A Framework for Gravity Based on Expansion Gradients of Space

John Sikora

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Abstract

We propose a reinterpretation of gravity as a consequence of spatial expansion gradients rather than curved spacetime. In this framework, mass reduces the expansion of space in its vicinity, creating gradients in the expansion field that manifest as gravitational attraction. The expansion field obeys a Poisson-like equation, and test masses move according to the local gradients of this field. This formulation reproduces Newtonian gravity in the weak-field limit, predicts gravitational redshift, and provides a conceptually different view of gravity without requiring curved spacetime.

1 Introduction

Standard General Relativity attributes gravity to the curvature of spacetime. In contrast, we explore a model where space itself expands at a constant speed (the speed of light, c) from a central origin point. Mass acts to locally *reduce* this expansion, creating gradients in the expansion field that determine the motion of matter and light.

2 Expansion Gradient Field

We define a scalar expansion field:

$$\phi(x^\mu) \tag{1}$$

which quantifies the local expansion rate of space. In regions of higher mass density, the expansion is reduced, leading to gradients in ϕ.

3 Field Equation

The expansion field obeys an equation similar to the Poisson equation for the Newtonian gravitational potential:

$$\nabla^2 \phi = \frac{16\pi G}{c^2} \rho \tag{2}$$

where ρ is the mass density and G is the gravitational constant.

4 Equation of Motion

The motion of test masses is driven by the gradient of the expansion field:

$$\frac{d^2 x^i}{dt^2} = -\partial^i \phi \tag{3}$$

This replaces the geodesic motion in curved spacetime and directly ties motion to the spatial expansion gradient.

5 Gravitational Redshift

Gravitational redshift arises naturally as light propagates through regions of different expansion rates:

$$\frac{\Delta\nu}{\nu} = \frac{1}{2}(\phi_{\text{obs}} - \phi_{\text{emit}}) \tag{4}$$

6 Connection to Newtonian Gravity

By identifying:

$$\phi = \frac{2\Phi_N}{c^2} \tag{5}$$

we recover the familiar Newtonian gravitational potential:

$$\nabla^2\Phi_N = 4\pi G\rho \tag{6}$$

7 Conclusion

This framework provides an alternative to curved spacetime by treating gravity as the motion of matter in response to spatial expansion gradients. It reproduces known gravitational effects in the weak-field limit and offers a new perspective on the role of expanding space in shaping the universe.