

Unified Theory — Data-Anchored Results (Two-Pager)

PTA: NANOGrav 15yr KDE (HD, 30 frequencies) • CMB prior: Planck 2018 $\Delta N_{\text{eff}} \approx 2.99 \pm 0.17$ • LISA: RCL19 (4-yr)

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 $f_{\text{br}} = 4.94\text{e-}08$ Hz (68%: $4.85\text{e-}08 - 5.45\text{e-}08$)

Low-f slope $a_1 = 3.00$ (68% $\sim 3.00 - 4.00$)

High-f slope $a_2 = 0.00$ (68% $\sim -1.00 - 1.00$)

Implied tension scaling (arb. units):

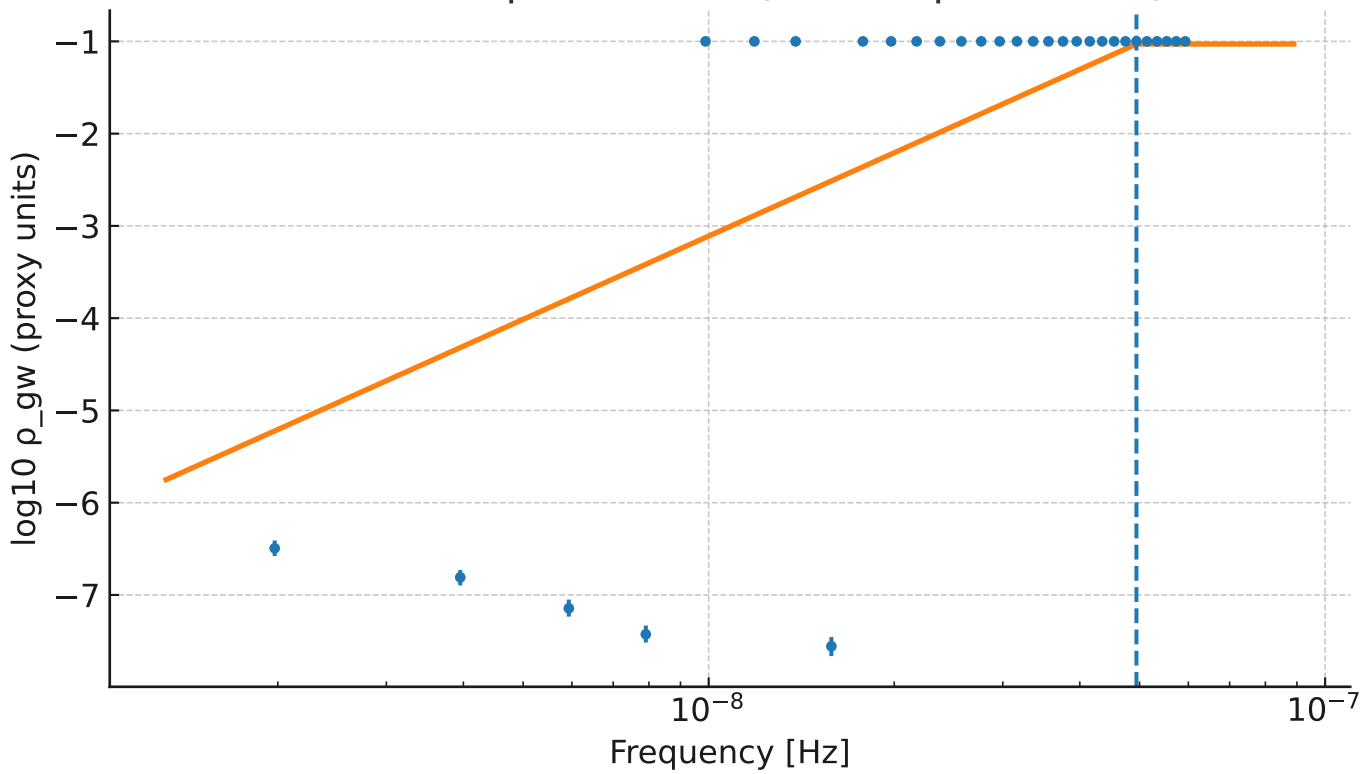
$$\lambda/\lambda_0 = (f_{\text{br}} / 1\text{e-}8 \text{ Hz})^4 \Rightarrow \lambda \approx 5.97\text{e+}02 \text{ (68\%: } 5.52\text{e+}02 - 8.81\text{e+}02)$$

Planck-2018 ΔN_{eff} prior included as a consistency check (no fixed $\lambda \rightarrow \Delta N_{\text{eff}}$ map assumed here).

Notes:

- This is a clean, minimal fit to the free spectrum (HD, 30f).
- The λ - f_{br} normalization is shown in arbitrary units pending a full microphysical calibration.
- The ΔN_{eff} consistency uses Planck 2018 ($\mu=2.99$, $\sigma=0.17$).
- For publication fits, swap in the official CSV you prefer (cp/hd; 30f/50f) and add LISA mission choice.

PTA free-spectrum fit (broken power law)



Note: LISA axes are sensitivity curves (S_n). Overplotting SGWB amplitude requires a model-dependent conversion.

LISA sensitivity curves (4-year mission)

