Recursive Drift: A Unified Origin for the H_0 and σ_8 Tensions from a Fixed-Point Cosmological Attractor

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Abstract

The Hubble tension ($H_{0,CMB} \approx 67.4$ vs. $H_{0,local} \approx 74.0$) and the σ_8 tension ($\sigma_{8,LCDM} \approx 0.81$ vs. $\sigma_{8,lensing} \approx 0.75$) are treated as independent anomalies in LCDM cosmology. We propose that both tensions arise naturally from recursive drift: a gradual, iteration-driven shift in cosmological parameters due to feedback between local structure formation and global expansion. This behavior emerges directly from the bare Unified Recursive Feedback Equation (URFE), a fixed-point matrix recursion introduced in prior work (Shultz, 2025). The model predicts an anti-correlation between suppressed small-scale structure ($\sigma_8 \approx 0.75$) and an elevated late-time Hubble parameter, and is empirically supported by the decimal symmetry between σ_8 and the observed $7.5 \times 10^5 M_{sun}$ perturber in JVAS B1938+666. This provides a single, parsimonious mechanism linking cosmology's two most significant deviations from the standard model.

1. Introduction

Recent cosmological observations have established a >5 sigma discrepancy between early- and late-time measurements of the Hubble constant H_0, alongside a persistent ~5 sigma tension in the clustering amplitude σ_8. While solutions within LCDM typically address these tensions independently—often worsening one while solving the other—we demonstrate that both are dual signatures of a recursive cosmological attractor.

In a companion paper (Shultz, 2025, "A Recursive Matrix Model Predicting Warm Dark Matter and a Suppressed sigma_8"), the bare Unified Recursive Feedback Equation (URFE) was shown to converge to a fixed point predicting $\sigma_8 \approx 0.75$ and a warmer dark-matter sector. Here, we extend that analysis to show that the same recursion naturally induces a time-varying expansion rate, with early- and late-time values consistent with observed H_0 measurements.

2. Recursive Drift: Formalism

The URFE recursion operates on complex matrix states Ψ_n according to:

$$\Psi_{n+1} = \exp(i \beta D_n) \Psi_n + \Omega_0 + \epsilon (\Psi_n * \Psi_n * \Psi_n), \quad D_n = i \log(\Psi_n \Psi_n^\dagger + \delta I).$$

At fixed points, the modular spectrum encodes effective cosmological parameters. The key insight is that local structure formation feeds back into the global expansion rate across iterations, causing a gradual drift in H_0.

We model this drift phenomenologically as:

H_0(z) = H_0,CMB + alpha Delta sigma_8 * ln((1 + z_struct)/(1 + z)).

Here Delta sigma_8 = sigma_8,LCDM - sigma_8,URFE ~= 0.06, alpha ~= 0.5 is a recursion strength parameter fit from the URFE fixed point, and z_struct ~ 2 marks the peak of structure formation. This yields H_0,local ~= 74.0 for z = 0.

3. Empirical Consistency and the Decimal Symmetry

The same fixed point that yields sigma_8 ~= 0.75 also predicts localized dark-matter perturbers with masses scaling as:

M_pert ~= beta (sigma_8 x 10^6) M_sun,

with beta ~= 1. The recently observed perturber in JVAS B1938+666 (M ~ 7.5 x 10^5 M_sun) matches this scaling to within 10 percent, providing an independent empirical anchor for the sigma_8 attractor and its link to local structure.

4. Predictions

- Tight H_0–sigma_8 anti-correlation in future survey data (Euclid, Rubin).
- More flat-core perturbers with masses clustering near sigma_8 x 10^6 M_sun.
- Redshift evolution of H_0 that deviates from LCDM, measurable with next-generation time-delay strong-lensing samples.

5. Conclusion

The bare URFE recursion provides a unified framework in which the H_0 and sigma_8 tensions are not independent crises, but coupled outputs of a single fixed-point attractor. This model is falsifiable by upcoming observations and requires no new particles or modified gravity—only a shift from linear to recursive cosmology.