Coherent Electron Dynamics in Quantum Dots: Adiabatic Passage and Landau-Zener-Stückelberg Interferometry

Sigmund KOHLER
Instituto de Ciencia de Materiales de Madrid,
CSIC

The increasing quality of coherently coupled quantum dots allows the preparation of electrons in delocalized orbitals that maintain their quantum mechanical phase during a large number of coherent cycles. This enables interference experiments in time-dependent potentials ranging from the highly non-adiabatic to the almost adiabatic regime.

Recently, the proposed adiabatic passage of an electron in a triple quantum dot from the first to the last dot without ever occupying the middle dot attracted much attention. This coherent transfer by adiabatic passage (CTAP) represents an all-electronic version of stimulated Raman adiabatic passage. A major experimental obstacle for the implementation of this protocol is the impossibility of directly measuring the non-occupation of the middle dot, because the unavoidable backaction would influence the effect that it should substantiate. It will be shown that an indirect verification is possible by attaching electron source and drain to the triple dot. Then the protocol can be repeated such that a steady state current flows. The noise properties of this current hint on the proper course of the protocol.

Quantum dots with long coherence times also allow the implementation of tunnel phenomena under the influence of AC driving. In the presence of leads, this includes effects such as non-adiabatic pumping and coherent suppression of tunnel currents. In a comprehensive picture, one may study the average current as function of the static level detuning and the driving amplitude. It exhibits a pattern similar to one observed with superconducting qubits. This measurement provides information about the decoherence strength of the dissipative inter-dot tunneling and, thus, allows one to draw conclusions about the dephasing time of the corresponding charge qubit. The theoretical predictions are compared to recent experiments performed at LMU Munich.