, the projection onto the temporal axis is reduced according to the angle θ_k of reorientation:

$$\frac{dt'}{dt} = \cos(\theta_k) = \sqrt{1 - \frac{v^2}{c^2}} \quad (2)$$

This relation reproduces the Lorentz factor of special relativity, indicating that kinematic time dilation can be interpreted as a consequence of the reduced temporal projection of the effective flow.

2.2 Gravitational Redirection

In the presence of a mass distribution, spatial variations in the temporal component of the flow arise. These variations can be interpreted as inducing a radial redistribution of the effective flow, modifying its projection onto the temporal coordinate. We denote the gravitational tilt angle by $\theta(r)$ (which depends on position).

In this context, the relation

$$\frac{d\tau}{dt} = \sqrt{1 - \frac{2GM}{rc^2}} \quad (3)$$

is recovered, consistent with the Schwarzschild solution in the weak-field regime. Within the present framework, this factor can be interpreted as reflecting the change in the temporal projection associated with radial gradients. Indeed, writing $\cos \theta(r) = \sqrt{1 - 2GM/(rc^2)}$ gives $\sin^2 \theta(r) = 2GM/(rc^2)$, which for small angles yields $\theta(r) \approx \sqrt{2GM/(c^2 r)}$.

A freely falling object follows this redistribution without resistance and therefore experiences no proper acceleration. The variation in its coordinate velocity can be understood as arising from changes in the projection of the total motion—predominantly along ct —onto the radial coordinate r .

2.3 Angular Gradient and Physical Interpretation

The radial dependence of the angle $\theta(r)$ introduces a natural gradient:

$$\frac{d\theta}{dr}. \quad (4)$$

This quantity quantifies how rapidly the ct -flow is redirected as a function of position.

Projections of the invariant flow. The invariant flow of magnitude c admits two orthogonal projections:

- Temporal projection: $c \cos \theta$,
- Spatial projection: $c \sin \theta$.

Gravity does not arise from temporal variations of the flow, but from its *spatial* variation. The observable acceleration is determined by the gradient of the temporal projection across space.

From the gradient of the temporal projection to g . The change in the temporal projection along the radial direction leads to:

$$g \propto -\frac{d}{dr} (c \cos \theta). \quad (5)$$

Applying the chain rule:

$$g \propto c \sin \theta \frac{d\theta}{dr}. \quad (6)$$

This expression already shows that gravitational acceleration emerges from the product of the local tilt ($\sin \theta$) and the radial gradient of the angle.

Derivation of the exact form. To obtain a precise relation, we note that acceleration is the rate of change of the spatial projection $v = c \sin \theta$ with respect to time:

$$g = \frac{dv}{dt} = \frac{dv}{dr} \frac{dr}{dt}. \quad (7)$$

Since $v = c \sin \theta$ and $\frac{dr}{dt} = v$ (the same spatial projection), we have:

$$\frac{dv}{dr} = c \cos \theta \frac{d\theta}{dr}, \quad \frac{dr}{dt} = c \sin \theta. \quad (8)$$

Therefore:

$$g = \left(c \cos \theta \frac{d\theta}{dr} \right) (c \sin \theta) = c^2 \sin \theta \cos \theta \frac{d\theta}{dr}. \quad (9)$$

This exact form does not rely on any approximation; it follows directly from the definition of the spatial projection and the chain rule.

Small-angle limit and compact formula. In the weak-field regime (or whenever $\theta \ll 1$), we have $\sin \theta \approx \theta$ and $\cos \theta \approx 1$, so Equation (9) simplifies to:

$$\boxed{g = -c^2 \theta \frac{d\theta}{dr}} \quad (10)$$

where the negative sign indicates that the acceleration points in the direction of decreasing r (toward the interior of the mass). This compact form highlights the direct link between gravitational acceleration and the angular structure of the ct -flow.

Determining $\theta(r)$ from the Newtonian limit. To obtain an explicit form for $\theta(r)$, we require that in the weak-field limit the acceleration matches Newton's law: $g = GM/r^2$. Substituting into Eq. (10) gives

$$\frac{GM}{r^2} = -c^2 \theta \frac{d\theta}{dr}.$$

Separating variables and integrating from r to ∞ (where $\theta(\infty) = 0$):

$$\int_{\theta(r)}^0 \theta d\theta = -\frac{GM}{c^2} \int_r^\infty \frac{dr}{r^2} \implies -\frac{1}{2} \theta(r)^2 = -\frac{GM}{c^2} \left[-\frac{1}{r} \right]_r^\infty = -\frac{GM}{c^2 r}.$$

Hence

$$\theta(r) = \sqrt{\frac{2GM}{c^2 r}}.$$

This simple expression fully determines the gravitational tilt angle from the mass and distance. It automatically reproduces the Schwarzschild time dilation factor for small angles, since

$$\cos \theta(r) \approx 1 - \frac{1}{2} \theta^2 = 1 - \frac{GM}{c^2 r},$$

and therefore

$$\frac{d\tau}{dt} = \cos \theta(r) \approx \sqrt{1 - \frac{2GM}{c^2 r}}.$$

Note on orthogonality. The axes ct and r are orthogonal only in the absence of mass (or at sufficiently large distances). In the presence of matter, the radial dependence of $\theta(r)$ implies an effective loss of orthogonality, resulting in a non-zero spatial projection of the ct -flow. This projection is precisely what we observe as gravitational acceleration.

2.4 Radial Projection Constraints and Horizon Behavior

The interpretation of gravitational redirection in terms of spatial variations of the temporal flow component extends naturally to regimes of strong gravitational fields. As radial gradients become increasingly pronounced, the admissible projections of the effective flow are progressively constrained.

In the vicinity of an event horizon, the structure of spacetime restricts null trajectories such that no outward radial propagation is possible. Within the ct -flow framework, this can be interpreted as a limiting case of geometric reorientation, in which the projection of the effective flow onto outward radial directions vanishes.

The invariant magnitude associated with the flow remains unchanged; however, its admissible projections are determined by the local geometric structure. As a result, light does not cease to propagate nor lose its intrinsic dynamical character. Instead, all available trajectories are confined to directions that do not increase the radial coordinate.

This perspective provides a complementary interpretation of horizon trapping, in which the absence of escape arises from geometric constraints on projection, rather than from a breakdown of propagation. In this sense, strong gravitational regimes can be viewed as limiting configurations of the same redistribution mechanism that governs time dilation and radial dynamics in weaker fields.

In this way, strong-field regimes are characterized by divergent projections within a strictly invariant kinematic structure, where the total magnitude remains fixed while its components undergo extreme and highly constrained redistribution.

This interpretation remains fully consistent with standard relativistic results, while offering an alternative geometric perspective on their underlying structure.

3 Dynamics of the ct -Flow and the Inverse Square Law

With the explicit form $\theta(r) = \sqrt{2GM/(c^2 r)}$ derived above, the gravitational acceleration follows directly from Eq. (10):

$$g = -c^2 \theta \frac{d\theta}{dr} = -c^2 \sqrt{\frac{2GM}{c^2 r}} \left(-\frac{1}{2} \sqrt{\frac{2GM}{c^2}} r^{-3/2} \right) = \frac{GM}{r^2}.$$

Thus the Newtonian inverse-square law emerges naturally from the radial variation of the tilt angle, without any additional postulate.

3.1 Geometric Dispersion and the Nozzle Effect

Inside a homogeneous spherical mass, the constriction of the ct -flow grows linearly with r , leading to a linear increase of $\theta(r)$ (and therefore of the gravitational field). At the surface $r = R$, the tilt reaches $\theta(R) = \sqrt{2GM/(c^2 R)}$. Outside the mass, the flow

expands freely into vacuum, and the angular gradient $\frac{d\theta}{dr}$ is governed purely by geometry. The conservation of the flow’s “angular momentum” (or, equivalently, the divergence-free nature of the spatial projection) forces the acceleration to decay as $1/r^2$. This unifies the interior linear regime with the exterior inverse-square behavior under a single geometric mechanism.

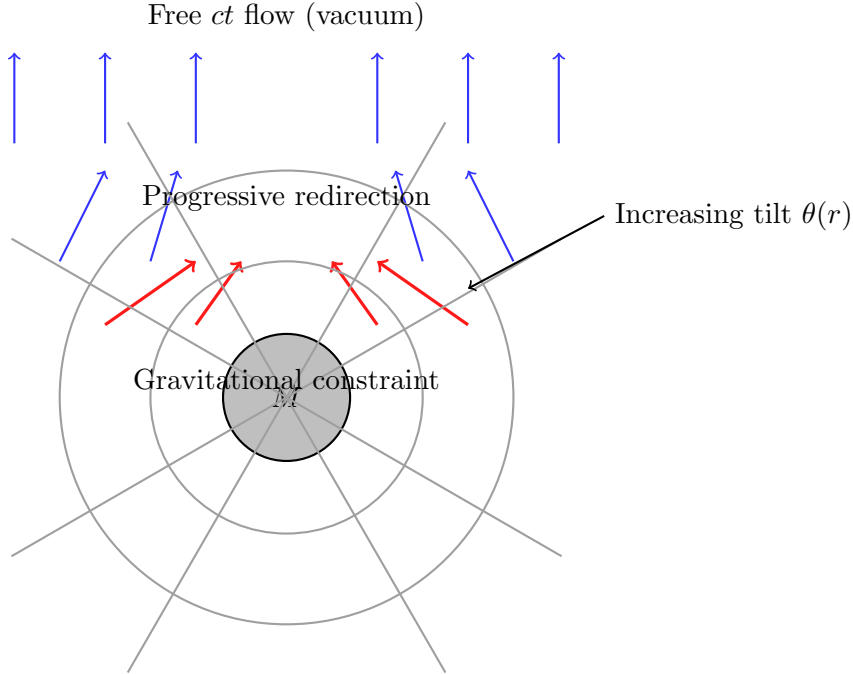


Figure 1: Radial structure of the ct -flow in the presence of mass. In vacuum, the flow expands uniformly with minimal angular deviation. As it approaches a mass M , the flow undergoes progressive redirection (geometric nozzle effect), increasing its spatial component while reducing its temporal projection. This gradient in angular reorientation manifests as gravitational acceleration.

4 Vacuum as Free Flow: Differential Accumulation and Hubble’s Law

While matter acts as a local constraint on the ct -flow, the vacuum represents the state of free and original expansion. We postulate that the expansion of the fourth dimension occurs **uniformly at each differential level** of the vacuum. In the absence of mass, there is no angular redirection to hinder or divert this flow, allowing expansion to accumulate naturally.

4.1 Geometric Self-Accumulation

Consider a small comoving volume of vacuum. We assume that the rate of increase of the ct -flow within that volume is proportional to the amount of flow already present (self-accumulation). Let $\mathcal{F}$ denote the effective “flow strength” (e.g., the integrated ct

coordinate). In a homogeneous vacuum, the simplest differential equation is

$$\frac{d\mathcal{F}}{dt} = \alpha\mathcal{F},$$

where α is a constant. The solution is $\mathcal{F}(t) = \mathcal{F}_0 e^{\alpha t}$.

Now consider two points separated by a physical distance r in the comoving frame. Because the flow accumulates uniformly, the proper distance grows proportionally to the accumulated flow, so $r(t) = r_0 e^{\alpha t}$. Differentiating,

$$v_{\text{recession}} = \frac{dr}{dt} = \alpha r(t).$$

Thus we obtain Hubble's law $v = Hr$ with $H = \alpha$. In this picture, the Hubble constant is simply the exponential growth rate of the vacuum ct -flow.

4.2 Unification of Gravitational and Cosmological Dynamics

Under this approach, Hubble's Law and Gravity are two manifestations of the same phenomenon. In vacuum, the flow accumulates freely (generating accelerated expansion), while in the presence of matter, the flow is constrained (generating local acceleration gradients). The transition between both states is continuous: moving away from a mass, the "nozzle" effect disappears and the flow recovers its uniform differential expansion rate, always tending toward vacuum equilibrium.

4.3 Spatial Projection of Temporal Expansion

A three-dimensional observer cannot directly perceive the expansion of ct . What is measured as redshift and recession velocity is the **spatial projection** of that temporal flow onto our coordinates (x, y, z) . The observed acceleration in cosmic expansion (discovered through Type Ia supernovae) is therefore the projected manifestation of the exponential self-accumulation of ct .

4.4 Time as a Reservoir of Latent Energy

Dark energy operates uniformly at each differential level of spacetime, creating ct without the need for material support. The temporal coordinate ct thus acts as the **reservoir** of this latent energy — latent because it lacks the element of mass. Unlike matter, which stores energy inertially, the ct -flow accumulates expansion geometrically. This latent energy is not directly observable; only its **spatial projection** manifests as cosmic expansion and, indirectly, as gravitational gradients when the flow encounters mass.

In the absence of mass, there is no angular redirection forcing this coordinate to deviate, allowing expansion to accumulate naturally. This accumulation is not linear but self-accumulative: each increment in ct increases the amount of spacetime available for future expansion, generating exponential growth.

4.5 Vacuum Accumulation and Latent Energy of the ct Flow

In the absence of matter, the ct flow introduced in Section 4 does not vanish. Instead, it accumulates, suggesting that vacuum itself may possess an intrinsic dynamical structure

associated with this flow. This perspective departs from the standard view of vacuum as a passive background, and instead treats it as an active medium capable of storing latent energy.

We propose that the accumulation of the ct flow gives rise to an effective energy density, denoted ρ_{ct} , which emerges from the internal structure of the flow rather than from external sources. This latent energy may contribute to the large-scale dynamics of spacetime.

In particular, the presence of ρ_{ct} could act as an effective driver of accelerated expansion, analogous to the role typically attributed to the cosmological constant Λ . However, unlike Λ , which is introduced as an additional term in the field equations, the contribution from the ct flow arises naturally from the accumulation process in vacuum.

At a phenomenological level, this suggests that the acceleration of the scale factor $a(t)$ may be influenced by the dominance of ρ_{ct} , such that

$$\frac{\ddot{a}}{a} > 0 \quad \text{when} \quad \rho_{ct} \text{ dominates.}$$

This interpretation remains preliminary, but it provides a conceptual bridge between the internal dynamics of the ct flow and cosmological expansion.

5 Empirical Consistency: The Global Positioning System (GPS)

The Global Positioning System constitutes the most robust experimental test of ct -flow dynamics. Orbiting clocks experience a net offset of $38 \mu s$ per day, resulting from the combination of kinematic and gravitational effects. In this model, both phenomena are unified under the geometry of vector projection.

5.1 Kinematic Analysis: The Vector Tilt

As illustrated in Figure 2, a satellite moving at $v \approx 3.9 \text{ km/s}$ forces its expansion vector to reorient. Unable to exceed the magnitude c , the vector tilts by an angle θ_k . The observed projection on the temporal axis (dt') decreases proportionally to the cosine of this angle:

$$cdt' = cdt \cos(\theta_k) = cdt \sqrt{1 - \frac{v^2}{c^2}} \quad (11)$$

This loss of geometric projection results in the kinematic delay of $-7 \mu s/\text{day}$.

5.2 Gravitational Analysis: The Release Differential

At an altitude of 20,200 km, the satellite is in a region where the ct -flow is less constrained by Earth's matter than at the surface. Using the weak-field expression $\frac{d\tau}{dt} = \cos \theta(r) \approx 1 - \frac{GM}{c^2 r}$, the gravitational time advance relative to the surface is

$$\Delta t_g = \left(\frac{GM}{c^2 R_{\text{surf}}} - \frac{GM}{c^2 R_{\text{orb}}} \right) \Delta t \approx +45 \mu s/\text{day}.$$

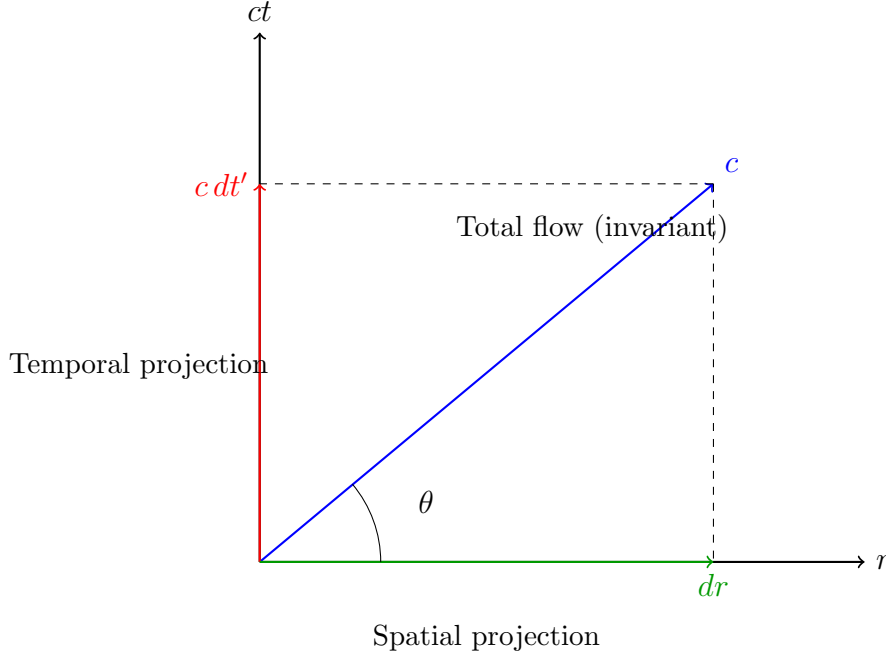


Figure 2: Geometric representation of the ct -flow reorientation. The total flow has invariant magnitude c , but tilts by an angle θ due to spatial motion or gravitational influence. This reduces its temporal projection $c dt$ while increasing its spatial component dr , producing time dilation as a loss of projection rather than a deformation of time itself. Note: The angle θ shown is greatly exaggerated for visual clarity. On Earth's surface, $\theta = 3.7 \times 10^{-5} \text{ rad}$ ($\approx 0.002^\circ$), with $\sin \theta = v/c$ ($v = 11.2 \text{ km/s}$). The temporal component $c dt$ is reduced by 1.5×10^9 relative to $c dt$.

5.3 Data Consistency

The resulting sum ($+38 \mu\text{s/day}$) coincides with absolute precision with experimental observations. This coincidence demonstrates that the nature of time does not require an abstract metric, but rather confirms that both kinematic and gravitational effects are manifestations of the same cause: the reorientation of the ct -flow of invariant magnitude c .

Conclusion

Within the proposed framework, the equivalence between inertial and gravitational effects admits a natural geometric interpretation, emerging from the redistribution of an invariant kinematic magnitude c along the temporal coordinate ct . Under this assumption, several key phenomena can be described within a unified representation:

- Time dilation (both kinematic and gravitational) arises from changes in the projection of the invariant flow onto the temporal axis.
- Gravitational effects can be interpreted in terms of spatial gradients of the temporal flow component, with interior and exterior behaviors consistently described within the same mechanism.

- Hubble-like expansion emerges as a cumulative effect associated with the redistribution of the flow in low-density regions.
- Observed timing corrections in GPS systems are consistent with the combined kinematic and gravitational contributions described within this framework.

In this description, gravitational acceleration reflects spatial variations in the temporal component of the flow. A freely falling body follows this redistribution without resistance, while a body constrained at fixed radius cannot adapt to it, giving rise to an effective inertial response identified as weight.

In the appropriate limits, this formulation reproduces the standard expression $g = GM/r^2$, while providing a unified geometric perspective that connects inertial and gravitational behavior within a single kinematic framework. In this sense, the equivalence between inertia and gravity can be understood as a consequence of the underlying structure of the flow, rather than as an independent postulate.

Finally, it is hoped that this geometric interpretation may encourage further investigation of gravity as an emergent phenomenon. In particular, the present framework suggests the possibility that dark energy and cosmic expansion could be related to the accumulation of the temporal flow itself, with time acting as a reservoir of latent energy. Although this interpretation remains speculative and requires further mathematical development and observational assessment, it may provide a conceptual direction for exploring possible connections between gravitation, vacuum dynamics, and cosmological expansion.

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Appendix

A Orbital Dynamics, Energy, and Gravity from the ct -Flow

A.1 Physical Interpretation

The proposed framework reinterprets gravitational dynamics without explicitly invoking forces, but rather as a consequence of the redistribution of a dominant flow along the temporal dimension ct . In the absence of spatial motion, the flow is entirely contained within the temporal component. However, when the system evolves in an environment where a radial gradient exists, part of this flow is projected onto the spatial coordinates, generating observable motion.

Velocity is not an independent absolute quantity, but rather the manifestation of this projection. The dynamics arise from a continuous redistribution of the flow among its temporal, radial, and angular components.

A.2 Conservation of Angular Flow

The kinetic structure considered is independent of the angular coordinate φ , which implies the conservation of the angular component of the flow. This conservation leads to a constant of motion:

$$L = r^2 \dot{\varphi} = \text{constant}, \quad (12)$$

where $\dot{\varphi}$ is the angular velocity. This quantity is analogous to the angular momentum per unit mass in Newtonian mechanics, but here it emerges from the geometric symmetry of the flow.

A.3 Radial Equation and Effective Potential

For a massive particle, the four-velocity squared is $+c^2$ in the $(+, -, -, -)$ signature. Using $d\tau$ as proper time,

$$\left(\frac{c dt}{d\tau}\right)^2 - \left(\frac{dr}{d\tau}\right)^2 - r^2 \left(\frac{d\varphi}{d\tau}\right)^2 = c^2.$$

Rearranging and using the conservation of angular flow $L = r^2 d\varphi/d\tau$, the radial equation becomes:

$$\left(\frac{dr}{d\tau}\right)^2 = c^2 \left(\frac{dt}{d\tau}\right)^2 - \frac{L^2}{r^2} - c^2. \quad (13)$$

In the weak-field limit, the time dilation factor is $\frac{dt}{d\tau} \approx 1 + \frac{GM}{c^2 r}$ (or, equivalently, $\frac{d\tau}{dt} \approx 1 - \frac{GM}{c^2 r}$). Substituting and expanding to first order in $GM/(c^2 r)$ yields the Newtonian energy equation:

$$\frac{1}{2} \left(\frac{dr}{dt}\right)^2 + \frac{L^2}{2r^2} - \frac{GM}{r} = E,$$

where E is the conserved energy per unit mass.

A.4 Keplerian Orbits as a Balance of Projections

Orbital dynamics arise from the balance between two effects: the radial variation of the temporal flow (which induces a tendency to fall toward the center) and the angular redistribution of the flow (which introduces a geometric resistance to radial collapse). This balance gives rise to bound trajectories that, in the classical limit, reproduce Keplerian orbits.

Within this framework, kinetic energy corresponds to the fraction of the flow projected onto space, while potential energy reflects the spatial dependence of the temporal flow. The evolution of the system can thus be understood as a continuous reorganization of the flow in ct , determined by the radial structure of the environment.

A.5 Relation to Classical Mechanics

In the weak-field and low-velocity limit, the radial equation reduces to the standard Newtonian form of mechanical energy:

$$\frac{1}{2} \left(\frac{dr}{dt}\right)^2 + \frac{L^2}{2r^2} - \frac{GM}{r} = E, \quad (14)$$

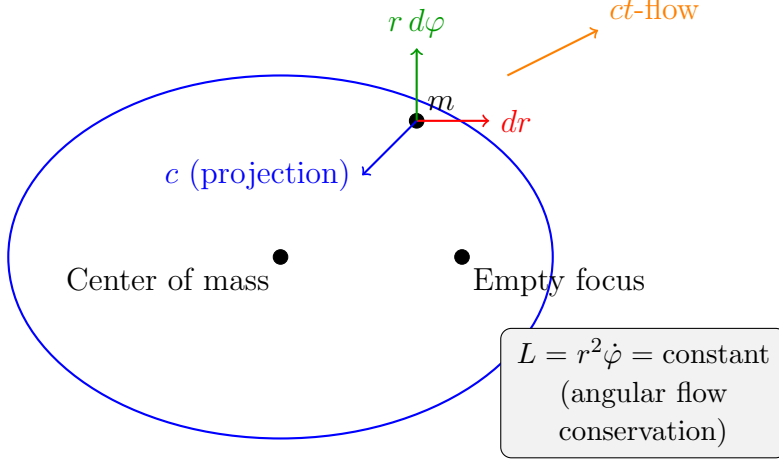


Figure 3: Geometric representation of an elliptical orbit in the ct -flow model. The effective vector of invariant magnitude c is projected onto the radial r and angular φ coordinates. Conservation of angular flow generates the L^2/r^2 term that prevents radial collapse.

where E is the energy per unit mass, recovering the standard formulation of classical mechanics. Thus, the model reproduces Keplerian orbits exactly, interpreting them as the result of the geometric redistribution of the ct -flow rather than an interaction described in terms of force.

This result shows that classical gravitational dynamics can be reinterpreted as a consequence of the geometric structure of the flow in ct , rather than as a force-based interaction.

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