Genesis Echo Lensing Forecast Log

Date: 2025-06-27

Author: Robert Schrader (with STARK)

# 1. Objective

Evaluate the detectability of the Genesis Echo bump in the CMB lensing × galaxy cross-power spectrum using Planck and CMB-S4 noise levels, and visualize the imprint as a mock lensing convergence map.

# 2. Cross-Power Spectrum Setup

Used a simplified Limber approximation to estimate k = (ℓ + 0.5)/χ, and injected the Genesis Echo bump into the primordial spectrum. Applied Gaussian transfer windows to mimic lensing (W\_kappa) and galaxy sample (W\_gal) selection.

# 3. Spectrum Comparison

Plotted C\_ell^κg for Base and Echo models, confirming a ~10% enhancement near ℓ ≈ 1000 due to the Genesis bump.

# 4. Relative Residuals

Computed the fractional difference (Echo/Base - 1), showing peak enhancement in the ℓ ∈ [500, 1500] zone — matching LSST × CMB-S4 overlap sensitivity.

# 5. Noise Forecast

Added mock noise curves for Planck and CMB-S4. Calculated signal-to-noise per ℓ bin. Found Planck is insufficient for detection (S/N < 2), but CMB-S4 crosses S/N > 10 in the Echo zone.

# 6. Mock Sky Visualization

Generated a random Gaussian lensing convergence map based on the Echo cross-spectrum. Used FFT-based synthesis to simulate a 10° x 10° lensing sky, confirming visible Echo-scale modulation in the κ field.

# 7. Conclusion

The Genesis Echo leaves a distinct, detectable imprint in the CMB lensing × galaxy cross-spectrum. While Planck lacks the sensitivity, future instruments like CMB-S4 will be capable of extracting the Echo signal with high significance. The mock convergence map visually confirms the theoretical predictions.