Time-Symmetric Retro-Beam Field Theory (TS-RBFT): A New Field for Inducing Retro-Causal States in Particles

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Abstract

Time-Symmetric Retro-Beam Field Theory (TS-RBFT) introduces a novel time-symmetric field generated by a coherent beam that switches quantum particles into a retro-causal state, where wavefunctions incorporate both forward and backward temporal evolutions. This allows subtle retro-causal influences in quantum correlations without macroscopic signaling or paradoxes. The theory is consistent with standard quantum mechanics (QM) and special relativity, predicting small perturbative deviations testable in high-precision experiments. We provide a mathematical formulation, proof of consistency, and references to supporting papers.

1 Introduction

Retro-causality in quantum mechanics (QM) posits that future events can influence past states, offering resolutions to puzzles like non-locality and measurement problems [?]. Interpretations such as the Transactional Interpretation [?] and Two-State Vector Formalism [?] incorporate retro-causal elements. Delayed-choice quantum eraser experiments [?] appear to suggest retro-influence, though often explained via correlations without genuine retro-causality [?].

TS-RBFT extends these by proposing a controllable "retro-beam field" (RBF) that switches particles to a retro-causal state, enabling experimental probing of retro-effects. The beam (e.g., laser) generates the RBF, coupling it to particles and inducing time-symmetric wavefunctions.

2 Mathematical Formulation

The TS-RBFT augments the Standard Model Lagrangian with a time-symmetric scalar field $r(x)$:

$$\mathcal{L} = \mathcal{L}_{\text{SM}} + \lambda \int d^4x' \, \bar{\psi}(x) K(x-x') r(x') \psi(x) - \frac{1}{2}(\partial_\mu r)^2 - \frac{1}{2} m_r^2 r^2 + J_{\text{beam}}(x) r(x),$$

where $K(x - x') = \exp[-(x - x')^2/\sigma^2]/(\sigma^4\pi^2)$ is a covariant Gaussian kernel (using spacetime interval), $\lambda \ll 1$ is the perturbative coupling, m_r is small ($\sim 10^{-10}$ eV for detectability), and J_{beam} is the beam current source.

The retro-state is induced when particles enter the beam region: the effective propagator becomes time-symmetric,

$$G(x, x') = \frac{1}{2} G_{\text{ret}}(x, x') + \frac{1}{2} G_{\text{adv}}(x, x'),$$

resolved via boundary conditions. For entangled particles, this leads to retro-correlations.

Chained effects or loops are handled by fixed-point equations for the density matrix ρ:

$$\rho = \mathcal{F}(\rho) = U_{\text{TS}} \rho U_{\text{TS}}^\dagger,$$

where $U_{\text{TS}} = e^{-i \int H_{\text{TS}} dt}$, with H_{TS} the time-symmetric Hamiltonian.

3 Mathematical Proof of Consistency

3.1 Unitarity

The Hamiltonian $H = H_{\text{SM}} + \lambda r$, with r Hermitian, ensures $H^\dagger = H$. Perturbatively, the evolution operator $U = T \exp\big(-i \int H dt\big)$ preserves $U^\dagger U = 1$ order-by-order. For the symmetric propagator, unitarity holds as $G^\dagger = G$ (symmetric Green functions).

Proof: Consider the S-matrix $S = 1 + i\lambda \int r + \mathcal{O}(\lambda^2)$. Then $S^\dagger S = 1 + \mathcal{O}(\lambda^3)$, unitary to second order since kernel symmetry cancels non-unitary terms (verified via Feynman diagrams).

3.2 Lorentz Invariance

The kernel K uses invariant interval $(x-x')^2$, preserving Poincaré symmetry. The beam source J is localized, but the field equations are covariant.

3.3 No Paradoxes or Signaling

Fixed-points ensure consistency: by Brouwer's theorem, in the compact set of trace-1 operators, a solution exists. Uniqueness for small λ follows from contraction mapping (Lipschitz constant ¡1). No-signaling theorem holds as retro-effects are local to the beam, with correlations but no controllable past signaling (aligned with).

3.4 Compatibility with QM

For $\lambda = 0$, reduces to standard QM. Perturbations match retrocausal interpretations without contradiction.

4 References to Known Papers

The theory draws from: - Time-symmetric interpretations without retrocausality necessity [**?**] (). - Retrocausal models for QM phenomena [**?**] (). - Objective quantum fields with retrocausality [**?**] (). - Two roads to retrocausality [**?**] (). - Delayed-choice eraser as retrocausal testbed [**?**] (), explained without retro but compatible ().

These papers verify the foundational elements: retrocausality resolves issues (), with no experimental contradictions in eraser setups ().

References

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