Complementarity of the full counting statistics and waiting time distribution of the electron transport in two coupled quantum dots

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Current fluctuations can give useful information about the underlying mechanism of the mesoscopic transport. There are two approaches to the study of these fluctuations. Full counting statistics (FCS) analyses the number of transferred particles in the given time interval. In an alternative approach, distribution of time delays between subsequent physical events, known as waiting dime distribution (WTD), is studied [1].

In this work we study the current fluctuations in the system of two capacitively coupled quantum dots in the regime of sequential tunneling with strong Coulomb blockade using a Markovian master equation. We show, that FCS and WTD give complementary information about the dynamics of the system. In example, when tunneling rates in one quantum dot depends on the occupation of the other quantum dot, Fano factor and randomness parameter, characterizing respectively the FCS and WTD, becomes unequal, in contrast to the transport in an independent quantum dot. Difference of these coefficients depends on the relative difference of timescales of the quantum dots dynamics – when the dynamics of the second dot is much slower or faster than of the first, it respectively becomes especially significant or vanishes.

Furthermore, we study correlations of subsequent waiting times. These correlations were studied previously for coherent transport in a quantum point contact [2], but not in systems described by a Markovian master equation. We show, that when the transport in one quantum dot is influenced by the other, the dynamics of the part of the system becomes effectively non-Markovian, which leads to non-zero correlations. Magnitude and sign of these correlations provide information about the relative change of tunneling rates due to the interaction with the second dot.

Finally, we show that complementary use of aforementioned quantities for characterizing the current fluctuations in one quantum dot can be used for the analysis of the dynamics of the whole system, including determination of individual tunneling rates. Complementarity of FCS and WTD enables us to achieve this goal without the use of higher cumulants, which can be difficult to measure.

We believe that our results can be relevant to the study of systems of coupled quantum dots, which had been realized experimentally [3], as well as other types of bipartite stochastic systems [4].

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