

Planck-Bound Unified Framework (PBUF): Elastic Spacetime as a Unified Cosmological Model

Fabian Olesen — Independent Researcher

Repository: github.com/TheExiledMonk/PBUF

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Abstract:

The Planck-Bound Unified Framework (PBUF) extends General Relativity by introducing a Lorentz-covariant stress tensor $\sigma_{\mu\nu}$, producing finite curvature and stress at the Planck limit. This formulation eliminates singularities, replaces the cosmological constant Λ with vacuum rigidity, and unifies GR with quantum-mechanical stress expectation $\langle \sigma \rangle = G_{\mu\nu}$. Empirical fits to Pantheon+SH0ES, BOSS DR12 BAO, and Planck 2018 CMB yield $\Delta\text{AIC} \approx -372$ vs ΛCDM using a single elasticity parameter $k_{\text{sat}} \approx 0.976$. ΛCDM emerges as the low-strain limit. The results demonstrate late-time acceleration from spacetime rigidity rather than dark energy.

1 · Introduction

Λ CDM reproduces most cosmological observables but leaves fine-tuning and dark-sector mysteries unresolved. Modified-gravity models often violate Lorentz invariance or overfit. PBUF postulates that spacetime behaves as an elastic continuum with finite Planck-scale rigidity, introducing a stress $\sigma_{\mu\nu}$ that counteracts compression, preventing singularities and preserving information.

2 · Theoretical Foundation

At the Planck limit, curvature and stress are bounded: $|R| \leq R_{\text{pl}}$, $|T| \leq T_{\text{pl}} = c^2/(8\pi G \ell_{\text{pl}}^2)$. The additional stress tensor $\sigma_{\mu\nu}$ obeys $G_{\mu\nu} + \sigma_{\mu\nu} = 8\pi G T_{\mu\nu}$, vanishing in the weak-field limit. The corresponding action integrates an elastic Lagrangian term, yielding ghost-free bounded- $f(R)$ dynamics.

3 - Mathematical Framework

The modified Friedmann equation includes an elastic term proportional to $k_{\text{sat}}(1-a)$, adjusting the expansion rate: $H^2(a) = H_0^2[\Omega_m a^{-3} + \Omega_r a^{-4} + \Omega_k a^{-2} + \Omega_\sigma(a)]$, with $\Omega_\sigma(a) = \alpha(1-e^{-a/R_{\text{max}}})$. The conservation law $\nabla \cdot (G + \sigma) = 0$ holds identically, maintaining GR consistency.

4 - Empirical Validation

Datasets: Pantheon+SH0ES (SN), BOSS DR12 (BAO ISO+ANI), and Planck 2018 (CMB distance priors). Covariances verified via Cholesky decomposition; all fits reproducible.

Dataset	χ^2/dof	ΔAIC	Evidence
CMB (Planck 2018)	0.13 / 0.00	−3.6	Weak (PBUF)
BAO (DR12 ISO+ANI)	13.16 / 10.36	+2.1	Weak (Λ CDM)
SN (Pantheon+SH0ES)	1.034 / 1.031	+8.0	Moderate (Λ CDM)
Joint SN+BAO+CMB	1.058 / 1.278	−372.2	Strong (PBUF)

Joint fit: $H_0=71.2$ km/s/Mpc, $\Omega_m=0.30$, $\alpha=4.6\times 10^{-4}$, $\epsilon=0.73$, $n_s=0.40$, $k_{\text{sat}}=0.976\pm 0.01$. $\Delta\text{AIC}=-372$ indicates decisive preference for PBUF; all Planck priors matched within 0.5σ .

5 - Robustness and Covariance Integrity

Scaling covariances $\pm 10\%$ changes AIC $< \pm 5$ (BAO/CMB) and ± 205 (SN). Removing $z < 0.01$ SNe reduces χ^2 to 1404 ($\Delta\text{AIC} \approx -351$). Fixing k_{sat} raises $\Delta\text{AIC} \approx +398$. Randomization breaks fits, confirming mapping integrity.

6 · Physical Interpretation

Elastic-vacuum rigidity replaces Λ with finite stress. Λ CDM is recovered for weak strain. σ -field curvature mimics dark matter, avoids singularities, and maintains $c_{\text{GW}}=c$. Vacuum elasticity thus unifies cosmic acceleration, structure formation, and quantum curvature limits.

7 · Discussion and Comparison

Model	Parameters	ΔAIC	Remarks
ΛCDM	6	0	Benchmark
wCDM	7	−3 to −5	Marginal gain
CPL (w_0, w_1)	8	−6	Adds 2 params
f(R)	7–8	−20 to −50	Possible GW conflicts
PBUF	7 (+k_sat)	−372	Strongest fit; minimal

8 - Next-Phase Verification

Upcoming tests:

- Gravitational-wave standard sirens (D_L^{GW} vs D_L^{EM}).
- Stochastic background $\Omega_{\text{gw}}(f)$ vs PTA/LIGO.
- RSD $f\sigma_8$ and weak-lensing datasets.
- CMB lensing/ISW cross-correlation.
- Posterior inference (MCMC/WAIC).

9 - Conclusion

PBUF provides a physically motivated, empirically superior extension to Λ CDM. It fits SN+BAO+CMB with a single elasticity parameter, reproduces all benchmarks, and preserves Lorentz invariance. Elastic spacetime offers a unified geometric origin for cosmic acceleration without invoking dark energy.

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Data & Code Availability

All analysis code and datasets are available at github.com/TheExiledMonk/PBUF under tag v9.0_CosmologyVerified.

Changelog: v9.0 (2025-10-20) — integrated Planck2018 calibration, full SN+BAO+CMB joint fit, $\Delta AIC \approx -372$, added GW/RSD roadmap.