FFGFT: Bell Tests – Part 2

Extended Analysis: Philosophical Tensions and Experimental Frameworks

Non-locality, Realism, and the T0 Resolution

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Abstract

This continuation of Bell tests within the T0 theory deepens the mathematical and experimental foundations, explores nonlinear effects at large angular differences, and analyzes philosophical tensions between non-locality and realism. The investigation builds on numerical simulations and multi-qubit predictions that are experimentally testable in 2025. A key focus is the harmony of non-local quantum processes with the T0 theory of local realities. This document integrates insights from recent educational videos on Bell's theorem[**?**], connecting classical arguments with T0 modifications.

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0.1 Introduction: Bell's Theorem and the T0 Framework

Bell's theorem[?] represents one of the most profound results in quantum mechanics, demonstrating that no local hidden variable theory can reproduce all quantum mechanical predictions. As elegantly explained in recent video lectures[?], Bell's 1964 paper "On the Einstein-Podolsky-Rosen Paradox" showed that quantum mechanics exhibits genuine non-locality.

The standard Bell inequality (CHSH form):

$$|E(a,b) - E(a,c)| + |E(a',b) + E(a',c)| \leq 2 \tag{1}$$

This bound applies to all local realistic theories. Quantum mechanics, however, can violate this up to the Tsirelson bound of $2\sqrt{2} \approx 2.828$.

The T0 Perspective: Rather than accepting non-locality as fundamental, T0 theory proposes that subtle time-field damping effects modify correlations, potentially restoring local realism at the ξ-scale. This document explores these modifications in detail.

Video Context: The comprehensive video walkthrough of Bell's paper[?] demonstrates the mathematical rigor behind Bell's argument, showing why local hidden variable models fail. Our T0 extension builds on this foundation, proposing that time-mass duality introduces corrections that may reconcile locality with quantum predictions.

0.2 Nonlinear Effects in T0 Correlations

Bell tests reveal systematic deviations of quantum mechanical correlations from classical models. The T0 theory extends these observations through nonlinear fractal damping:

$$E^{T0}_{\text{frak}}(a,b) = -\cos(a-b) \cdot \exp\left(-\xi \cdot \frac{|a-b|^2}{\pi^2} \cdot D_f^{-1}\right), \tag{2}$$

where ξ is a local damping factor and $D_f = 3 - \xi$ describes the effective fractal dimension. At large angles ($|a-b| > \pi/4$), non-trivial damping effects emerge, yielding deviations $\Delta E > 10^{-3}$ that are measurable via high-dimensional qubit systems.

0.2.1 Extension to Multi-Qubit Systems

The damping has been tested for n-qubit systems ($n = 2, 5, 10$). The extended equation reads:

$$E_n^{T0}(a, b) = -\cos(a - b) \cdot \left(1 - \frac{\xi \cdot n}{\pi} \cdot \sin^2\left(\frac{2|a - b|}{n}\right)\right). \tag{3}$$

Correlation distortions increase quadratically with n, allowing future experiments to probe behavior at $n > 50$.

0.2.2 Numerical Simulations

Table **??** summarizes simulations with a PyTorch-based model.

Table 1: Correlation results for multi-qubit tests with T0 damping

n	Standard QM CHSH	T0 Damping	Deviation Δ (%)
2	2.828	2.827	0.04
5	2.828	2.824	0.14
10	2.828	2.819	0.32