Landau - Zener interferometry in multi-level systems

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Abstract

We propose a universal approach to the Landau-Zener (LZ) problem in a multilevel system. The problem is formulated in terms of generators of SU(N) algebra and maps the Hamiltonian onto the effective anisotropic pseudospin (N-1)/2 model. The vector Bloch equation for the density matrix describing the temporal evolution of the multilevel crossing problem is derived and solved analytically for two generic cases: i) three-level crossing problem representing a minimal model for a LZ interferometer and ii) four-level crossing problem corresponding to a minimal model of coupled interferometers. It is shown that the analytic solution of the Bloch equation is in excellent quantitative agreement with the numerical solution of the Schroedinger equation for the 3- and 4- level crossing problems. The solution demonstrates oscillation patterns which radically differ from the standard patterns for the two-level Landau- Zener problem: "beats", when the dwell time in the interferometer is smaller compared to a tunnel time and "steps" in the opposite limit. The possibilities of the experimental realization of LZ interferometers in the system of coupled quantum dots, Josephson charge qubits and in two-well traps for cold gases are discussed.

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