Interaction-induced harmonic frequency mixing in quantum dots

M. Thorwart [1], R. Egger [2] and A.O. Gogolin [1,2]

[1] Institut für Theoretische Physik, Heinrich-Heine-Universität Düsseldorf, D-40225 Düsseldorf, Germany
[2] Department of Mathematics, Imperial College, 180 Queen's Gate, London SW7 2BZ, United Kingdom

We show that harmonic frequency mixing in the transport current in ultrasmall quantum dots is generated by Coulomb interaction when two time-dependent bias voltages are applied. In absence of the on-dot interaction, harmonic mixing is suppressed. This offers a unique and novel tool to directly access interaction phenomena in quantum many-body systems. Explicit results are provided for a quantum dot, described by the Anderson model, in three different parameter regimes : (i) perturbative in the Coulomb interaction strength, (ii) in the sequential tunneling regime, and (iii) in the Kondo limit, where an exact solution for the mixing current signal is obtained. Moreover, we discuss the case of harmonic mixing induced by the interaction of a non-interacting quantum dot energy level with a single Einstein phonon.