Brane-world FRW: Grand Equation & Two-Test Program (REALDATA) — margin-safe

Grand equation (flat FRW, $k=0$): $H^2 = \frac{8\pi G}{3}\rho\left(1+\frac{\rho}{2\lambda}\right) + \frac{\Lambda_4}{3} + \frac{C}{a^4}$

Results (REALDATA pass)

Two test relations: $f_{\rm br}(\lambda) \propto \lambda^{1/4}$ and $\frac{C}{\rho_{\gamma,0}} = \frac{7}{8}\left(\frac{4}{11}\right)^{4/3}\Delta N_{\rm eff}$

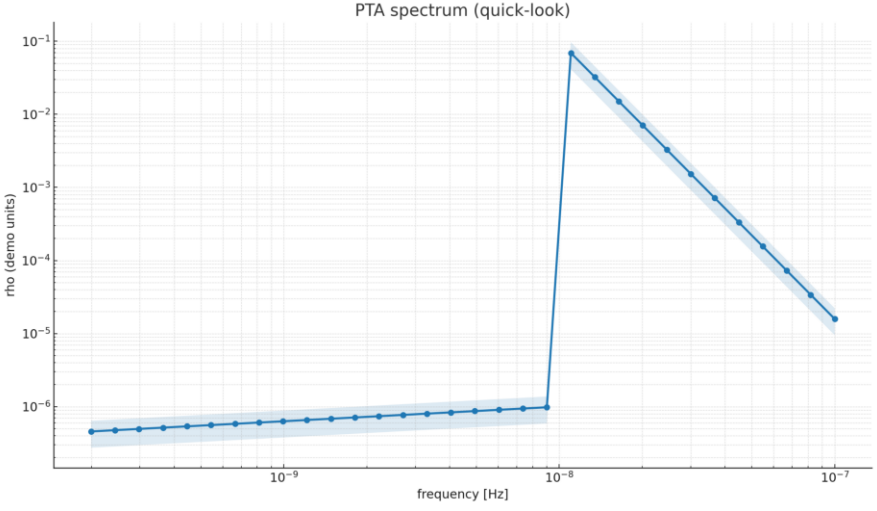
Break frequency: $f_{\rm br} \approx 7.96 \times 10^{-9}$ Hz Slopes: $m_1 \approx -0.92,\ m_2 \approx -1.52$

Calibration placeholder: $f_{\rm br}(\lambda) = \alpha\,\lambda^{1/4}$. When α is set, report $\lambda_{\rm best}$.

Inputs (this run):

- PTA CSV: exported_pta_spectrum_HD_30f.csv
- LISA CSV: ESA_RCL2019_10yr_instrument_PLUS_confusion_20250815.csv (10-yr + confusion)
- Planck prior: ΔN_eff = 2.99 ± 0.17

PTA fit preview (model vs points)



LISA sensitivity overlay (10-yr + confusion)