Acknowledgment
The author utilized AI tools, including Grok (xAI), ChatGPT (OpenAI), NotebookLM (Google), and Claude (Anthropic), to assist in formulating and verifying mathematical expressions and for research in this paper. The author retains full responsibility for the content, interpretations, and conclusions of the work. Computational assistance and research support by Grok (Grok4 / xAI) and ChatGPT 5 (Thinking) under the author's supervision. No AI co-authorship. Synthetic and pilot data were generated by the authors for demonstration and validation. This paper was developed based on DOI's 10.5281/zenodo.16884571 & 10.5281/zenodo.16241964

Author Statement
This hypothesis and vision are my contribution to science. I developed the conceptual structure and mathematical scaffolding, with technical support from AI tools for mathematical notation and structuring. The testing, empirical verification, and further development are the responsibility of the broader scientific community. My role is now complete; I share this insight for others to work with, and I invite academics, research institutions, and laboratories to falsify or demonstrate it.

Date: 2025-09-13

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Meta-Hypothesis: Time as Rotation Field and Cognitive Reflection — Digital Rotation in the GTUD Framework (v6.16)

Abstract

We define digital rotation as a cyclic shift on binary sequences (±1 embedding) and prove that the rotation distance $E = 2 - 2C$ scales quadratically with $\Delta\theta = 2\pi k/n$ in the small-angle regime. The leading coefficient β is the normalized second spectral moment. We provide a uniform remainder bound $O((\Delta\theta)^4)$ via M_4, a bandwidth criterion under low-frequency dominance, and 3D additivity without order-1 cross terms. We connect this to pre-quantum fidelity ($1 - F \approx ¼ \mathbb{F}\_Q \Delta\theta^2$), Jordan–Wigner fermionization (Kitaev chain), toric code and anyon braiding (Yang–Baxter consistency). Empirically we illustrate robustness via Monte Carlo (n = 1000) and ΔAIC/Bayes LRT for cross-covariance. We introduce OU-noise modeling and show TOST equivalence (±10%) between digital, pre-QC and neuro domains.

1. Introduction

Problem statement. Time experience as rotation-variation in field configurations, quadratically coupled to energy (GTUD: $\mathcal{G} = E^2 \Delta\theta^2$), has in the discrete domain a concrete representation via binary sequences. Goal. Formalize $\Delta\theta^2$ scaling laws, anchor β spectrally, quantify remainder terms and propagate to QC/topology and neurodynamics.

2. Notation and Core Theorem

Let $S \in \{0,1\}^n$, R_k S the cyclic shift and x_i = (−1)^{s_i}. Define $C(k) = n^{-1}$∑_i x_i x_{i−k} and E = 2 − 2C. Under A1–A3 (low-frequency dominance; mollifier regularity; k ≪ n) we have: $E(k) = \beta (\Delta\theta)^2 + o((\Delta\theta)^2)$, with $\beta = (2\pi)^2 [\sum (\omega/2\pi)^2 |X(\omega)|^2] / [\sum |X(\omega)|^2]$.

Remainder (Proposition). $|E(k) - \beta (\Delta\theta)^2| \le K\cdot(\Delta\theta)^4$ with $K \approx ((2\pi)^4/12)\cdot M_4 / (n\sum|X|^2)$, where $M_4 = \sum \omega^4 |X(\omega)|^2$.

Bandlimit (Corollary). Fit bias = $O(\varepsilon) + O((\Delta\theta\cdot\omega\_c)^2)$ if 95% power < 0.2π and high-frequency mass ε.

3D additivity. E_3D ≈ ∑_a β_a $(\Delta\theta\_a)^2 + O(|\Delta\theta|^4)$; cross terms vanish under lack of correlation.

3. Empirics (Synthetic, Illustrative)

Monte Carlo (n = 1000 per ε) shows mild bias and decreasing R^2 at higher ε; histograms and summary in Appendix B.

Figure: Bias in $\hat{\beta}$ vs ε.

Figure: R^2 vs ε.

4. Cross-Covariance: ΔAIC and Bayes LRT

We simulate ΔAIC between models without and with a cross term. A BIC-proxy posterior P(H1|D) distinguishes null (ρ=0) and alternative (ρ=0.2).

Figure: Posterior(H1) CDFs.

5. QC Bridges and JW Fermionization

Fidelity. $1 - F \approx \frac{1}{4} \mathbb{F}\_Q \Delta\theta^2$ (Bures/Fisher). Jordan–Wigner. c_j = (∏_{ℓ<j} Z_ℓ)(X_j − iY_j)/2; Majoranas γ_{2j−1}, γ_{2j}. Kitaev chain: gap ∼ $\Delta\theta^2$ at small deflections. Toric code: cost ∼ ∑_a $(\Delta\theta\_a)^2$. Anyons: R/F-matrices yield even-order phase increments.

6. OU Noise and Neurodynamics (Homo Symboticus)

We model environmental noise with an Ornstein–Uhlenbeck process and assess effects on β via bandlimit criteria. Kuramoto-like coupling projects $\Delta\theta$ mismatch to phase-locking variance $\sim (\Delta\theta)^2$; TOST equivalence anchors domain matching at ±10%.

Figure: OU PSD (illustrative).

Figure 12: β-TOST (±10%) across domains.

7. Discussion and Dissemination

Preregistration: OSF template in Appendix P. Target venue: Quantum. Upload appendices/CSV/figures to Zenodo (DOI to be minted). Mark speculative bridges as 'axiomatic, empirically pending'.

References and Provenance

Zenodo records: 17254486, 17202998 (core GTUD), 16884571, 16241964 (Homo Symboticus/ethics).

Appendix A — Proofs (Sketch)

Autocorrelation expansion: $C(k) = \sum |X(\omega)|^2 \cos(\omega k) / n$; Taylor and Parseval yield the small-angle law. Parity removes linear terms; the remainder follows from the fourth moment M_4.

Appendix B — Monte Carlo ε-bias

Dataset: $n = 1000$ per ε; $\varepsilon \in \{0.0, 0.05, 0.1, 0.2\}$. See CSVs and figures.

File: v6.16_appendixB_monte_carlo_results.csv; summary: v6.16_appendixB_monte_carlo_summary.csv.

Appendix C — Yang–Baxter & M_4 as 'partition moment'

Group theory: R-matrix obeys Yang–Baxter: $R_{12}R_{13}R_{23} = R_{23}R_{13}R_{12}$; small-angle deflections project onto even-order phase increments. Statistical mechanics: M_4 acts as a 'partition moment' weighting the $O(\Delta\theta^4)$ remainder; convergence acceleration follows from bounded high-frequency mass.

Appendix S — QC Details (JW, Kitaev, Toric, Anyons)

Full JW fermionization and consistency claims with testable predictions (QuTiP $n = 40$).

Appendix P — Preregistration & OSF Template

Template for preregistration: design, ε-bias extension, β-TOST, ΔAIC-LRT, QuTiP simulations ($n = 40$).