Differential Expansion Framework (DEF v9.0): Origin of Gravity from Spatial Attenuation

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Abstract

This paper presents version 9.0 of the Differential Expansion Framework (DEF), a minimal physical model in which gravity arises from the attenuation of a universal expansion field. Space expands isotropically at a propagation rate $E = c$, representing the maximal transfer rate of the underlying energy field. Matter locally reduces this expansion rate, creating spatial gradients that manifest as gravitational acceleration. The model reproduces the Newtonian limit, provides a nonlinear extension for stronger fields, and offers a physically intuitive explanation of gravity as differential expansion.

1 1. Expansion Field and Dimensional Definition

In the DEF, the background expansion field describes how the energy content of space propagates outward at rate $E = c$ (m s^{-1}). This rate does not represent the motion of matter but the *propagation of expansion itself*—the velocity at which uniform expansion equilibrates. Matter with density ρ slows the local propagation, giving a small perturbation $e(\mathbf{x}) < 0$ so that

$$E(\mathbf{x}) = c + e(\mathbf{x}), \qquad |e| \ll c. \tag{1}$$

The attenuation spreads isotropically and obeys

$$\nabla^2 e = \sigma c \rho, \tag{2}$$

where σ is the attenuation coefficient per unit mass. The factor of c ensures dimensional balance: both sides have units of s^{-2}. Matching to the Newtonian limit fixes

$$\sigma = \frac{4\pi G}{c^2}. \tag{3}$$

Equation (2) states that matter proportionally reduces the local expansion propagation rate, forming gradients in e.

2 2. Gravitational Potential and Motion

Define the potential

$$\phi = c\, e, \tag{4}$$

which translates the expansion perturbation into energy units. Substituting into Eq. (2) yields

$$\nabla^2 \phi = 4\pi G \rho. \tag{5}$$

This recovers the classical Poisson equation directly from expansion attenuation. The resulting acceleration follows

$$\mathbf{g} = -\nabla \phi, \tag{6}$$

so matter moves naturally toward regions of slower expansion. In this picture, gravitational attraction is a *response to differential expansion.*

3 3. Dynamic and Nonlinear Extension

When temporal changes or strong gradients are considered, the field evolves according to

$$\frac{1}{c^2}\partial_t^2\phi - \nabla^2\phi = -4\pi G\rho - \frac{|\nabla\phi|^2}{c^2}. \tag{7}$$

The nonlinear term $-|\nabla\phi|^2/c^2$ represents the self-reinforcing reduction of expansion where gradients are strong. In weak fields ($|\nabla\phi|/c \ll 1$), Eq. (7) reduces exactly to the Poisson form, maintaining consistency with Newtonian gravity.

4 4. Interpretation and Empirical Outlook

Gravity emerges as a byproduct of spatial energy propagation: matter attenuates expansion, producing gradients that cause motion toward slower regions. The constant $\sigma = 4\pi G/c^2$ couples the microscopic attenuation to the macroscopic gravitational constant G. Because the field propagates at c, small temporal modulations may appear as scalar waves, though expected amplitudes ($< 10^{-15}$ strain) remain below current sensitivity. Laboratory verification may arise indirectly through high-precision optical clock differentials ($\sim 10^{-18}$) or microgravity balance tests sensitive to differential expansion across controlled densities.

Conclusion

The core DEF equations

$$E = c + e, \quad e < 0 \text{ near mass}, \quad \nabla^2 e = \sigma c\rho, \quad \sigma = \frac{4\pi G}{c^2}$$

define gravity as a direct consequence of attenuated expansion. The potential $\phi = ce$ reproduces Newtonian gravity in the weak limit, while Eq. (7) introduces the nonlinear correction for strong fields. The DEF provides a physically intuitive, dimensionally consistent, and testable origin for gravitation rooted solely in the dynamics of spatial expansion.