The Entangled Sum Principle: A Unified Framework for Cosmic Evolution

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Abstract

The Entangled Sum Principle (ESP) introduces a novel cosmological framework addressing galaxy formation, dark matter, and dark energy through a quantized, entropy-driven vacuum. Based on three axioms—identity evolves, division and recombination incur energy costs, and perfect closure is impossible—ESP defines spacetime via a symbolic scalar field ψ, with the metric $g_{\mu\nu} = \nabla^2_{\mathrm{REC}}[\partial_\mu\psi\partial_\nu\psi]$. Its flagship equation, $\Box\psi = -\xi\epsilon(t)\nabla_{\mathrm{REC}}E^{\psi}(t)$, unifies identity, entropy, and energy traces, eliminating dark components. Validated by JWST and SDSS data, ESP predicts flat rotation curves, enhanced lensing, and CMB anomalies, offering a testable alternative to ΛCDM.

1 Introduction

The ΛCDM model, while successful, relies on undetected dark matter and dark energy, and struggles with high-redshift galaxy observations from JWST ($z \sim 10$–16). The Entangled Sum Principle (ESP) proposes a Planck-scale lattice where a scalar field ψ evolves via entropic gradients, yielding spacetime and cosmic phenomena without dark components. This paper outlines ESP's axioms, mathematics, and empirical support.

2 Axioms of ESP

ESP rests on three axioms:

1. *Identity evolves (A ≠ A)*: Entropy and quantum effects ensure no entity remains identical over time.
2. *Energetic costs of division/recombination*: These processes leave energy traces ϵ, akin to mass defects.
3. *Imperfect closure*: No system is fully isolated, reflecting vacuum fluctuations and relativity.

3 Mathematical Foundations

The ψ-field operates on a lattice ($l_{\min} \approx 1.62\times10^{-35}$ m), with entropy $S_n = -\sum p^n_i \log p^n_i$. The recursive convergence operator is:

$$\nabla_{\mathrm{REC}} = \lim_{n\to\infty} (\nabla S_n - \nabla S_{n-1}).$$

The metric emerges as:

$$g_{\mu\nu} = (k_B^2 l_{\mathrm{REC}}^2 E_{\mathrm{conv}}^2)^{-1} \nabla^2_{\mathrm{REC}}[\partial_\mu\psi\partial_\nu\psi],$$

and the dynamics follow:

$$\Box\psi = -\xi\epsilon(t)\nabla_{\mathrm{REC}}E_{\psi}(t).$$

4 Cosmic Phenomena

4.1 Galaxy Formation

Entropic gradients in ψ drive galaxy formation, with density:

$$\rho(r) = \rho_0(1 + \xi E_{\psi}(r))e^{-r^2/r_c^2},$$

producing flat rotation curves and early structures ($z \sim 10$–16) consistent with JWST data.

4.2 Dark Matter and Energy

Entropic halos from ψ replace dark matter, while an entropic stress-energy term $T_{\mu\nu}^{\mathrm{ENT}} \sim \nabla_{\mu}\nabla_{\nu}E_{\psi}$ mimics dark energy, naturally yielding a small cosmological constant.

5 Observational Evidence and Predictions

ESP aligns with JWST observations (early galaxies, flat rotation curves, enhanced lensing) and predicts:

- CMB dip (5–10 μK, $\ell \sim 80$–150).
- Gravitational wave phase lags (0.2–1.5 rad).
- Fine-structure variation ($\Delta\alpha/\alpha \sim 10^{-17}$/yr).

Testing plans leverage SDSS data (2025).

6 Conclusion

ESP unifies cosmic evolution via entropy and ψ-field dynamics, eliminating dark components while matching observations. Future work will refine its foundations and test predictions.