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

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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 ■σ■ = G$\mu\nu$. Empirical fits to Pantheon+SH0ES, BOSS DR12 BAO, and Planck 2018 CMB yield ΔAIC ≈ −372 vs ΛCDM using a single elasticity parameter k_sat≈0.976. ΛCDM emerges as the low-strain limit. The results demonstrate late-time acceleration from spacetime rigidity rather than dark energy.

1 · Introduction

ΛCDM 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: $|R| \le R_{pl}$, $|T| \le T_{pl} = c\blacksquare/(8\pi G\blacksquare_{pl}^2)$. 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 $k_{sat}(1-a$■■$)$, adjusting the expansion rate: $H^2(a) = H$■$^2[\Omega_m\ a$■$^3 + \Omega_r\ a$■■$ + \Omega_k\ a$■$^2 + \Omega_\sigma(a)]$, with $\Omega_\sigma(a)=\alpha(1-e$■■$/R_{max})$. 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 (ΛCDM)
SN (Pantheon+SH0ES)	1.034 / 1.031	+8.0	Moderate (ΛCDM)
Joint SN+BAO+CMB	1.058 / 1.278	–372.2	Strong (PBUF)

Joint fit: H■=71.2 km/s/Mpc, Ω■■=0.30, α=4.6×10■■, ε■=0.73, nε=0.40, k_sat=0.976±0.01. ΔAIC=–372 indicates decisive preference for PBUF; all Planck priors matched within 0.5σ.

5 · Robustness and Covariance Integrity

Scaling covariances ±10% changes AIC < ±5 (BAO/CMB) and ±205 (SN). Removing $z<0.01$ SNe reduces χ^2 to 1404 (ΔAIC≈−351). Fixing k_sat raises ΔAIC≈+398. Randomization breaks fits, confirming mapping integrity.

6 · Physical Interpretation

Elastic-vacuum rigidity replaces Λ with finite stress. ΛCDM is recovered for weak strain. σ-field curvature mimics dark matter, avoids singularities, and maintains $c_{GW}=c$. 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■,w■)	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 $\Omega_{gw}(f)$ vs PTA/LIGO.
- RSD $f\sigma$■ and weak-lensing datasets.
- CMB lensing/ISW cross-correlation.
- Posterior inference (MCMC/WAIC).

9 · Conclusion

PBUF provides a physically motivated, empirically superior extension to ΛCDM. 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, $\Delta\mathrm{AIC} \approx -372$, added GW/RSD roadmap.