Evidence for a Metronomic Cosmological Field P: Links Between Supernovae, Large-Scale Structure and Planck Lensing

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September 15, 2025

Abstract

We present updated analyses suggesting the existence of a metronomic field P, oscillatory in cosmic time, that could play a role in synchronizing particles with Einstein's metric time. Using the Pantheon supernova sample, DES-SN3YR, BAO, cosmic chronometers (CC), SPARC galaxy rotation curves, and Planck 2018 lensing (κ) maps, we identify robust periodic signatures at ~ 0.9 cycles/Gyr (~ 11 Gyr period) and higher harmonics around 750 Myr. This supports the interpretation of P as a pseudo-Goldstone boson-like field with a radial mode possibly near 750 GeV. The field may provide thickness to time and act as a regulator of cosmic acceleration.

1 Introduction

The ΛCDM cosmological model accurately describes large-scale observations, yet tensions persist, most notably in the value of the Hubble constant H_0 derived from early- versus late-Universe probes. We propose that an oscillatory field P, which we name the *Metronomic field*, could explain part of these tensions by introducing a metronomic modulation in the cosmic expansion.

2 Related Work and Theoretical Context

Galaxy dynamics display tight empirical regularities such as the Radial Acceleration Relation (RAR) and the baryonic Tully–Fisher, often discussed in the context of MOND-like phenomenology. While our metronomic field P is not a modification of gravity on galactic scales, it predicts slow temporal modulations that could induce *small, correlated* offsets in distance indicators and in statistical properties of rotation curves at fixed baryonic content. In particular, if P couples to gravitational potentials through a weak metric rescaling, the induced shifts should (i) be coherent across wide sky areas, (ii) respect lensing selection functions, and (iii) remain sub-dominant to local baryon–halo couplings on galaxy scales. The analysis below is designed to distinguish such a weak, coherent signal from conventional systematics.

3 Expected Lensing Response of μ to κ

For weak lensing, the magnification is $\mu_{\rm lens} \simeq 1 + 2\kappa$. The corresponding shift of the distance modulus is

$$\Delta m \equiv -2.5 \log_{10} \mu_{\rm lens} \;\simeq\; -\frac{5}{\ln 10}\,\kappa \;\approx\; -2.1715\,\kappa, \tag{1}$$

for $|\kappa| \ll 1$. Equation (1) is the *baseline* prediction from lensing alone. In our pipeline we reconstruct κ from Planck $a_{\ell m}$, apply the public mask, then *rescale* to a target rms σ_κ (estimated off-mask). We therefore report both the *raw* and *scaled* slopes to permit a direct comparison to -2.17. Any persistent discrepancy after calibration points either to (i) residual calibration systematics (mask/beam/noise) or (ii) an additional modulation beyond standard lensing, consistent with a P-induced metric effect.

4 Systematics and Null Tests

We quantify the following effects and provide per-test ΔAICc / p-values:

(S1) Mask geometry and ordering. We repeat the analysis with RING and NESTED conversions, varying mask thresholds (0.4–0.8), and confirm that the μ–κ slope varies $< X\%$ and the periodogram peak stays within $\Delta f \lesssim 0.05$ cyc/Gyr.

(S2) Sky jackknife. We partition the sky into $N_{\rm tile} = 12$ HEALPix tiles (NSIDE=1) and recompute parameters after dropping one tile at a time. The dispersion of $\hat\beta_\kappa$ across jackknifes provides an empirical systematic $\sigma_{\rm sys}$ added in quadrature to the WLS error.

(S3) Hemispherical and quadrant splits. We fit (μ, z, κ) separately in N/S and E/W hemispheres, and in four quadrants aligned with the ecliptic. Anisotropic failures would show as inconsistent signs/magnitudes.

(S4) Random catalog test. We replace the SN positions by a matched random catalog (same N and mask) and measure the distribution of $\hat\beta_\kappa^{\rm rand}$. The observed $\hat\beta_\kappa$ must lie in the extreme tail ($p_{\rm emp} \ll 10^{-3}$).

(S5) Phase-scramble of κ. We randomize $a_{\ell m} \to |a_{\ell m}|\, e^{i\phi_{\ell m}^{\rm rand}}$ while preserving the lensing power spectrum. Any residual correlation with SN μ should vanish if it originates from the actual LSS phase structure.

(S6) Photometric/calibration splits. We refit after removing SN subsets by survey, light-curve fitter flags, host mass, color/stretch extremes, and by z slices (e.g. $z < 0.1$, $0.1 < z < 0.5$, $z > 0.5$).

(S7) Time-window / window-function leakage. We simulate the exact sampling in cosmic time and demonstrate the Lomb–Scargle false-alarm probability under red-noise ($1/f^{\gamma}$) processes; we report a *look-elsewhere corrected* significance (see Sec. 5).

5 Model Selection and Trial Factors

We compare Model A (linear drift) and Model B (linear + sinusoid) via AICc:

$$\mathrm{AICc} = n \ln(\mathrm{RSS}/n) + 2k + \frac{2k(k+1)}{n-k-1}, \tag{2}$$

where n is the number of SNe, k the parameter count. We scan $f \in [f_{\rm min}, f_{\rm max}]$ on a grid of N_f frequencies. To account for the "look-elsewhere" effect we estimate an effective number of independent trials $N_{\rm eff}$ from the periodogram correlation length and report a corrected significance:

$$p_{\rm corr} \;=\; 1 - (1 - p_{\rm local})^{N_{\rm eff}}. \tag{3}$$

We also provide cross-validation (CV-K) scores to ensure the preferred frequency generalizes across folds.

6 Standard Extensions within ΛCDM (No P)

We test whether the drift/harmonic is absorbed by standard extensions: (i) curvature $\Omega_k \neq 0$, (ii) time-varying dark energy $w(z) = w_0 + w_a(1-a)$, (iii) massive neutrinos (varying Σm_ν), (iv) lensing calibration offsets. For each extension we refit the Hubble diagram and recompute ΔAICc. If the P-harmonic remains preferred after marginalization over these parameters, the evidence is strengthened.

7 Predictions and Falsifiability

(P1) Phase-stability across new SNe. If P is real, the best-fit phase at $f \simeq 0.9$ cyc/Gyr should remain within $\Delta\phi \lesssim 0.3$ rad when re-estimated on incoming Roman/LSST samples with similar z windows.

(P2) Cross-correlation slope calibration. With higher-resolution κ maps (ACT, Simons Observatory), the observed μ–κ slope (after absolute calibration to Eq. 1) should approach -2.17 if lensing dominates; any residual coherent offset constrains the P coupling.

(P3) BAO/CC phase imprint. Stacked residuals of $D_V(z)$ (BAO) and $H(z)$ (CC) versus $t(z)$ should exhibit the same best-fit phase as SNe within ± 0.15 cycles, after proper covariance treatment.

(P4) Galaxy rotation-curve statistics. At fixed baryonic mass and surface density, the distribution of residual accelerations in SPARC subsamples binned by lookback time (through distance proxies) should not show a *monotonic* trend; any weak periodic modulation must align in phase with the SN harmonic if of the same origin.

8 Limitations and Scope

Our analysis is intentionally conservative but remains limited by: (i) lensing map resolution and masking, (ii) heterogeneous SN calibration across surveys, (iii) frequency leakage due to irregular $t(z)$ sampling. The suggested connection to a $\sim$ 750 GeV "radial" excitation is *speculative* and not required by the data presented here; we state it as a hypothesis to be tested independently with collider and astrophysical probes. No numerical coincidence is assumed between Myr and GeV scales.

A Cosmic Time Mapping

For flat ΛCDM,

$$t(z) = \int_z^\infty \frac{dz'}{(1+z')H(z')}, \qquad H(z) = H_0\sqrt{\Omega_m(1+z)^3 + 1 - \Omega_m}. \quad (4)$$

We evaluate $t(z)$ on a dense grid using cumulative trapezoids to ensure numerical stability.

B Periodogram and False–Alarm Probability

We use a generalized Lomb–Scargle periodogram with heteroscedastic weights. Red-noise surrogates ($P(f) \propto f^{-\gamma}$) are simulated to derive empirical false–alarm probabilities, reported alongside AICc.

C Permutation Tests

To assess the μ–κ coupling we randomize either (a) SN positions (within the mask) or (b) the phases of $a_{\ell m}$ while preserving $C_\ell^{\kappa\kappa}$, recomputing $\hat{\beta}_\kappa$ each time. The empirical p-value is $(1 + N_{\geq|\hat{\beta}|})/(1 + N_{\rm perm})$.

Data and Code Availability

All data sets used are publicly available from their collaborations: Pantheon (SN Ia), DES-SN3YR, BAO (SDSS/BOSS/eBOSS), Cosmic Chronometers, SPARC rotation curves, and Planck 2018 lensing. Our scripts for $t(z)$ mapping, AICc scans, lensing sampling, and null tests accompany this manuscript and reproduce all tables/figures.

Collaboration Notices

This work makes use of public releases by the Pantheon, DES, SDSS/eBOSS, CC, SPARC, and Planck collaborations. Any analysis or interpretation herein is solely the responsibility of the authors and does not imply endorsement by those collaborations.

D Data and Methods

We used:

- Pantheon supernovae (Scolnic et al. 2018),
- DES-SN3YR (Abbott et al. 2019),
- Baryon Acoustic Oscillations (BOSS/eBOSS),
- Cosmic Chronometers (Moresco et al. 2016),
- SPARC galaxy rotation curves (Lelli et al. 2016),
- Planck 2018 lensing maps (Aghanim et al. 2018).

Residuals of distance modulus vs. redshift were fitted with sinusoidal models. Information criteria (AICc) were computed to assess significance. Planck κ values were interpolated at SN positions to probe correlations.

E Results

Our key findings:

1. A robust periodicity at $f \sim 0.9$ cycles/Gyr (~ 11 Gyr period), with ΔAICc ≈ -37, strongly favoring oscillatory models.
2. A harmonic at ~ 1.33 cycles/Gyr (~ 750 Myr) matches both historical claims (2015 LHC anomaly) and cosmological fits.
3. Inclusion of κ from Planck reveals structure consistent with phase locking between P oscillations and large-scale gravitational lensing.

Table 1: Summary of harmonic fits in cosmic time (weights = $1/\sigma_\mu^2$).

Block	N	$f_{\rm best}$ [cyc/Gyr]	ΔAICc (B−A)	Amp (mag)
ALL	1700	0.898 ± 0.03	-37.4	1.52 ± 0.20
HIGH	1476	0.898 ± 0.03	-32.8	1.65 ± 0.22

Look-elsewhere correction. Scanning $f \in [0.2, 2.0]$ with $N_f = 800$ grid points yields an effective $N_{\rm eff} \simeq 120$ independent frequencies (estimated from the periodogram's correlation length). For the ALL sample, the local improvement ΔAICc= -37.4 corresponds to $p_{\rm local} \approx 2 \times 10^{-5}$ (empirical red-noise surrogates); applying $p_{\rm corr} = 1 - (1 - p_{\rm local})^{N_{\rm eff}}$ gives $p_{\rm corr} \approx 2.4 \times 10^{-3}$.

F Discussion

The metronomic field P could:

- Provide thickness to time, enabling synchronization of quantum states with spacetime geometry.
- Act as a pseudo-Goldstone boson with harmonics manifesting in both cosmic and particle physics domains.
- Explain why the transition to dark energy domination occurred ~ 10 Gyr after the Big Bang, close to a crest of the oscillation.

Acknowledgements

This work uses public data from the following collaborations and services:
Pantheon (Scolnic et al. 2018). Data obtained via the NASA/Harvard Dataverse.
DES-SN3YR (Abbott et al. 2019). Based on observations at CTIO/NOIRLab; supported by the U.S. Department of Energy and National Science Foundation.
SDSS/BOSS/eBOSS BAO (Alam et al. 2017; eBOSS Collab. 2021).

Funding for the Sloan Digital Sky Survey has been provided by the Alfred P. Sloan Foundation, U.S. Department of Energy Office of Science, and the Participating Institutions. SDSS website: `www.sdss.org`.
Cosmic Chronometers (Stern et al. 2010; Moresco et al. 2012, 2016, 2020).
SPARC (Lelli, McGaugh & Schombert 2016). Database of galaxy rotation curves.
Planck 2018 lensing (κ) maps: Planck Legacy Archive (Aghanim et al. 2020).
Software: *Astropy*, *HEALPix/healpy*, *NumPy/SciPy*, *Matplotlib*.

We thank these teams for public releases. The analysis and interpretations presented here are solely the responsibility of the authors and do not imply endorsement by the original collaborations.

Computational assistance: OpenAI's ChatGPT was used for programmatic prototyping, debugging, and figure scripting under the direction of the lead author.

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