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Particle detectors in superposition in de Sitter spacetime

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Cosmological particle creation is the phenomenon by which the expansion of spacetime results in the production of particles of a given quantum field in that spacetime. In this paper, we study this phenomenon by considering a multi-level quantum particle detector in de Sitter spacetime coupled to a massless real quantum scalar field. Rather than considering a fixed classical trajectory for the detector, following recent novel approaches we consider a quantum superposition of trajectories, in particular of static trajectories which keep a fixed distance from one another. The main novel result is that, due to the quantum nature of the superposition of trajectories, the state of the detector after interaction with the field is not only a mixture of the thermal states that would be expected from each individual static trajectory, but rather exhibits additional coherences due to interferences between the different trajectories. We study these in detail and associate them with the properties of the particle absorbed by the detector from the thermal bath.

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