Letter: A testable brane-world unification with early-time ρ² and dark radiation

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Abstract

We obtain an effective 4-D cosmology with a ρ² correction and a dark-radiation term from a higher-D brane setup. The brane tension λ sets a GW spectral break (f_br∝λ^{1/4}) and correlates with ΔN_eff, enabling a falsifiable joint test using PTA→LISA and CMB/BBN. We provide posteriors using the official NANOGrav 15-yr KDE spectrum with a Planck-2018 prior and include LISA sensitivity context.

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

$$f_{\rm br}(\lambda) \propto \lambda^{1/4}, \quad C/\rho_{\gamma,0} = \tfrac{7}{8}\left(\tfrac{4}{11}\right)^{4/3}\Delta N_{\rm eff}$$