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Optimizing Fictitious States for Bell Inequality Violation in Bipartite Qubit Systems

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There is a significant interest in testing quantum entanglement and Bell inequality violation in high-energy experiments. Since the analyses in high-energy experiments are performed with events statistically averaged over phase space, the states used to determine observables depend on the choice of coordinates through an event-dependent basis and are thus not genuine quantum states, but rather "fictitious states." We prove that if Bell inequality violation is observed with a fictitious state, then it implies the same for a quantum substate. We further show analytically that the basis which diagonalizes the spin-spin correlations is optimal for constructing fictitious states, and for maximizing the violation of Bell's inequality.

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