Appendix d

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1 Appendix D: Experimental Predictions of Entropy Recursion Field Theory

1.1 D.1 Proton Decay from SU(5) Recursion Tension

The theory predicts SU(5) as the natural unifying gauge structure arising from surface recursion. As recursion expands and symmetry breaks:

$$SU(5) \rightarrow SU(3)_C \times SU(2)_L \times U(1)_Y$$

Transitions mediated by heavy X and Y bosons (off-diagonal components of SU(5)) lead to predicted proton decay. While suppressed at low recursion stages, these transitions imply a proton lifetime on the order of:

$$\tau_p \sim 10^{34} to 10^{36} years$$

The theory predicts correlations between surface tension rate (entropy flow velocity) and decay frequency.

1.2 D.2 Quantized Horizon Signatures in CMB

Surface entropy tiling leaves imprint patterns at large scales. If cosmic horizon tiling affects early surface recursion, then the cosmic microwave background (CMB) should contain:

- Angular power spectrum anisotropies at Planck-tiling multiples
- Small-angle mode suppression near entropy inflection points

These deviations should align with predicted surface recursion harmonics.

1.3 D.3 Gravitational Wave Microstructure

Recursive horizon collapse is not smooth — it generates metric perturbations. These surface-induced instabilities result in gravitational waves with:

- Fine-grain frequency modulations

- Phase discontinuities matching horizon memory shedding events

Space-based detectors like LISA may resolve these Planck-harmonic modulations in future binary black hole mergers.

1.4 D.4 Dark Energy Surface Pressure Testability

The theory interprets vacuum energy Λ as a surface tension gradient term:

$$\Lambda \propto \left(\frac{dS}{dA}\right) \nabla\Phi$$

Therefore, any variation in large-scale gravitational potential Φ due to horizon structure should result in measurable deviations in the Hubble constant H_0. Observable tension between early-universe (CMB) and late-universe (supernovae) measurements is naturally explained by recursive surface tension dynamics.

2 Introduction