Waiting time distribution revealing the internal spin dynamics in a double quantum dot

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Current fluctuations can give useful information about the underlying mechanism of mesoscopic transport. The most common approach to the study of current fluctuations is a full counting statistics (FCS) which analyzes the distribution of the number of particles transferred in a given time interval. Alternatively, one may study the distribution of time delays between subsequent physical events known as waiting time distribution (WTD) [1]. Both approaches have been already successfully applied experimentally to the study of internal dynamics of quantum dot systems [2].

One may ask if FCS and WTD are equivalent, or if they can provide a distinct information. This study gives an answer to this question. I analyze WTD and the zero-frequency FCS of unidirectional electron transport through a double quantum dot molecule attached to spin-polarized leads using the quantum master equation. The studied system is similar to the one recently realized experimentally by Fábián *et al.* [3]. It is shown, that in the considered system WTD exhibits a non-trivial dependence on the value of the exchange coupling between dots and the gradient of the applied magnetic field, which reveals the coherent oscillations between the spin states of the molecule. The zero-frequency FCS, on the other hand, is independent of the aforementioned quantities, thus giving no insight into the internal dynamics. The fact, that the used approaches give a nonequivalent information, is associated with the focusing on different timescales – FCS analyzes the long-time behavior of current fluctuations while WTD is sensitive to the short-time one. Importantly, such a nonequivalence of FCS and WTD is possible only when the subsequent waiting times are correlated and therefore the renewal theory, relating FCS and WTD, is not applicable [4].

In conclusion, WTD may provide information about the internal dynamics of the system which are not given by the zero-frequency FCS. This highlights the usefulness of the analysis of the waiting time distribution for the study of transport mechanism in mesoscopic systems.

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