Multilevel interference resonances in strongly driven four-level quantum systems

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Abstract

In this paper, we study multilevel resonances in a strongly driven four-level quantum system, where one level is periodically swept through other levels with constant energy separation E and $2E$. Near the multi-photon resonance conditions, we find qualitatively different behavior for the number of even or odd photons. We explain this phenomenon in terms of families of interfering trajectories of the multilevel system. For beginning our detailed analysis based on a perturbative treatment in terms of the small parameters that characterize the strong driving limit, we introduce the strong-dephasing regime that is modeled by Gaussian white-noise fluctuations on each of the unperturbed energy levels. Within this model we calculate the rates of inter-level transitions, working up to fourth order in the couplings. Finally, we connect our results to the experiments in which current through spin-blockaded double quantum dots was measured in the presence of strong ac driving. The setup can be relevant for a variety of nanoscale, solid state and atomic or molecular systems. In particular, it provides a clear mechanism to explain recent puzzling experimental observations in strongly driven double quantum dots.

Keywords: Quantum dot, Interference phase, Strong dephasing regime, Transition rate, Multi-level interference resonances

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