Genesis Echo CMB-S4 Detection Forecast

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1 Overview

This document summarizes the forecast for detecting the Genesis Echo bump in the CMB temperature power spectrum using a CMB-S4–like experiment.

2 Genesis Echo Bump Model

We model the fractional change in the TT power spectrum as a Gaussian bump:

$$\frac{\Delta C_\ell}{C_\ell} = A \exp\left[-\frac{1}{2}\left(\frac{\ell - \ell_0}{\sigma_\ell}\right)^2\right],$$

with parameters:

- Amplitude $A = 0.10$,
- Central multipole $\ell_0 = 1400$,
- Width $\sigma_\ell = 280$.

3 Noise Contributions

The total fractional uncertainty in each C_ℓ combines cosmic variance and instrument noise:

$$\sigma_{\rm cv}(\ell) = \sqrt{\frac{2}{2\ell+1}}, \tag{1}$$

$$N_\ell = \Delta_T^2 \exp\left[\ell(\ell+1)\sigma_b^2\right], \quad \sigma_b = \frac{\rm FWHM}{\sqrt{8\ln 2}},\ \Delta_T = 1\,\mu\text{K-arcmin}, \tag{2}$$

$$\sigma_{\rm inst}(\ell) = \frac{\sqrt{N_\ell}}{C_\ell}. \tag{3}$$

4 Total Signal-to-Noise

Summing over multipoles $\ell = 100$ to 3000, the total S/N is:

$$\text{SNR} = \sqrt{\sum_\ell \left(\frac{\Delta C_\ell / C_\ell}{\sqrt{\sigma_{\rm cv}(\ell)^2 + \sigma_{\rm inst}(\ell)^2}}\right)^2} \approx 83.4.$$

5 Conclusion

A future CMB-S4 experiment can detect the 10% Genesis Echo bump at high significance (SNR ~ 83) by focusing on multipoles around $\ell \approx 1400$. This provides a clear observational test of the Godframe activation scenario.