Spin-dependent shot noise enhancement in a quantum dot

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Spin-dependent dynamics in the transport through quantum dots can be probed in a measurement of the electron shot noise. The time-dependent correlations of the current fluctuations provide additional information unavailable in a measurement of the time-averaged conductance.

The transfer of charges through quantum dots is correlated in comparison to the stochastic Poisson process of single barrier tunneling. For a single resonant level in the quantum dot shot noise becomes suppressed, while for a multi-level system competition between different transport channels results in an enhanced shot noise power [1]. A dependence of the blockade mechanism on the electron spin [2] can be induced by injecting electrons from spin-polarized leads [3]. This spin blockade effect has been observed for a quantum dot in magnetic field as a modulation of the Coulomb blockade peak amplitude or in the occurrence of negative differential conductance [3].

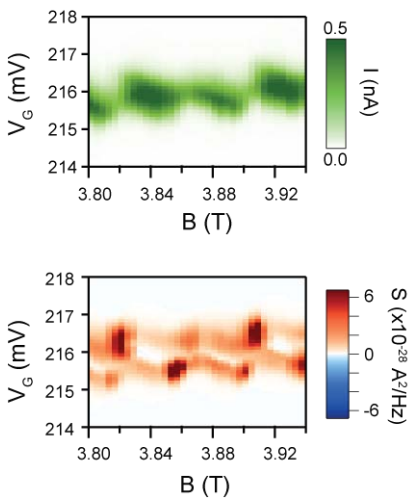

Fig. 1: Current and excess shot noise for a quantum dot in the spin blockade regime.

We present our measurements of the electron shot noise for a quantum dot in the spin blockade regime, where we observe super-Poissonian shot noise at the Coulomb blockade peak. The shot noise enhancement follows a regular pattern corresponding to the position and amplitude modulation of the Coulomb blockade peak in magnetic field. The complex internal level structure [4] of the quantum dot in this regime implies a dynamical blockade as the mechanism behind the observed enhancement. The periodic occurrence of peaks in the shot noise corresponds well to the alternating spin configuration of the quantum dot level system and is explained by the competition of transport channels with different spin giving rise to spin-dependent transport dynamics.

[1] O. Zarchin, Y. C. Chung, M. Heiblum, D. Rohrlich, and V. Umansky, Phys. Rev. Lett. **98**, 066801 (2007).
[2] A. Cottet, W. Belzig, and C. Bruder, Phys. Rev. B **70**, 115315 (2004).
[3] M. Ciorga, A. S. Sachrajda, P. Hawrylak, C. Gould, P. Zawadzki, S. Jullian, Y. Feng, and Z. Wasilewski, Phys. Rev. B **61**, R16315 (2000), M. Ciorga, M. Pioro-Ladriere, P. Zawadzki, P. Hawrylak, and A. S. Sachrajda, Applied Physics Letters **80**, 2177 (2002).
[4] M. C. Rogge, E. Räsänen, and R. J. Haug, Phys. Rev. Lett. **105**, 046802 (2010).