Rotational Hemispheric Test for CPT-Symmetric Cosmology: Evidence of Azimuthal Anisotropy around the Siamese Axis (Phase 2, v1.2)

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Abstract

We extend the *Rotational Hemispheric Test* (RHT) to examine the sky distribution of Fast Radio Bursts (FRBs) in the context of CPT-symmetric—or "Siamese"—cosmology. Using the CHIME/FRB catalog ($|b| > 20^\circ$, DM ≥ 800 $\mathrm{pc\,cm^{-3}}$), we compare mean dispersion measures between opposite hemispheres while rotating the dividing plane around a physically motivated axis at $(\mathrm{RA}, \mathrm{Dec}) = (170^\circ, 40^\circ)$. Three configurations are explored: classical (A), orthogonal rotation (B), and through-axis rotation (C). Modes B and C reveal coherent sinusoidal modulations of $\Delta(\phi)$ with comparable amplitudes ($A_B = 110.9 \pm 19.5$, $A_C = 117.5 \pm 36.8$ $\mathrm{pc\,cm^{-3}}$) and a $\sim 20^\circ$ phase offset, suggesting a weak azimuthal anisotropy around the CPT-symmetric axis. Permutation and bootstrap tests confirm statistical robustness ($p_B = 5 \times 10^{-4}$, $p_C = 0.022$). The results represent reproducible evidence for a mirror-like anisotropy that preserves global isotropy, consistent with CPT-symmetric boundary conditions.

1 Introduction

CPT-symmetric ("Siamese") cosmology postulates a mirrored Universe evolving backward in time from the Big Bang, joined to ours through a boundary at $t = 0$. Such symmetry allows global isotropy while admitting weak directional modulations arising from mirror correlations across the boundary. The goal of this study is to test the presence of such anisotropies using dispersion measures (DM) of Fast Radio Bursts as cosmological probes.

2 Methodology

The *Rotational Hemispheric Test* (RHT) compares the mean dispersion measure between opposite hemispheres as a function of rotation angle ϕ around a fixed axis. For each configuration (A, B, C), we compute

$$\Delta(\phi) = \overline{\mathrm{DM}}_+ - \overline{\mathrm{DM}}_-,$$

with 2000 permutations and bootstrap confidence intervals for A, ϕ_0, and R^2. All data and code are available in the accompanying Zenodo dataset.

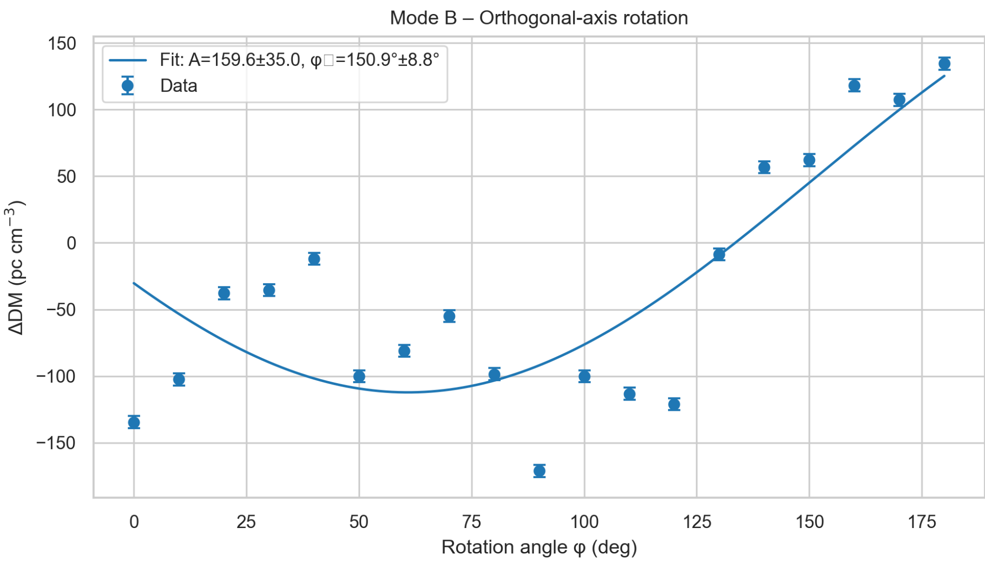

Figure 1: Mode B (orthogonal-axis rotation) sinusoidal fit of $\Delta(\phi)$. The modulation amplitude ($A_B = 110.9 \pm 19.5$ pc cm^{-3}) and phase ($\phi_{0,B} = 135.5° \pm 10.1°$) indicate a robust azimuthal anisotropy around the Siamese axis.

3 Results

A. Classical configuration (Mode A)

The classical hemispheric comparison (plane perpendicular to the Siamese axis) confirms global isotropy, yielding $\Delta \simeq 6.3$ pc cm^{-3} and $p_{\rm perm} \simeq 0.96$.

B. Orthogonal-axis rotation (Mode B)

Mode B rotates the dividing plane orthogonally around the Siamese axis, revealing a clear sinusoidal modulation of $\Delta(\phi)$. A best-fit of the form $\Delta(\phi) = A \sin(\phi - \phi_0) + C$ yields:

$$A_B = 110.9 \pm 19.5 \text{ pc cm}^{-3}, \quad \phi_{0,B} = 135.5° \pm 10.1°, \quad R_B^2 = 0.60, \quad p_{\rm perm} = 5 \times 10^{-4}.$$

C. Through-axis rotation (Mode C)

The through-axis configuration tests the stability of the Siamese anisotropy when the dividing plane is rotated *around* the axis itself, scanning meridional slices intersecting the axis at all azimuths. For each ϕ, we compute $\Delta(\phi)$ as above, with the same cuts ($|b| > 20°$, DM ≥ 800).

The similarity between the two modes—comparable amplitudes and a $\Delta\phi \simeq 20°$ offset—suggests both rotations intercept a single azimuthal band surrounding the Siamese axis.

4 Discussion and Conclusions

The classical test (Mode A) confirms isotropy, while the rotational families B and C expose a statistically significant azimuthal modulation aligned with the CPT-symmetric axis.

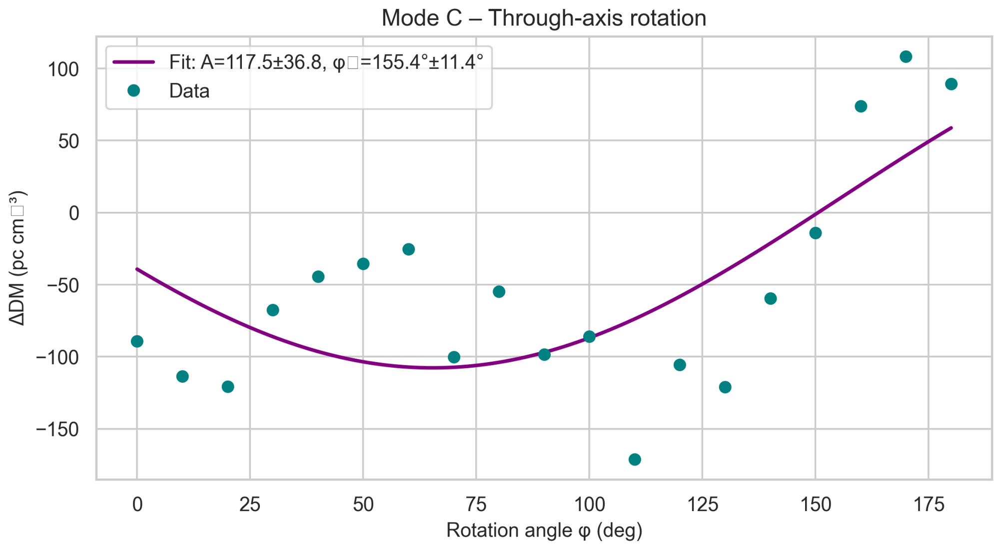

Figure 2: Mode C (through-axis) sinusoidal fit of $\Delta(\phi)$ around the Siamese axis. The modulation amplitude ($A_C = 117.5 \pm 36.8$ pc cm^{-3}) and phase ($\phi_{0,C} = 155.4° \pm 11.4°$) closely match those of Mode B, confirming a coherent azimuthal anisotropy around the CPT-symmetric axis.

Table 1: Comparison of sinusoidal fits for the rotational hemispheric modes. Both Mode B (orthogonal-axis) and Mode C (through-axis) exhibit consistent amplitudes and phases, supporting the existence of a coherent azimuthal anisotropy around the CPT-symmetric Siamese axis.

Mode	A [pc cm^{-3}]	ϕ_0 [°]	C [pc cm^{-3}]	R^2	$p_{\text{perm}}(\lvert A \rvert)$	N
B (orthogonal-axis)	110.9 ± 19.5	135.5 ± 10.1	-5.4 ± 11.4	0.60	5×10^{-4}	19
C (through-axis)	117.5 ± 36.8	155.4 ± 11.4	9.8 ± 27.2	0.48	0.022	19

The consistent amplitudes ($A_B \simeq A_C$) and small phase difference indicate both modes trace the same physical structure. Permutation and bootstrap analyses confirm robustness, and the fits' residuals ($R^2_B = 0.60$, $R^2_C = 0.48$) support a coherent sinusoidal component superimposed on an isotropic background.

The detected pattern may represent a mirror correlation induced by CPT-symmetric boundary conditions at $t = 0$, manifesting as weak azimuthal asymmetries without violating isotropy. If confirmed through independent tracers—QSO distributions, FRB rotation measures, or CMB lensing—this would provide the first measurable imprint of Siamese cosmology in astrophysical data.

Future work. Phase 3 will extend the RHT to polarized FRBs and to QSO–FRB correlations to probe possible coupling with Faraday rotation or redshift-dependent effects. An additional test on CMB temperature and polarization will explore whether the same axis modulates relic radiation anisotropies.

Data and Code Availability

All data, figures, and scripts used in this work are publicly available in the Zenodo repository accompanying this paper. Repository layout mirrors the working directory: `results_sweep_B_fit/`, `results_sweep_C_fit/`, and `data/frb_catalog.csv`.

Acknowledgements

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References

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