Tachyons as the Particles of Quantum Entanglement: A Field-Theoretic Model via Spontaneous Symmetry Breaking

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Abstract:

This paper presents a theoretical framework where the tachyonic fields, which emerge from the spontaneous symmetry breaking in Higgs-like scalar potential, are considered the mediators of quantum entanglement. The virtual excitations of the tachyonic scalar field are preserved by treating them as off-shell, non-energy-transmitting carriers of the correlations. These tachyons serve as the particles of entanglement which links distant systems without violating causality. In Lagrangian which contains negative mass-squared term, tachyonic Feynman propagator in position space is derived to show that it remains nonzero for spacelike separations. These functions are extended to multi-point correlations and mapped onto the observables used in Bell-type experiments to enable direct comparison with quantum nonlocality tests. By the numerical simulations, it's demonstrated that the normalized propagator-based expectation values lead to CHSH inequality violations, producing the features of entanglement. This paper offers a field-theoretic foundation for quantum entanglement, from a different perspective while being grounded in standard field theory. This provides a mathematically consistent and physically grounded explanation for nonlocal quantum correlations with the implications for fundamental physics and quantum information theory.

Keywords:

Tachyonic fields, quantum entanglement, nonlocal correlations, Higgs, spontaneous symmetry breaking