Spin and shot noise effects in a one-dimensional quantum dot

Maura Sassetti[1], Alessandro Braggio[1], Rosario Fazio[2], and Bernhard Kramer[3]

[1] *Dipartimento di Fisica, INFM-Lamia, Università di Genova, Genova, Italy*
[2] *Scuola Normale Superiore, NEST-INFM, Pisa, Italy*
[3] *I. Institut für Theoretische Physik, Universität Hamburg, Hamburg, Germany*
sassetti@fisica.unige.it

Spin and shot noise effects are analyzed in the transport through a one-dimensional quantum dot. The quantum dot is formed by two local impurities embedded in a one-dimensional quantum wire [1]. Specifically, it is investigated to what extend the non-Fermi liquid behavior, due to electron correlations, influences the current and the shot noise. It is shown that spin and charge density waves, confined in the island, lead to excitations that are clearly revealed in characteristic features of the non-linear transport properties [2]. The differential conductance reveals distinct spin-, charge-, and spin-charge-peaks that are smeared by the temperature. New informations on correlation effects are obtained evaluating the shot noise and the corresponding Fano factor. Several limiting cases including continuum and discrete energy level distributions in the dot are considered. It is shown that the presence of interactions and correlations drastically change the behavior of the Fano factor with respect to the non-interacting case [3]. The presence of a magnetic field, acting locally only on the excitations in the quantum dot, can induce strong polarization, limited only by temperature effects. For zero temperature, complete polarization, stable against increasing the effective electron-electron interactions, can be achieved. It can be controlled by a gate voltage that can be used to switch of the spin of a single electron. When polarization is not complete, it can be power-law enhanced by electron interactions. It is predicted [3,4] that the above features can be observed in experiments on semiconductor-based quantum dots embedded in quantum wires that are fabricated by using the cleaved-edge overgrowth technique [1], and also in carbon nanotubes.

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