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The Twin Paradox in Quantum Field Theory

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The theory of relativity fundamentally reshaped our understanding of space and time, introducing conceptual shifts often illustrated explicitly through apparent paradoxes. Among these, the twin paradox stands out by clearly demonstrating how two observers following different spacetime trajectories can experience distinct elapsed times. Physically meaningful statements about elapsed time require the use of clocks, which, as physical systems, should be modeled using our best available theories of matter. In this work, we introduce a version of the twin paradox in which clocks are modelled as Unruh-DeWitt detectors. Our results offer insights into the indefiniteness of causal structures at scales where quantum effects become significant.

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