TT 37 Transport - Fluctuations and Noise

Zeit: Mittwoch 10:15–12:15 Raum: TU H3027

TT 37.1 Mi 10:15 TU H3027

High-frequency shot noise measurement of a quantum point contact — •Udo Hartmann[1], Franck Balestro[2], Eugen Onac[2], Laurens W. van Beveren[2], Ronald Hanson[2], Yuli V. Nazarov[2], and Leo P. Kouwenhoven[2] — [1]Physics Department and CeNS, Ludwig-Maximilians-Universität München, Theresienstr. 37, 80333 München, Germany — [2]Kavli Institute of Nanoscience Delft and ERATO Mesoscopic Correlation Project, Delft University of Technology, PO Box 5046, 2600 GA Delft, The Netherlands

We present an experimental realisation of a quantum dot (QD) high-frequency noise detector that measures the current shot noise produced by a nearby quantum point contact (QPC) by means of noise-assisted tunnelling. We investigate the dependence of the detector signal on the voltage across the QPC and on the QPC transmissions which is consistent with previous low-frequency measurements [1,2]. We observe and explain the saturation and quantum features in the detector signal.

[1] Y. P. Li, *et al.*, Appl. Phys. Lett. **57**, 774 (1990).
[2] A. Kumar *et al.*, Phys. Rev. Lett. **76**, 2778 (1996).

TT 37.2 Mi 10:30 TU H3027

Statistics of Current Fluctuations and Coulomb Interaction in Diffusive Conductors — •Dmitry Bagrets — Institut für Theoretische Festkörperphysik, Universität Karlsruhe, 76128 Karlsruhe.

I evaluate the full current statistics (FCS) in the low dimensional (1D and 2D) diffusive conductors in the incoherent regime, $eV \gg 1/\tau_D$, τ_D being the diffusion time through the conductor[1]. It is shown that Coulomb interaction substantially enhances the probability of big current fluctuations for short conductors with $\tau_D \ll \tau_E$, τ_E being the voltage dependent energy relaxation time, leading to the exponential tails in the current distribution. These tails arise from the huge fluctuations of the current of electron-hole pairs which are excited by the low frequency classical fluctuations of the electromagnetic field in the system. The current fluctuations are most strong for temperatures below $1/\tau_D$, provided $\tau_D \sim \tau^*(V)$, where the time scale $\tau^*(V)$ is parametrically smaller than the energy relaxation time $\tau_E(V)$. Remarkably, the time $\tau^*(V)$ transforms to the decoherence time $\tau_\varphi(T)$, known from the theory of weak localization[2], if one substitutes voltage for the temperature.

[1] D. A. Bagrets, cond-mat/0406483, to appear in Phys. Rev. Lett.
[2] B.L. Altshuler, A.G. Aronov and D.E. Khmelnitsky, J.Phys. C **15** 7367 (1982)

TT 37.3 Mi 10:45 TU H3027

Super-Poissonian Noise in Complex Quantum Dots — •Wolfgang Belzig — Department of Physics and Astronomy, University of Basel, Klingelbergstr. 82, 4056 Basel, Schweiz

We examine the full counting statistics of quantum dots, which display super-Poissonian zero-frequency shot noise. By an extension to a generic situation with many excited states we identify the underlying transport process. The statistics allows to clearly identify the bunching-processes which leads to the enahnced noise. The obtained results could be useful to determine transport characteristics in molecules and large quantum dots, since the noise (an higher cumulants) allow to identify the internal level structure, which does not show up in the average current.

TT 37.4 Mi 11:00 TU H3027

Tunneling through coupled quantum dots - Dephasing and Counting Statistics — •Gerold Kiesslich[1], Peter Samuelsson[2], Andreas Wacker[2], and Eckehard Schöll[1] — [1]Institut für Theoretische Physik, TU Berlin, Hardenbergstr. 36, 10623 Berlin — [2]Dept. of Physics, University of Lund, Box 118, SE-22100 Lund, Sweden

The electronic transport through two coupled quantum dots (QDs) in series can be described either in a fully coherent approach (e.g. density matrix description) or in a simple sequential tunneling treatment (Pauli master equation with Fermi's Golden rule for coupling between the QDs). It turns out that both descriptions provide the same average current for noninteracting QDs [1]. In contrast, the zero-frequency spectral power density is different for intermediate coupling strengths between the QDs reflecting its sensitivity on coherence in the tunneling process. In a phenomenological escape model we study the influence of the transition between the sequential and coherent limit on the current fluctuations. In particular, the counting statistics is obtained by means of a stochastic path-integral method [2]. The noise and the skewness are discussed in detail with respect to decoherence in the tunneling process.

[1] H. Sprekeler, G. Kießlich, A. Wacker, and E. Schöll. Phys. Rev. **B**, 125328, (2004)
[2] S. Pilgram, A.N. Jordan, A.V. Sukhorukov, and M. Büttiker. Phys. Rev. Lett. **90**, 206801 (2003)

TT 37.5 Mi 11:15 TU H3027

Correlations in noisy Landau-Zener transitions — •Stefan Scheidl[1] and Valery L. Pokrovsky[2,3] — [1]Institut für Theoretische Physik, Universität zu Köln — [2]Department of Physics, Texas A&M University, College station — [3]Landau Institute for Theoretical Physics, Chernogolovka

We analyze the influence of colored classical Gaussian noise on Landau-Zener transitions during a two-level crossing in a time-dependent regular external field [1]. Transition probabilities and coherence factors become random due to the noise. We calculate their two-time correlation functions, which describe the response of this two-level system to a weak external pulse signal. The spectrum and intensity of the magnetic response are derived. Although the noise enters the equation of motion for the Bloch vector in a multiplicative way, non-perturbative analytic results are obtained by a resummation of diagrams in the limit of a short noise correlation time. Our results also cover regimes where fluctuations are of the same order of magnitude as averages.

[1] V.L. Pokrovsky and S. Scheidl, Phys. Rev. B 70, 014416 (2004)

TT 37.6 Mi 11:30 TU H3027

Shot noise in AC-driven nanoscale conductors — •Sigmund Kohler, Michael Strass, Jörg Lehmann, Sébastien Camalet und Peter Hänggi — Institut für Physik, Universität Augsburg, 86135 Augsburg

An ac drving force can significantly modify the electron transport through nanoscale conductors. Some paradigmatic effects in such systems are the current enhancement by resonant driving, the induction of a ratchet or pump current, and the suppression of the DC current by the purely coherent influence of the driving field [1,2]—their experimental observability depends crucially on whether the current flows at a tolerant noise level. For the investigation of the current noise in the mentioned situations, we employ a Floquet theory for periodically time-dependent coherent conductors which provides both the current and its noise properties. If the driving frequency is either large or close to a resonance, the time-dependent transport setup can be approximated by a static effective system which consists of a renormalized conductor Hamiltonian and an effective distribution function for the lead electrons. The analytical results are tested against an exact numerical solution.

[1] S. Camalet, S. Kohler, P. Hänggi, Phys. Rev. B **70**, 155326 (2004)
[2] S. Kohler, J. Lehmann, and P. Hänggi, submitted to Phys. Rep.; cond-mat/0409251.

TT 37.7 Mi 11:45 TU H3027

Shot noise in tunneling transport through molecules and coupled quantum dots — •Jasmin Aghassi[1,2], Axel Thielmann[1], Matthias Hettler[1], and Gerd Schön[1,2] — [1]Forschungszentrum Karlsruhe, Institut für Nanotechnologie, Postfach 3640, 76021 Karlsruhe — [2]Universität Karlsruhe, Institut für Theoretische Festkörperphysik

We consider charge transport through a nanoscopic object such as single molecules or coupled quantum dots, that is weakly coupled to metallic electrodes. We explicitly account for the electronic interactions and the resulting many-body states of the molecule/quantum dots, and allow for relaxation of the excited states. The current-voltage characteristics as well as the current noise are calculated within first-order perturbation expansion in the coupling strengths. For the case of a semi-quantitative model of benzene we predict negative-differential-conductance accompanied with super-poissonian noise. For a series coupled quantum dots, we analyze the shot noise in the various regimes of transport depending on the inter-dot coupling and participating many-body states.

TT 37.8 Mi 12:00 TU H3027

Schwingungseigenschaften und Wärmeleitfähigkeit ungeordneter Festkörper — •Walter Schirmacher — Physik-Department E13, TU München, 85747 Garching