

Letter: Testable brane-world unification with early-time ρ^2 and dark radiation

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Abstract

We derive a four-dimensional effective cosmology exhibiting a ρ^2 correction and a dark-radiation term. A single parameter—the brane tension λ —sets a gravitational-wave spectral break $f_{\text{br}}\propto\lambda^{\{1/4\}}$ and correlates with ΔN_{eff} . Using the NANOGrav 15-yr KDE spectrum with a Planck-2018 N_{eff} prior, we present posteriors and a PTA→LISA context. The framework reduces to GR at late times and is falsifiable by a joint PTA + CMB/BBN consistency test.

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

A higher-D brane setup yields a 4-D Friedmann equation with a ρ^2 term and a dark-radiation piece. A single parameter λ fixes the GW spectral break and correlates with ΔN_{eff} ; one λ must jointly fit PTA→LISA and CMB/BBN.

Data/prior: Official NANOGrav 15-yr KDE spectrum (CSV) + Planck-2018 prior on $N_{\text{eff}} = 2.99 \pm 0.17$ (with BAO).