

A testable brane-world unification (PRL-style preview)

Author

Ricardo Maldonado (Independent Researcher) — sales@rank.vegas

Abstract

We present a minimal brane-world framework yielding a modified Friedmann equation $H^2 = (8\pi G/3) \rho (1+\rho/2\lambda) + \Lambda/3 + C/a^4$ ($k=0$). A single scale (brane tension λ) connects a predicted stochastic-GW spectral break $f_{br} \propto \lambda^{1/4}$ and a dark-radiation term linked to ΔN_{eff} . Using the NANOGrav 15-yr KDE free-spectrum plus a Planck-2018 ΔN_{eff} prior, we demonstrate a data-anchored fit, and provide a compact reproducibility pack.

Keywords

brane cosmology; modified Friedmann equation; stochastic gravitational wave background; dark radiation; ΔN_{eff} ; LISA; PTA; early universe

Framework, Predictions, Data Pass, Consistency

Framework (SMS projection)

The 5D Einstein equations, combined with the Gauss–Codazzi relations and Israel junction conditions, induce on the brane the SMS form: $G_{\{\mu\nu\}} + \Lambda_4 g_{\{\mu\nu\}} = (8\pi G)T_{\{\mu\nu\}} + \kappa_5^4 \Pi_{\{\mu\nu\}} - E_{\{\mu\nu\}}$. In FRW, $\Pi_{\{\mu\nu\}}$ produces the high-energy ρ^2 term; $E_{\{\mu\nu\}}$ projects bulk Weyl curvature, behaving like a dark-radiation constant C/a^4 .

Predictions & Falsifiability

One parameter, λ , controls: (i) a broken-power-law SGWB with break $f_{\text{br}}(\lambda)$ at the $\rho^2 \rightarrow \rho$ transition; (ii) a dark-radiation contribution tied to ΔN_{eff} via $C/\rho\gamma,0 = (7/8)(4/11)^{4/3} \Delta N_{\text{eff}}$. A single λ must jointly fit PTA→LISA context and CMB/BBN bounds—otherwise the model is falsified.

Data-anchored pass (public inputs)

We fit a broken power law to the NANOGrav 15-yr KDE free-spectrum (30 frequency bins) under a loose Planck-2018 ΔN_{eff} prior (2.99 ± 0.17). We overlay ESA-standard LISA sensitivity curves (Robson–Cornish–Liu, instrument-only and instrument+confusion; 4-yr and 10-yr). This pass is for figure-quality illustration; full likelihood fits can swap in the official CSVs without changing layout.

Consistency checks

Einstein/PPN limit holds for $\rho \ll \lambda$; binary-pulsar constraints are preserved; late-time SMS corrections are negligible. An explicit RS-style toy embedding lists anomaly constraints and a simple Yukawa localization mechanism; a toy quark/lepton page sketches mass hierarchies.

Unified Theory — Data-Anchored Results (ESA LISA curves)

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

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 $f_{\text{br}} = 2.37\text{e-}09 \text{ Hz}$

Low-f slope $a1 = -0.50$

High-f slope $a2 = -1.02$

Implied tension scaling (arb. units):

$$\lambda/\lambda_0 = (f_{\text{br}} / 1\text{e-}8 \text{ Hz})^4 \Rightarrow \lambda \approx 3.17\text{e-}03$$

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

