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Quantum Spread Complexity in Neutrino Oscillations

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Neutrino flavor oscillation is a widely studied physical phenomenon with significant implications for our understanding of particle physics and the search for physics beyond the standard model. Oscillation arises due to the mixing between flavor and mass eigenstates, and their evolution over time. It is a quantum system where flavor transitions are typically studied using probabilistic measures. Neutrinos have also shown potential for quantum information tasks due to their inherent features, such as entanglement and nonlocal correlations. Quantum information theory is a rapidly growing field of research, with various measures of quantum correlations and entanglement tested for their ability to be used for diverse quantum information processing tasks. One such measure, quantum complexity, is increasingly being applied to investigate complex systems in many areas of physics. However, its practical application to physical systems is still limited. In this context, the quantum complexity formalism can be used as an alternative measure to study neutrino oscillations. In particular, quantum spread complexity can reveal additional information about the violation of charge-parity symmetry in the neutrino sector. Our results suggest that complexity favors the maximum violation of charge-parity, which is consistent with recent experimental data.

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