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# Tunable $\Lambda$-system to detect timelike Unruh effect

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The Unruh effect, resulting from the entanglement of modes across the right and left wedges of Rindler spacetime, predicts that a uniformly accelerating observer perceives the Minkowski vacuum as a thermal bath. Despite its theoretical significance, this effect remains undetected. The Unruh effect has a timelike counterpart due to the entanglement between past and future Rindler light cones. Similar to the conventional Unruh effect, the timelike Unruh effect also imparts an additional geometric phase to a detector confined to a spacetime trajectory within one of the future or past light cones. We employ quantum circuits—specifically flux qubits—to design a $\Lambda$-detector with two degenerate ground states and a excited state whose energy levels can be tuned to measure the geometric phase change induced by this effect. This detector, with a transition frequency scaled inversely with time in Minkowski coordinates, corresponds to a detector with a constant transition frequency in future/past Rindler coordinates. Simulations show that this system can effectively measure the geometric phase associated with the timelike Unruh effect, providing a feasible experimental setup for its detection. This demonstrates an application of quantum computing to test the nature of spacetime.

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