Appendix A

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1 Introduction

Appendix A: Full Mathematical Expansion of Recursive Horizon Theory

A.1: Gravitational Field from Entropy Flow

We define a scalar entropy field $S(x)$ over a 3D spatial hypersurface embedded in a Lorentzian manifold M. Let $\Phi(x)$ be the gravitational potential induced by entropy distribution.

We postulate that entropy gradients generate gravitational potential via:

$$\frac{\delta S}{\delta x^i} = -\partial_i \Phi(x) \quad or \quad \nabla S(x) = -\nabla \Phi(x)$$

Taking divergence of both sides yields:

$$\nabla \cdot \nabla S(x) = -\nabla \cdot \nabla \Phi(x) \Rightarrow \nabla^2 S(x) = -\nabla^2 \Phi(x)$$

We invert this to derive the Poisson equation for gravitational potential:

$$\nabla^2 \Phi(x) = 4\pi G \, \frac{\delta S}{\delta V}$$

This implies: - Gravitational curvature is sourced by local entropy density per unit volume, - Entropic force arises as:

$$\vec{F}(x) = -\nabla \Phi(x)$$

This connects entropy geometry directly to Newtonian gravity through a statistical interpretation of mass-energy localization as entropy compression.