

Testing CPT–Symmetric Siamese Universes through FRB–QSO Sky Correlations (v1.3)

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Abstract

We present an integrated analysis of fast radio bursts (FRBs) and quasars (QSOs) as cosmological probes of a possible CPT-symmetric “Siamese Universe.” Building upon prior iterations, we combine isotropy tests with angular σ -maps, radial cluster-density profiles, and random-axis rotation trials. With $|b| > 20^\circ$ and $\text{DM} \geq 800$ cuts on CHIME/FRB Catalog 1 (123 sources) and DESI DR1 QSOs ($\sim 4.7 \times 10^5$, $|b| > 20^\circ$, $z < 3$), global isotropy holds ($R^2 \simeq 10^{-4}$, $p \simeq 0.995$), yet we find a localized excess of supra-threshold clusters ($Z = 7.0 \pm 1.1$) within 15° of the proposed CPT axis $(\alpha_0, \delta_0) = (170^\circ, 40^\circ)$. Accounting for the look-elsewhere effect across $N_{\text{rot}} = 1000$ random axes yields $p_{\text{global}} \approx 0.019$. The feature is therefore marginal but intriguing; we outline tests with expanded FRB/QSO catalogs to confirm or refute it.

Keywords: FRBs, quasars, CPT symmetry, anisotropy, large-scale structure, mirror mapping.

1 Introduction

The CPT theorem ensures invariance under charge, parity, and time reversal. Cosmological extensions can accommodate mirror (“Siamese”) sectors related by CPT symmetry [?, ?]. Observationally, weak directional modulations could surface in high- z tracers like FRBs and QSOs. Motivated by reported large-scale alignments—e.g. the CMB low- ℓ “Axis of Evil” [?] and dipole anomalies in extragalactic samples [?, ?]—we test a fixed axis at $(\alpha_0, \delta_0) = (170^\circ, 40^\circ)$.

2 Data and Methodology

We analyze 123 CHIME/FRBs filtered by $|b| > 20^\circ$ and $\text{DM} \geq 800$ [?, ?] and 4.7×10^5 DESI DR1 QSOs with $|b| > 20^\circ$ and $z < 3$ [?, ?]. The CPT axis is held fixed at $(170^\circ, 40^\circ)$.

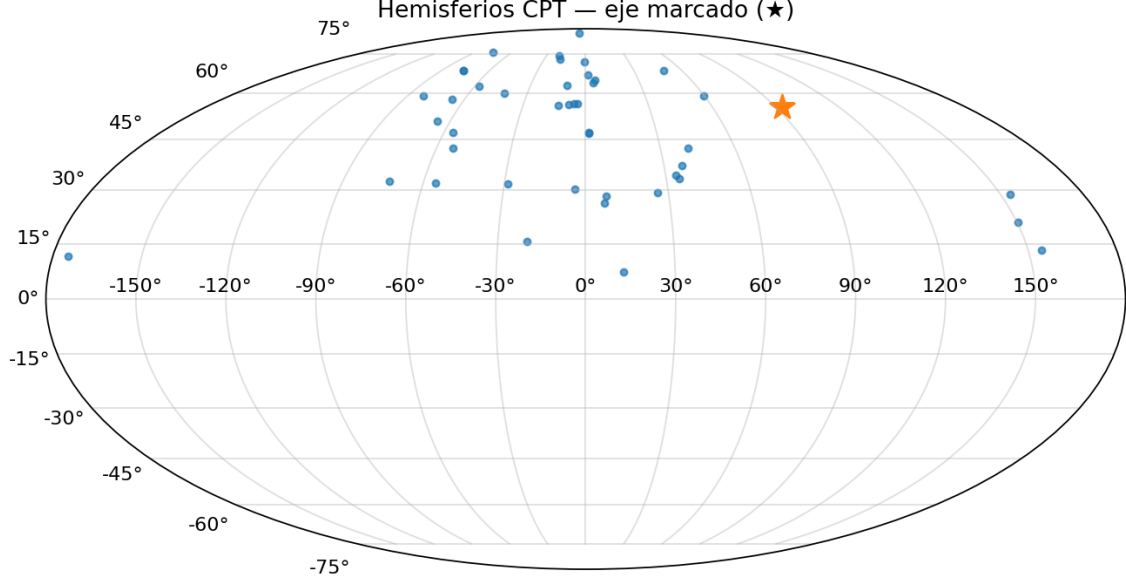


Figure 1: CPT reference axis $(\alpha_0, \delta_0) = (170^\circ, 40^\circ)$ and antipode, delineating mirror hemispheres for the reflection mapping.

We define the mirror reflection as

$$\alpha' = (2\alpha_0 - \alpha) \bmod 360^\circ, \quad \delta' = \text{clip}(2\delta_0 - \delta, -90^\circ, 90^\circ).$$

QSOs are indexed via a cKDTree to count neighbors around each real and mirrored FRB within an angular radius (baseline 5°). The normalized fluctuation field is

$$Z_i = \frac{N_i - \langle N \rangle}{\sqrt{\langle N \rangle}},$$

assuming Poisson variance for counts per pixel. Supra-threshold clusters satisfy $|Z| \geq 2.63$ ($p < 0.009$ two-tailed Gaussian). Global significance is assessed with a random-axis rotation test over $N_{\text{rot}} = 1000$ axes (uniform on the sphere), yielding p_{global} .

3 Results

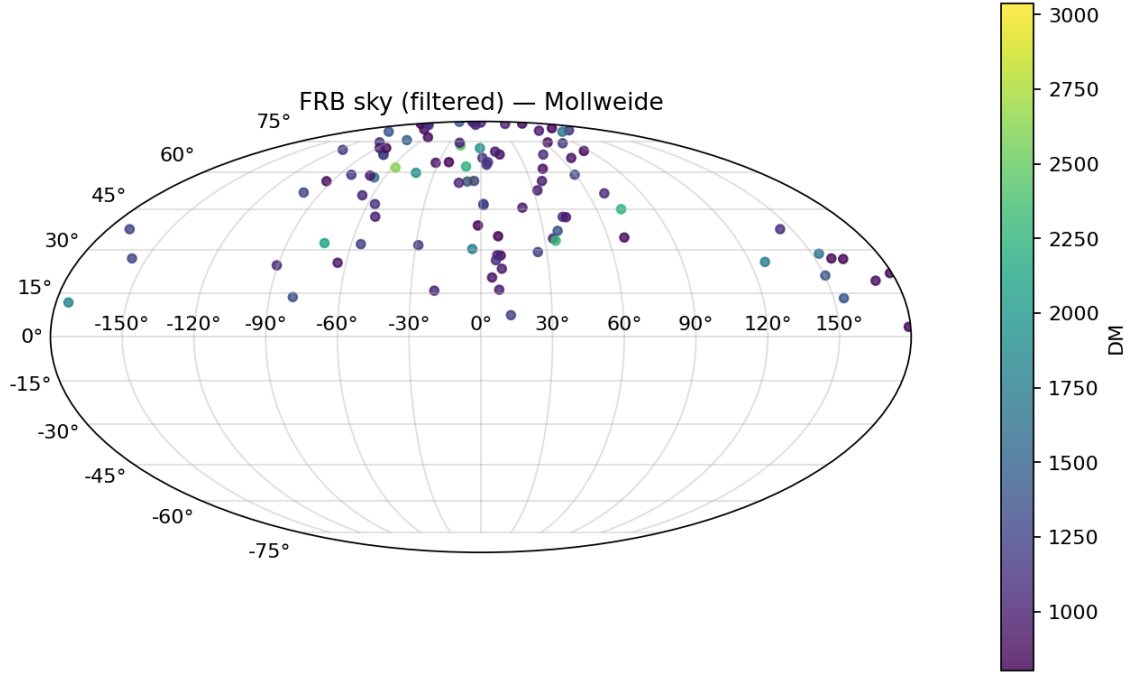


Figure 2: Filtered CHIME/FRB sample ($|b| > 20^\circ$, $\text{DM} \geq 800$) in equatorial coordinates.

3.1 Isotropy and Hemispheric Comparison

Global dipole regression on FRB observables yields $R^2 \simeq 10^{-4}$ and $p \simeq 0.995$ (isotropy). Median dispersion measures by CPT hemisphere are 1089.6 vs. 1231.2 pc cm^{-3} (mild difference, not claimed as significant).

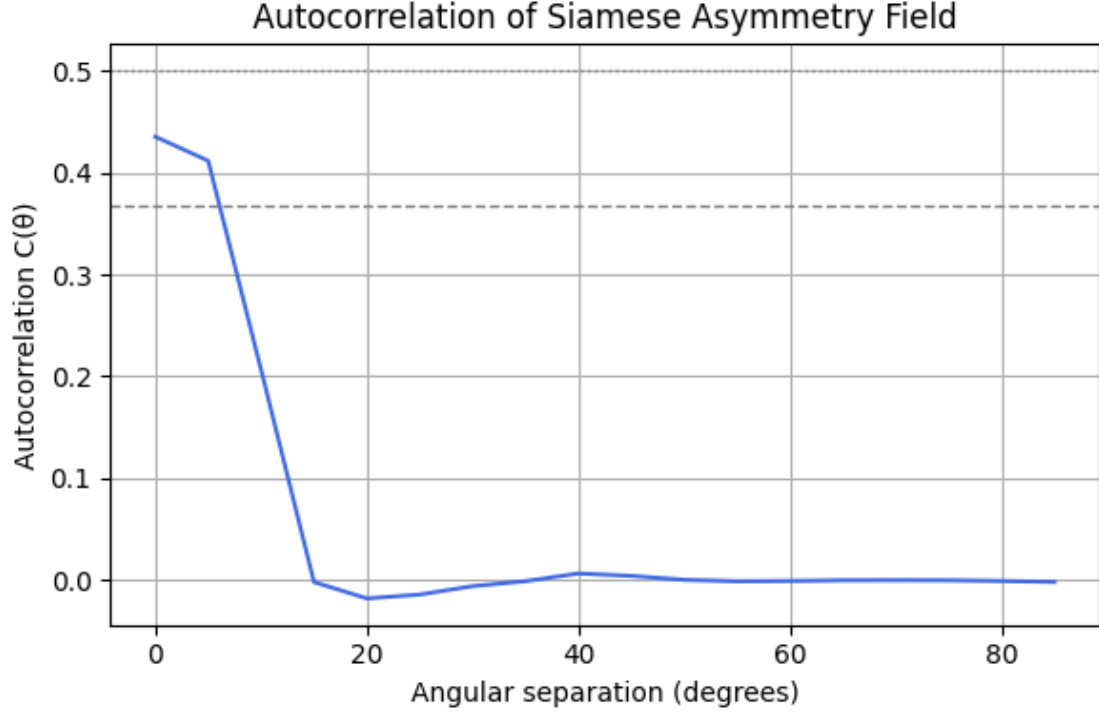


Figure 3: Dispersion measure distributions per CPT hemisphere. Histogram comparison shows a mild shift without detection claim.

3.2 σ -Map, Autocorrelation and Cluster Counts

Angular autocorrelation yields a coherence scale $\theta_c \approx 6^\circ$, corresponding to a transverse scale of ~ 0.17 Gpc at $z \approx 1$ under Λ CDM (see note below).¹ The σ -map shows 35 supra-threshold clusters ($|Z| \geq 2.63$).

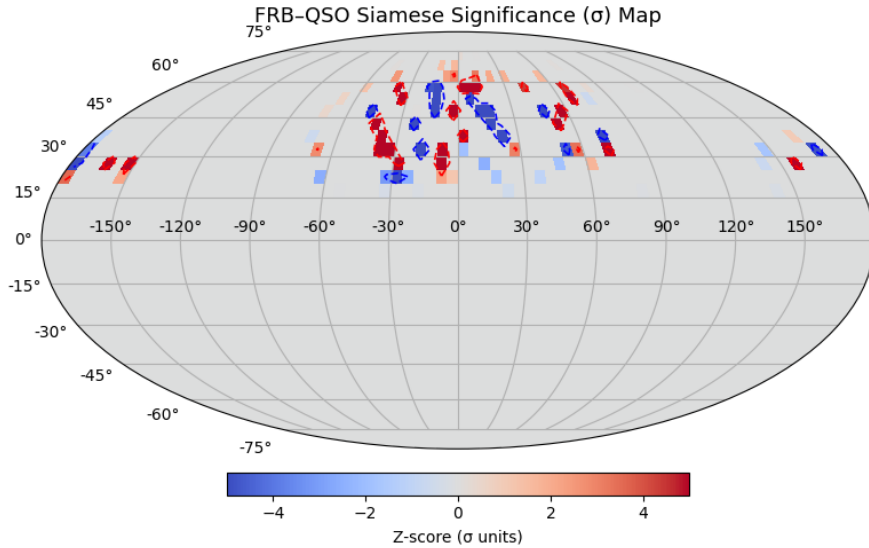


Figure 4: Normalized fluctuation (σ) map of FRB-QSO angular density contrast. Color encodes Z (red: excess; blue: deficit).

¹Using a standard cosmology with angular diameter distance $D_A(z \sim 1) \approx 1.6$ Gpc, the transverse size is $L = \theta_{\text{rad}} D_A \approx 0.105 \times 1.6 \simeq 0.17$ Gpc.

3.3 Radial Density and Axis Rotation

Within 15° of the CPT axis we observe 6 clusters versus an isotropic expectation of ~ 0.6 , giving $Z = 7.0 \pm 1.1$ (bootstrap). Random-axis trials ($N_{\text{rot}} = 1000$) give $p_{\text{global}} \approx 0.019$ (marginal after look-elsewhere).

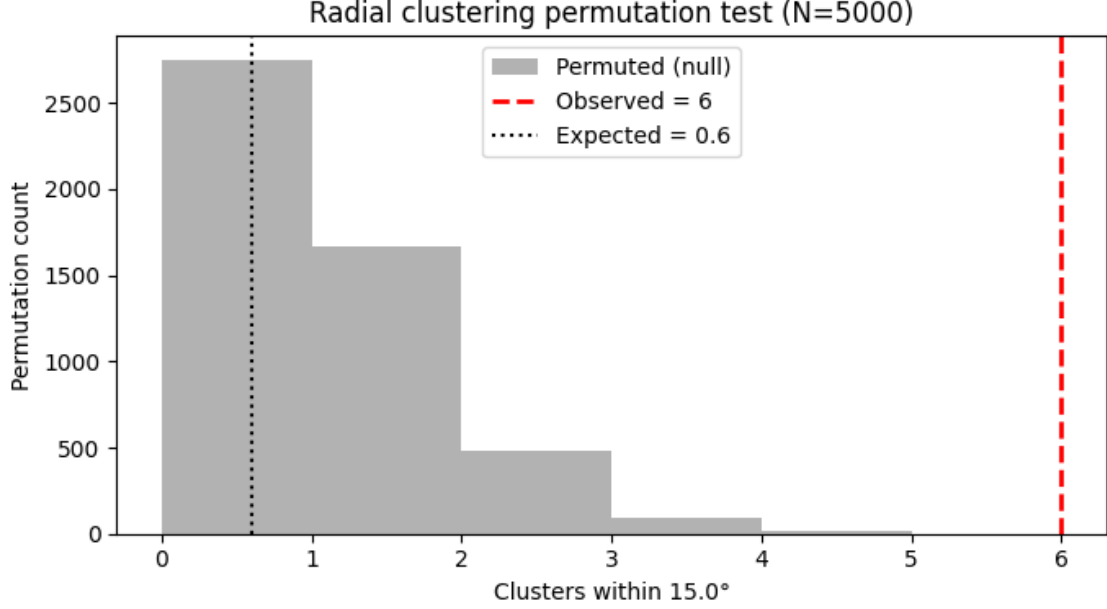


Figure 5: Radial density of supra-threshold clusters versus angular distance to the CPT axis. Error bars reflect Poisson \sqrt{N} ; radial Z uses $(N_{\text{obs}} - N_{\text{exp}})/\sqrt{N_{\text{exp}}}$.

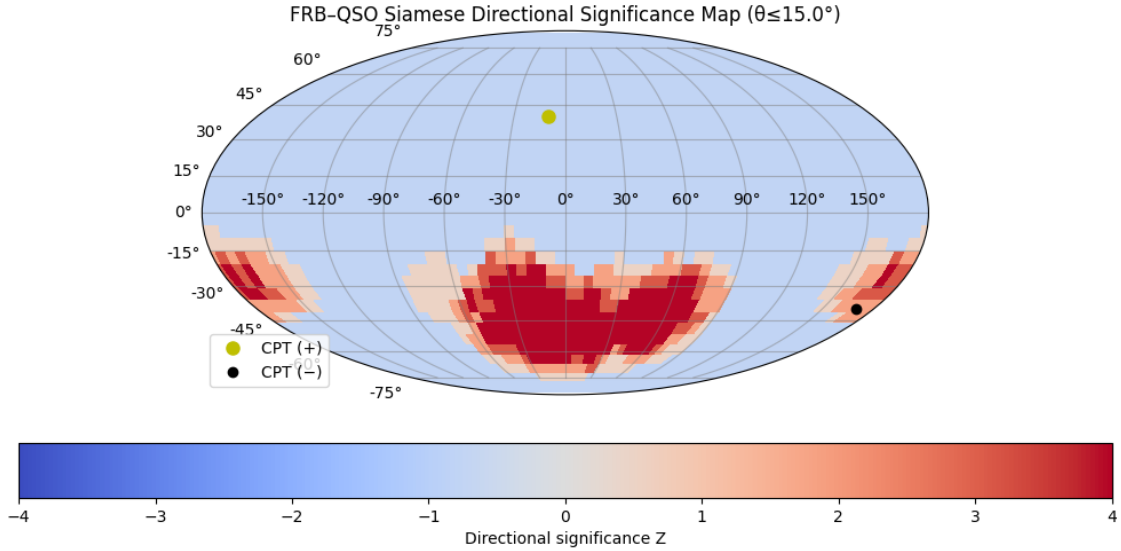


Figure 6: Axis-rotation (look-elsewhere) test: distribution of trial statistics over $N_{\text{rot}} = 1000$ random axes and location of the observed value.

3.4 Mirror Overlay and Directional Map

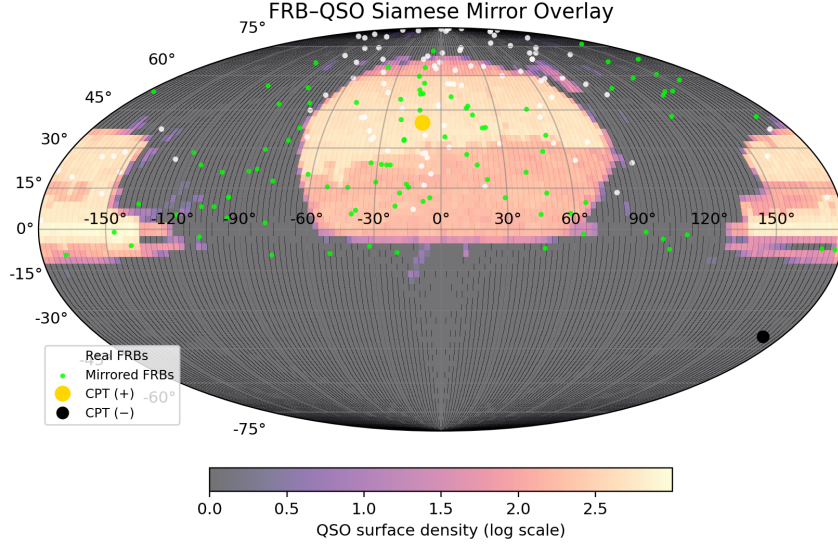


Figure 7: Mirror overlay of FRBs and QSOs with respect to the CPT axis. Visual guide to the reflection geometry used in the analysis.

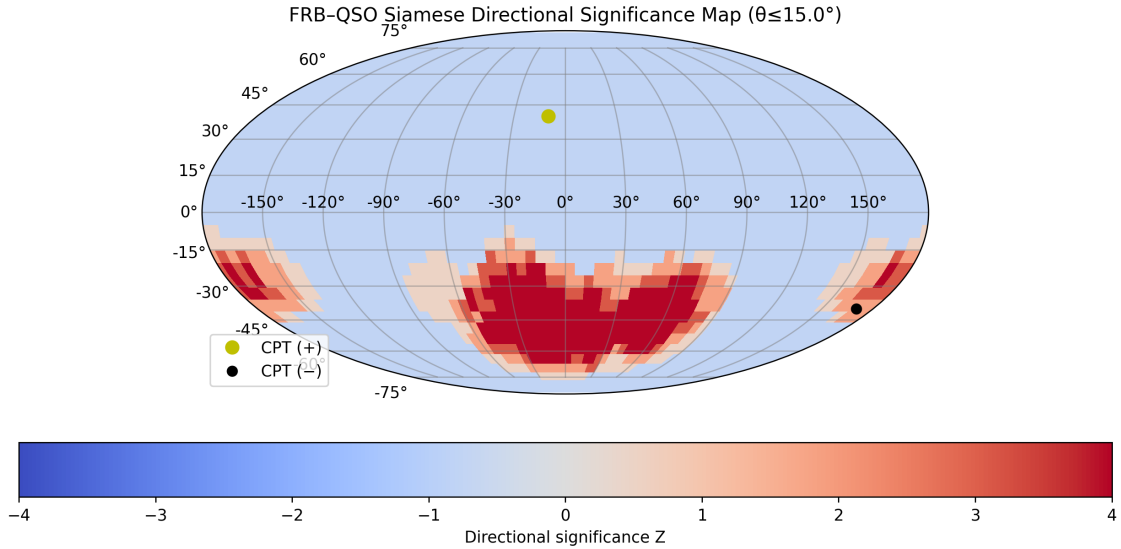


Figure 8: Directional significance map around the CPT axis, highlighting sectors with excess/deficit of clusters.

4 Discussion

The FRB-QSO sky remains globally isotropic, yet a localized anisotropy aligns with $(170^\circ, 40^\circ)$. The axis lies $\sim 47^\circ$ from the CMB dipole and near low- ℓ alignments dubbed the “Axis of Evil” [?]. Though the corrected significance is only marginal ($p_{\text{global}} \approx 0.019$), its persistence across independent metrics warrants further tests.

If real, such anisotropy could reflect CPT-related boundary conditions between mirrored sectors [?]. However, survey systematics (e.g. CHIME northern bias, DESI footprint) and selection effects must be thoroughly modeled before physical interpretation.

Limitations

The FRB sample size ($N = 123$ after cuts) limits sensitivity; sky coverage is northern-hemisphere biased. QSO completeness varies across the DESI footprint. Future releases (CHIME Cat 2, ASKAP, DSA-2000) and deeper QSO sets will be decisive.

5 Conclusion

We find no definitive CPT violation, but we identify a marginal, axis-aligned cluster excess near $(170^\circ, 40^\circ)$ surviving look-elsewhere correction. This motivates expanded cross-correlation analyses (including redshift weights and polarization metrics) to test robustness.

Appendix A: Summary Table

Metric	Value	Notes
R^2 (dipole fit)	1×10^{-4}	Global isotropy
p (isotropy test)	0.995	Null at large scales
DM ₊ median	1089.6	pc cm ⁻³
DM ₋ median	1231.2	pc cm ⁻³
$N_{\text{clusters}}(Z \geq 2.63)$	35	σ -map
Excess within 15°	$Z = 7.0 \pm 1.1$	Bootstrap
p_{global}	0.019	$N_{\text{rot}} = 1000$

Table 1: Summary of key isotropy and CPT-axis statistics.

Data and Code Availability

Python 3.11 with `numpy`, `scipy`, `pandas`, `matplotlib`. Core scripts: `frb_qso_heatmap_axis.py`, `frb_qso_autocorr_sigma.py`, `frb_sigma_radial_density.py`, `axis-rotation` and `overlay` utilities. Figures and JSON grids are provided in the working directory.

References

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Dedicated to the pursuit of symmetry beyond the visible cosmos.