

A Simple, Testable Unified Theory

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

Falsifiable links:

- Break in the stochastic GW background: $f_{\text{br}} \propto \lambda^{1/4}$
- Dark-radiation mapping: $C/\rho_{\gamma,0} = \frac{7}{8}\left(\frac{4}{11}\right)^{4/3}\Delta N_{\text{eff}}$

This run:

- PTA: NANOGrav 15yr KDE (HD, 30 frequencies) → broken power-law fit
- CMB prior: Planck-2018 $\Delta N_{\text{eff}} = 2.99 \pm 0.17$ (consistency check)
- LISA overlays: 4-yr instrument-only and +confusion variants (RCL19)

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