1 Appendix E: Fermion Mass Hierarchy from Surface Phase Timing

1.1 E.1 Mass as Recursion-Stabilized Surface Tension

In this framework, mass is not an intrinsic property but the result of stabilized recursion tension across Planck-tiled surfaces. Surface defects (spinor twist patterns) gain persistence when entropy gradients around them converge. This stabilization defines inertial resistance to motion — i.e., mass:

$$m \propto \lim_{resonance} \sum_{i=1}^{n} (\pm 1, 0) \cdot \Phi(x_i)$$

The summation reflects the recursive interactions between trinary surface states and local gravitational potential wells.

1.2 E.2 Hierarchy from Recursive Phase Delays

Different fermion generations emerge from differences in their alignment with the recursive phase of horizon surfaces. The more a fermion's configuration misaligns from the entropy field's minimal action phase, the more tension it accrues — resulting in higher effective mass.

Let $\phi(x)$ be the local recursion phase. Then mass is modulated by deviation from phase lock:

$$m_f \propto |\phi(x) - \phi_{lock}|^k$$

where k is a curvature response exponent specific to the field geometry.

1.3 E.3 Prediction: Log-Spacing of Generations

Because phase alignment proceeds logarithmically during horizon recursion collapse, the model naturally predicts a log-spaced mass spectrum across generations:

$$m_n \sim m_1 \cdot \log^n(f), \quad n = generation index$$

This aligns with observed mass ratios (e.g., m_e, m_μ, m_τ) without fine-tuning.

1.4 E.4 Origin of Yukawa Couplings

In standard field theory, mass arises via Yukawa couplings to the Higgs field. Here, Yukawa couplings are not fundamental but effective descriptions of:

- Local entropy tension mismatch,
- Recursive identity field resistance,
- Phase delay of convergence.

Thus, each fermion's apparent coupling strength reflects its recursive anchoring stability, not arbitrary constants.

Appendix f

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2 Introduction