

From the Thaumatrope to the Geodesic: Time Dilation as the Inertia-Free Regulator of a Static Future

Scientific Essay — Part II

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Abstract

This essay continues the critical analysis of a cosmological framework grounded in free-fall expansion. The focus rests on the fundamental dilemma of how a non-monotonic radius trajectory can be mathematically and physically justified without relying on classical dynamic equations of motion. We investigate the extent to which the established closure algorithm depends on the equality of time dilations and how the zero-energy universe concept is energetically stabilized. Finally, we demonstrate that the resolution to the apparent paradox lies not in a classical Newtonian force, but in the complete neutralization of inertia by the weightlessness inherent to free fall.

1 The Temporal Seam: The Algebraic Thaumatrope

The cosmological model described in Part I faces a strict mathematical test when attempting to dynamically describe the transition from the epoch of expansion ($a < 0.155$) to the phase of slight contraction ($a > 0.155$). According to classical mechanical principles, the time derivative of the radius (dR/dt) would have to invert its sign at this peak. In a purely kinematic universe, such a reversal would be inextricably coupled to a dramatic shift in the observed redshift.

However, because the model resolves this transition purely algebraically via the closure condition of the *Main Equation*, the mathematical framework behaves like a perfect thaumatrope or flip-book: it sequences static snapshots of energetic equilibrium. Each frame for a given scale factor a is self-consistent and closed, yet the physical law that causally drives the system from one frame to the next remains unformulated within classical force dynamics.

2 The Equality of Time Dilations as a Metabolic Gear

This sequence of frames is not a mathematical artifact; it rests fundamentally on the postulated equality of kinetic and gravitational time dilation:

$$\sqrt{1 - \frac{v^2}{c^2}} = 1 + \frac{\phi}{c^2} \quad (1)$$

In traditional relativity, motion (v) and spatial curvature (ϕ) are complementary yet distinct physical phenomena. Through their mathematical interchangeability in the present model ($v \equiv v_\phi$), the closure algorithm gains the license to translate the real, macroscopic outward motion of celestial bodies entirely into a static property of the field without any loss of physical information. The mass factor q of dark matter thus becomes a property of the potential itself:

$$q = \frac{1}{1 + \frac{\phi}{c^2}} \quad (2)$$

Time dilation acts here as the ultimate regulator: because the passage of time is massively slowed down within the dense field of the early phase, the cosmological redshift z along the line of sight is decentralized and interpreted purely as gravitational time dilation. Consequently, the observed redshift is decoupled from the actual behavior of the radius, allowing the latter to mathematically contract while the expansion characteristic of the redshift is preserved.

3 Energetic Consistency of the Zero-Energy Postulate

A second critical benchmark is the energetic viability of the zero-energy universe in the context of free-fall mechanics. In a classical physical sense, free fall implies the continuous conversion of potential energy into kinetic energy, where the sum of both quantities remains strictly constant.

In the investigated model, however, numerical evaluations show that the free-fall velocity v remains nearly constant just below the speed of light c over the vast majority of the expansion history, even as the global gravitational potential changes drastically. A classical conservation of energy for an isolated test particle is therefore not maintained along the time axis. The mathematical closure of the total energy to exactly zero is achieved only because the fluctuating energy difference is fully shifted onto the dynamic mass factor of dark energy ($x(a)$) in every single step:

$$x(a) = \frac{1}{\Omega_{\text{bs}}} - q(a) - k(a) \quad (3)$$

Thus, within this model, the zero-energy universe is not the dynamic result of a mechanical motion. Instead, it is an overarching algebraic axiom to which the density distributions of the dark sectors must unconditionally conform in each individual frame of the sequence.

4 From Force Gradients to the Absence of Inertia

In searching for the missing link between the individual frames, one physical approach defines the force F as the gradient of a field-dependent energy difference ΔE_0 , which is directly based on the variable speed of light c' within the gravitational field:

$$F = \frac{d}{dr} \left(-\frac{1}{2} \cdot \Delta E_0 \right) \quad (4)$$

This equation derives a real physical force from the relativity of time dilation. In the current state of the model, however, this force acts merely as a locally readable measurement rather than a dynamic drive, as it is not integrated into a temporal differential equation ($F = m \cdot \ddot{r}$).

The radical and conceptually most elegant resolution of this dilemma lies in the physical nature of free fall itself: the state of perfect free fall is characterized by absolute weightlessness. Because the gravitational mass (which responds to the field) is exactly identical to the inertial mass (which resists any change in motion), these two fundamental properties of matter neutralize each other completely.

Consequently, no driving mechanical force is required for the universe to transition from $a = 0.15$ to $a = 0.16$. The system possesses no inertial resistance against which a cosmic motor would have to work. Matter glides entirely effortlessly and free of inertia along the geometry mapped out by the potential.

5 Concluding Remarks

The decoupling of dynamics and geometry demonstrated here reveals a profound truth about the nature of free fall on a cosmological scale. The perceived deficit of the model — the absence of a classical, force-based equation of motion — proves upon closer physical inspection to be

its greatest conceptual strength. By defining the expansion as a weightless, outward free fall, the model emancipates the universe from the necessity of a mechanical drive. The cosmos does not drift from one epoch to the next under the dictate of spacetime forces; it glides without resistance as an energetically neutral entire system through the sequences of its own geometry. The force components derived from time dilation are not engines of expansion, but merely the local, static measurements of a perfectly balanced equilibrium. Within this inertia-free elegance, even the non-monotonic bend of the cosmic radius at $a \approx 0.155$ loses its paradoxical nature: it represents no mechanical reversal of direction, but the harmonious, undisturbed settling of infinite space into its static future. The universe does not contract out of exhaustion; rather, it comes to rest in an asymptotic standstill because, in infinite free fall, time itself has become the ultimate and force-free architect of cosmic geometry.