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

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

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

Inputs (this run):
- PTA CSV: exported_pta_spectrum_HD_30f.csv
- LISA CSV: ESA_RCL2019_10yr_instrument_ONLY_20250815.csv (10-yr instrument-only)
- Planck prior: ΔN_eff = 2.99 ± 0.17

PTA fit preview — ρ (demo units) vs frequency [Hz]
- PTA median
- 16–84% band

LISA sensitivity (10-yr instrument-only) — S_n [1/Hz] vs frequency [Hz]