

The Decoupling of Dynamics and Geometry: A Critical Analysis of Free-Fall Cosmology and the Concept of a Static Future

Scientific Essay

September 28, 2026

Abstract

This essay investigates an alternative cosmological model that describes the expansion of the universe not through the stretching of space itself (Λ CDM standard model), but as an outward motion in free fall. Central to this analysis is the apparent paradox that the local free-fall velocity and the gravitational potential equivalent are quantitatively decoupled from the global temporal rate of change of the cosmic radius. Using the model’s mathematical closure conditions and numerical data, we demonstrate how the model formulates a mathematically consistent framework of a radius growth that approaches zero while maintaining a constant, relativistic free-fall velocity.

1 Introduction

In modern standard cosmology, the expansion of the universe is inextricably linked to the metric of space. Galaxies recede from one another because the space between them expands; the recession velocity at the boundary of a cosmological volume is directly coupled to the time derivative of the scale factor or the radius ($v = \dot{R}$).

The alternative model discussed here, based on Richard Feynman’s field-dynamic treatment of gravitation, radically breaks with this dogma. It postulates a universe with a total energy of exactly zero, whose expansion is understood as an outward-directed free fall. A fundamental consequence of this approach is the numerical and conceptual decoupling of the local free-fall velocity v from the global geometric rate of change of the cosmic radius (dR/dt).

2 The Dual Interpretations of Free-Fall Velocity

The foundation of the model is built upon the equality of kinetic (Special Relativity) and gravitational (General Relativity) time dilation:

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

From this relation, two complementary perspectives emerge, which are treated as mathematically interchangeable throughout the model:

- **The kinetic reading (v):** Describes the real, local outward velocity of matter in free fall.
- **The static reading (v_ϕ):** Translates the gravitational potential ϕ (energy per unit mass, m^2/s^2) via the speed of light c into a potential equivalent, which also carries the unit of meters per second (m/s):

$$v_\phi \equiv c \sqrt{1 - \left(1 + \frac{\phi}{c^2}\right)^2} \quad (2)$$

Although both quantities possess the dimension of velocity (m/s), they exclusively describe local physical states at the boundary of a considered homogeneous sphere and not the global expansion rate of the entire system.

3 The Mathematical Paradox: Why $v \neq dR/dt$

In the classical Newtonian limit or within the Friedmann metric, the velocity at the boundary of an expanding sphere is necessarily the temporal change of the radius. In the proposed free-fall cosmology, however, the cosmic radius $R(a)$ at each scale factor a is determined purely algebraically via a global energy balance equation (the *Main Equation*), rather than by integrating the velocity over time ($\int v dt$).

This fundamental independence is most clearly observed in the late phase of the universe (the present epoch at $a = 1$):

1. **Divergence of magnitudes:** While the local free-fall velocity v_0 reaches nearly the speed of light at $\sim 2.961 \cdot 10^8$ m/s, the geometric rate of change of the radius with respect to the scale factor is $dR/da = -426.8 \cdot 10^{22}$ m.
2. **Inversion of signs:** Converting dR/da into the temporal rate of change dR/dt under the assumption of a linear time component ($a = t/t_0$) yields for the present day:

$$\frac{dR}{dt} = \frac{dR}{da} \cdot \frac{1}{t_0} \approx -9.83 \cdot 10^6 \text{ m/s} \quad (3)$$

The sign is negative. This means that while the free-fall component continues to exhibit a high-energy outward characteristic, the actual radius of the universe is already slightly contracting.

4 The Physical Resolution: Gravitational Redshift

Such a system would be contradictory within a kinematic cosmology, as a shrinking radius would imply a blueshift of light. The model resolves this by decentralizing the cosmological redshift z and interpreting it purely as a phenomenon of gravitational time dilation. A light signal emitted at the boundary of the sphere and received at the center arrives shifted according to the ratio of the two clock rates:

$$1 + z = \frac{1}{\sqrt{1 - \left(\frac{r}{R_h}\right)^2}} \quad (4)$$

Because the redshift is thus a geometric property of the line of sight within the gravitational field and does not stem from a Doppler effect, the global radius R is free to move independently of v . Its dynamics are balanced precisely to preserve the zero-energy condition.

5 Asymptotic Transition to the Static End State

As shown in Table 1, the trajectory of the radius $R(a)$ for future epochs ($a > 1$) displays a monotonic convergence toward a fixed limiting value of $\sim 0.9665 R_0$.

Table 1: Numerical Approach to the Static End State

Scale factor a	Radius $R(a)/R_0$	dR/da (10^{22} m)
1	1.0000	-426.8
2	0.9832	-107.2
5	0.9732	-17.12
10	0.9698	-4.272
50	0.9672	-0.171

The rate of geometric change (dR/da) falls off proportionally to a^{-2} and vanishes completely at infinity. In this algebraic system, the static state acts as a mathematical attractor. The local kinetic energy of matter (described by $v \approx c$) remains frozen in the field, while the global expansion grinds to a halt.

6 Conclusion

The investigated model demonstrates a mathematically consistent alternative to spatial expansion. The unit m/s for v and v_ϕ must not be confused with the global expansion velocity of space; it is a measure of the local gravitational potential enclosed within the spherical volume. By fully replacing kinematic expansion with gravitational time dilation, the model successfully demonstrates a stable, asymptotically static future for the universe without reproducing the Eddington instability characteristic of the classical static Einstein universe.