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A generalized framework for the quantum Zeno and anti-Zeno effects in the strong coupling regime

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It is well known that repeated projective measurements can either slow down (the Zeno effect) or speed up (the anti-Zeno effect) quantum evolution. Until now, studies of these effects for a two-level system interacting with its environment have focused on repeatedly preparing the excited state via projective measurements. In this paper, we consider the repeated preparation of an arbitrary state of a two-level system that is interacting strongly with an environment of harmonic oscillators. To handle the strong interaction, we perform a polaron transformation and then use a perturbative approach to calculate the decay rates for the system. Upon calculating the decay rates, we discover that there is a transition in their qualitative behaviors as the state being repeatedly prepared continuously moves away from the excited state and toward a uniform superposition of the ground and excited states. Our results should be useful for the quantum control of a two-level system interacting with its environment.

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