From Hubble Tension to Temporal Drift: An update on the Metronomic Field Framework

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

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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 $a_{\ell m} \to |a_{\ell m}|\, e^{i\phi^{\mathrm{rand}}_{\ell m}}$ 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 $f \in [f_{\min}, f_{\max}]$ on a grid of N_f frequencies. To account for the "look-elsewhere" effect we estimate an effective number of independent trials N_{eff} from the periodogram correlation length and report a corrected significance:

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

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_{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 $N_{\text{eff}} \simeq 120$ independent frequencies (estimated from the periodogram's correlation length). For the ALL sample, the local improvement ΔAICc$= -37.4$ corresponds to $p_{\text{local}} \approx 2 \times 10^{-5}$ (empirical red-noise surrogates); applying $p_{\text{corr}} = 1 - (1 - p_{\text{local}})^{N_{\text{eff}}}$ gives $p_{\text{corr}} \approx 2.4 \times 10^{-3}$.

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.

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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*.

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