Time-dependent quantum transport in molecular junctions: Some effects of electron-phonon interactions

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The study of time-dependent current fluctuations in nanoscale conductors is of great importance as it can provide informations on the interactions and quantum correlations between electrons [1]. While these studies have been traditionally restricted to the stationary regime, the advent of single-electron sources [2], has triggered a renewed interest in investigating the short-time behavior as well [3].

This presentation aims at reviewing some recent advances in this field of research. In particular, we develop a theoretical approach to study the transient dynamics and the time-dependent statistics of charge transfer for the Anderson-Holstein model in the regime of strong electron-phonon coupling [4]. The generating function for the time-dependent charge transfer probabilities is evaluated numerically by discretization of the Keldysh contour. The method allows us to analyze the system evolution to the steady state after a sudden connection of the dot to the leads, starting from different initial conditions.

It is shown that the transient dynamics is slowed down significantly upon increasing e-ph interactions, thus resulting in an apparent bistable behavior [4]. Simple analytical results are obtained in the regime of very short times which provide a simple unifying explanation for this polaronic « blocking-deblocking » dynamics based on an analogy between optics and nanoelectronics.

We finally analyze the waiting time distribution and charge transfer probabilities, showing that only a single electron transfer is responsible for the rich structure found in the short-time regime [4]. A universal scaling (independent of the model parameters) is found for the relative amplitude of the higher order current cumulants in the short-time regime [4], starting from an initially empty dot.

[1] Y. M. Blanter and M. Büttiker, Phys. Rep. 336, 1 (2000).

[2] G. Fève et al., Science 316, 1169 (2007).

[3] K. Thibault, J. Gabelli, Ch. Lupien, and B. Reulet, Phys. Rev. Lett. 114, 236604 (2015).

[4] R. Seoane Souto, R. Avriller, R. C. Monreal, A. Martin-Rodero and A. Levy Yeyati, Phys. Rev. B 92, 125435 (2015).