Full Counting Statistics and Superpoissonian Shot Noise in a Magnetic Tunneling Structure

Tomasz Szczepański [1], Vitalii Dugaev [1], Józef Barnaś [2] and Farkhad Aliev [3]

[1] *Department of Physics, Rzeszów University of Technology, al. Powstańców Warszawy 6, 35-959 Rzeszów, Poland*
[2] *Departament of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland*
[3] *Dpto. De Fisica de la Materia Condensada, C-III, Universidad Autonoma de Madrid, 28049, Madrid, Spain*

We consider the problem of electron transport via localized molecular states and the shot noise in organic tunnel junctions. To understand the origin of superpoissonian shot noise in these structures we follow the approach of Ref. [1]. The model is based on tunneling through a two-level (or multi-level) system, like a molecule or quantum dot. Transport through the molecular layer in the junction can be understood as hopping from the source electrode across the barrier to a molecule and hopping through the second barrier to the drain electrode. The model assumes that one of the two levels is well below the Fermi level of the drain electrode, while the second is between the Fermi levels of the source and drain electrodes. One also assumes strong electron correlation at the molecule

Our generalization of approach [1] is related to the spin-dependent tunneling through the molecules in magnetic junctions. Therefore, we introduce different probabilities for tunneling of spin-up and spin-down electrons to the molecule. We also include different probabilities of the tunneling to the lower and upper levels of the molecules. To describe transport in this system we used the formalism of full counting statistics by solving relevant master equation for the probability of the molecule to be in one of possible states.

The generalization of the two level model to the magnetized structures turns out to be crucial for the shot noise. In particular, we found that the Fano factor in this system is superpoissonian and its magnitude can be changed with the variation of the tunneling amplitude. In the particular case of nonmagnetic system and equal tunneling from upper and lower levels we find that Fano factor F=3 is accordance with [1]. We also discuss electron tunneling through a chain of molecules in relatively thick junctions, when energy levels of different molecules are not exactly at the same energy. In this case, the Fano factor is close to the poissonian statistics value F=1.

[1] W. Belzig, Phys. Rev. B **71**, 161301(R) (2005).