Formal Compilation of the Entangled Sum Principle (ESP) Axioms

Drew Farwell
drew@edgenemi.com

July 29, 2025

Abstract

This document formalizes the six axioms of the Entangled Sum Principle (ESP), a framework aiming to unify cosmic phenomena through a quantized vacuum lattice driven by entropy, phase transitions, and information interference. Building on Codex 2, it incorporates Axiom 0 and extends three derived principles into formal axioms. Each axiom includes a statement, scientific rationale, derivations, and equations, ensuring testability with 2025 data (JWST, SDSS DR17, HETDEX). The axioms challenge ΛCDM's reliance on dark matter/energy, offering falsifiable predictions (e.g., flat halo cores, CMB anomalies).

1 Introduction

The Entangled Sum Principle (ESP) posits that identity evolves via entropy-driven convergence on a quantized lattice, rejecting classical $A = A$. This compilation formalizes six axioms, integrating Axiom 0 and three emergent principles, with derivations rooted in ψ-field dynamics and recursive entropic convergence (∇_{REC}). Equations align with general relativity (GR) and quantum mechanics, targeting anomalies like the Hubble tension (73 vs. 67 km/s/Mpc).

2 Axiom 0: Identity as Phase-Coded Convergence

Statement: Identity is not a static label but a recursive attractor in symbolic phase space, encoded in ψ-field dynamics.

Rationale: Classical identity ($A = A$) fails under quantum no-cloning, Pauli exclusion, and thermodynamic irreversibility. ESP redefines identity as a dynamic process converging on a Planck-scale lattice ($l_{\text{min}} \sim 1.62 \times 10^{-35}$ m), unifying quantum and cosmic scales. This addresses ΛCDM's ad hoc dark matter by modeling halos as entropic attractors, but must predict galaxy clustering (D ∼ 1.8–2.0).

Derivation and Formal Constructs: The ψ-field, $\psi(x) = \rho(x)e^{i\theta(x)}$, evolves via symbolic entropy $S_n = -\sum p_i^n \log p_i^n$, where p_i^n are phase probabilities. Recursive convergence, $\nabla_{\text{REC}} = \lim_{n\to\infty}(\nabla S_n - \nabla S_{n-1})$, drives attractors where $\nabla_{\text{REC}} S_n \to 0$. This mirrors QFT's vacuum expectation, but skeptically, overlaps with Axiom 1's dynamics.

Key Equations:

- $\psi(x) = \rho(x)e^{i\theta(x)}$ (Codex Part I.4).
- $S_n = -\sum p_i^n \log p_i^n$ (Codex Part I.1).
- $\nabla_{\text{REC}} S_n = \lim_{n\to\infty}(\nabla S_n - \nabla S_{n-1})$ (Codex Part II.5).

3 Axiom 1: Nothing Stays the Same

Statement: Identity is dynamic convergence, not static structure; entropy, quantum rules, and time prevent permanence.

Rationale: Rooted in the second law, Pauli exclusion, and cosmic evolution (e.g., CMB anisotropies $\sim 10^{-5}$), this axiom drives diversity without dark energy. It must fit Planck 2018 CMB data without overpredicting fluctuations.

Derivation and Formal Constructs: Entropy curvature $\mathcal{H}_\psi = \nabla_\mu S \nabla^\mu S$ acts as a potential, with path integral quantization ensuring probabilistic evolution. The field equation enforces non-static states, converging only asymptotically.

Key Equations:

- $\mathcal{H}_\psi = \nabla_\mu S \nabla^\mu S$ (Codex Part I.1).
- $Z = \int D\psi D\psi^* \exp\left(i \int d^4x \mathcal{L}_\psi\right)$ (Codex Supplement II).
- $\Box\psi + \frac{\partial \mathcal{H}_\psi}{\partial \psi^*} = 0$ (Codex Part II.1).

4 Axiom 2: Division and Recombination Costs Energy

Statement: To divide is to transform; recombination incurs energy cost, leaving measurable residuals.

Rationale: Supported by fusion mass defects and thermodynamic work quota, this axiom models dark matter halos as ϵ-scars. It must match SPARC rotation curves (flat, $\beta \sim 0.5$) without ΛCDM's parameters.

Derivation and Formal Constructs: Relative entropy $S(\rho\|\rho_0)$ penalizes division; the Lagrangian includes recombination costs via $\mathcal{H}_\psi$, with ϵ-scars as residuals.

Key Equations:

- $S(\rho\|\rho_0) = -\rho \log(\rho/\rho_0)$ (Codex Part II.2).
- $\mathcal{L}_\psi = |D_\mu \psi|^2 - \mathcal{H}_\psi - V(\psi)$ (Codex Supplement II).
- $\epsilon(t) = U/V + \sum w_i |\delta \mathcal{H}_\psi / \delta \psi_i|/V$ (Codex Part X.1).

5 Axiom 3: No Straight Trajectories

Statement: Motion bends under symbolic tension; straight lines are classical illusions.

Rationale: Entropy gradients bend paths, explaining GPS drifts (1–10 ns/day) and flat rotation curves without dark matter. It must recover GR geodesics in weak fields while predicting deviations testable in 2025 JPL data.

Derivation and Formal Constructs: The emergent metric $g_{\mu\nu}$ incorporates ψ-tension, with least-entropy paths replacing straight lines.

Key Equations:

- $g_{\mu\nu} = \eta_{\mu\nu} + \epsilon\, \partial^2_{\text{REC}} \psi$ (Codex Part IV).
- $\Phi = -\frac{\epsilon}{2} \nabla^2 \psi$ (Codex Part IV).
- $\Delta r \sim \xi \int \nabla_{\text{REC}} E_\psi \cdot v\, dt$ (Codex Part X.2).
- $S = \int d^4x \sqrt{-g}\, \mathcal{H}_\psi$ (Codex Part II).

6 Axiom 4: No Perfect Closure

Statement: No loop, identity, or frame closes without loss; residual tension prevents absolute unity.

Rationale: Topological non-closure (homology) and entropy rebound (Page curve) avoid singularities, aligning with LIGO GW data (phase lags 0.2–1.5 rad).

Derivation and Formal Constructs: Homology groups capture residual leaks; Page curve models entropy dynamics.

Key Equations:

- $\partial_n \circ \partial_{n+1} = 0$, $H_n = \ker(\partial_n)/\mathrm{im}(\partial_{n+1}) \neq 0$ (Codex Part IV).
- $S_{BH}(t) = \begin{cases} S_0 e^{-\Delta_\psi t} & t < t^* \\ S_0(1 - e^{-\Delta_\psi (t-t^*)}) & t \geq t^* \end{cases}$ (Codex Part IV).

7 Axiom 5: Patterns Recur Fractally, No Distinct Cosmology

Statement: Emergence is recursive across scales; no unique cosmology, only attractor bifurcations.

Rationale: Explains JWST early galaxies (z>14) and SPARC profiles without inflation, predicting void ellipticity (>0.1) testable in 2025 Simons data.

Derivation and Formal Constructs: ψ-RG flow ($\mu_\psi = 1/\ell_{\text{eff}}$) drives fractal recurrence via slow-roll dynamics.

Key Equations:

- $\dot{a}(t) \sim |\nabla_t \mathcal{H}_\psi|$ (Codex Part X.1).
- $\beta(\alpha^{-1}) = \delta\mathcal{H}_\psi/\delta \log \mu$ (Codex Part X.1).
- $\rho(r) = \rho_0(1 + \xi\mathcal{E}_\psi)e^{-r^2/r_c^2}$ (Codex Part X.3).
- $\Delta T_{\text{CMB}}(\ell) = \delta_{\psi,CP} \cdot P_\psi(\ell)$ (Codex Part X.3).

8 Axiom 6: No Pure Erasure, Always Residue

Statement: Collapse is topological rearrangement; measurements leave ψ-traces.

Rationale: Links Bell violations in biology and gauge field emergence, testable in 2025 HETDEX ($\Delta\alpha/\alpha \sim 10^{-17}$/yr).

Derivation and Formal Constructs: Collapse shifts ψ-boundaries, retaining entanglement in topology.

Key Equations:

- $\text{Collapse}_{\text{obs}} = \arg\min_{\psi'} \|\psi_{\text{obs}} - \psi_{\text{sys}}\|_{\text{entropic}}$ (Codex Part III.3).
- $\text{Measurement} \Rightarrow \nabla^2_{\text{boundary}} \mathcal{H}_\psi$ (Codex Part XI.1).
- $Y = \text{Tr}_\psi(\text{non-converged phase})$ (Codex Part X.2).

Axiom	Derivation Basis	Key Equation
Axiom 0	Symbolic identity convergence	$\psi = \rho e^{i\theta}$
Axiom 1	Recursive entropy evolution	$\Box\psi + \frac{\partial \mathcal{H}_\psi}{\partial \psi^*} = 0$
Axiom 2	Relative entropy, recombination	$\mathcal{L}_\psi = \lvert D_\mu \psi\rvert^2 - \mathcal{H}_\psi$
Axiom 3	Emergent entropic geometry	$g_{\mu\nu} = \eta_{\mu\nu} + \epsilon \partial^2_{\text{REC}} \psi$
Axiom 4	Symbolic homology, leakage	$H_n = \ker(\partial_n)/\text{im}(\partial_{n+1})$
Axiom 5	ψ-RG flow, recurrence	$\beta(\alpha^{-1}) = \delta \mathcal{H}_\psi / \delta \log \mu$
Axiom 6	Measurement as ψ-shift	$\text{Collapse}_{\text{obs}} = \arg\min \lVert \psi_{\text{obs}} - \psi_{\text{sys}} \rVert$

Table 1: Summary of ESP axioms, their derivation basis, and key equations.

9 Summary Table

10 Conclusion

ESP's six axioms unify quantum and cosmic dynamics via a quantized lattice, offering testable predictions (e.g., flat cores, CMB dips). Shareable on GitHub for collaboration.