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Design and Simulation of a Quantum Circuit for the Study of Three Flavor Neutrino Oscillations

Neutrino oscillations, manifested as flavor transitions during propagation, arise from the mismatch between the flavor and mass eigenstates. In this work, we apply quantum computing techniques to model neutrino oscillations and investigate their dynamics under three physical scenarios: vacuum propagation, the inclusion of a CP-violating phase, and propagation through a constant matter potential. Three distinct quantum circuits are implemented and tested both on a two-qubit quantum processor and in simulated environments. The results reproduce the expected oscillation behavior across the three scenarios, demonstrating the ability of few-qubit quantum systems to capture increasingly complex features of neutrino oscillations and highlighting their potential for quantum simulation of physical phenomena.

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