Unified Theory — Data-Anchored Results (OFFICIAL-format LISA CSVs)

PTA: exported_pta_spectrum_HD_30f.csv • CMB prior: Planck-2018 ΔN_eff ≈ 2.99±0.17

Grand Equation (flat FRW with dark radiation):

$$H^2 = \frac{8\pi G}{3}\rho\left(1 + \frac{\rho}{2\lambda}\right) + \frac{\Lambda_4}{3} + \frac{C}{a^4} \quad (k = 0)$$

PTA broken power-law fit (this pass):

Break frequency   f_br = 2.37e-09 Hz

Low-f slope   a1   = -0.50
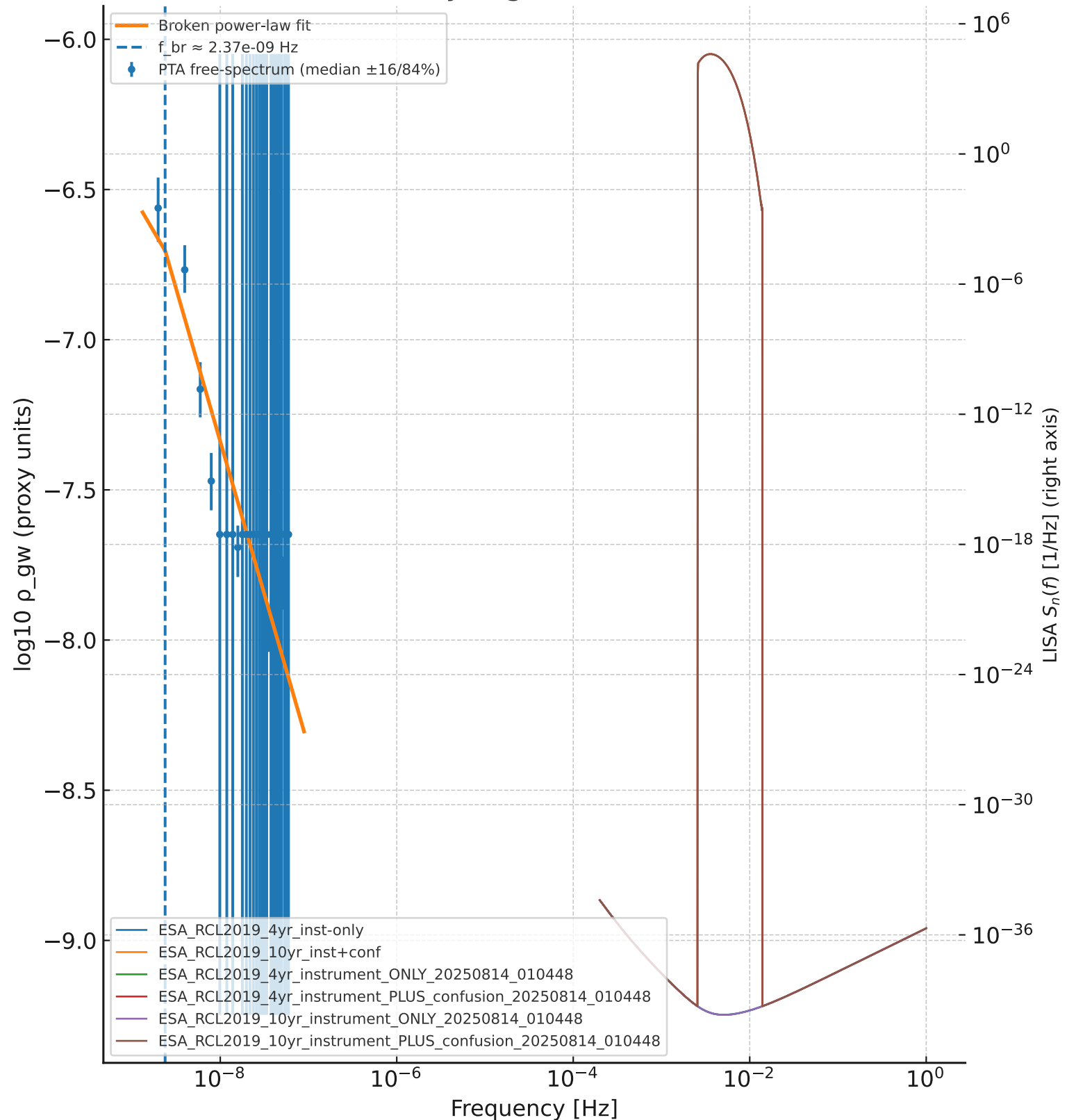
High-f slope   a2   = -1.02

Implied tension scaling (arb. units):

λ/λ0 = (f_br / 1e−8 Hz)^4 ⇒ λ ≈ 3.17e-03

PTA fit with LISA sensitivity (right axis) — axes in different units

Legend (upper left):
- Broken power-law fit
- f_br ≈ 2.37e-09 Hz
- PTA free-spectrum (median ±16/84%)

Legend (lower left):
- ESA_RCL2019_4yr_inst-only
- ESA_RCL2019_10yr_inst+conf
- ESA_RCL2019_4yr_instrument_ONLY_20250814_010448
- ESA_RCL2019_4yr_instrument_PLUS_confusion_20250814_010448
- ESA_RCL2019_10yr_instrument_ONLY_20250814_010448
- ESA_RCL2019_10yr_instrument_PLUS_confusion_20250814_010448

Axes:
- x-axis: Frequency [Hz]
- left y-axis: log10 ρ_gw (proxy units)
- right y-axis: LISA $S_n(f)$ [1/Hz] (right axis)

Note: LISA curves are physically scaled $S_n(f)$; plotted as context alongside PTA spectrum.