TT 3: TR: Fluctuations and Noise

Time: Monday 10:15–11:45 Location: H20

TT 3.1 Mon 10:15 H20

Interactions, Coherence, and Multistability in Transport Statistics of coupled Quantum Dots — Gernot Schaller, •Gerold Kiesslich, and Tobias Brandes — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin

We present a novel generalized coarse-graining n-resolved master equation technique [1]. By introducing a virtual detector counting the number of transferred electrons in single-electron transport the coherences and the Lamb shift can be conveniently included. For illustration, we consider transport through interacting levels that are either serially or parallely coupled to two leads. We show for the parallel setup that the coherences can lead to strong current suppression, giant Fano factors and bistable transport statistics. In the serial case a finite coarse graining time can resolve the shortcomings of the Born-Markov-secular approximation such as unphysical currents.

[1] G. Schaller, G. Kießlich, and T. Brandes, in press, Phys. Rev. B, arXiv:0908.3620

TT 3.2 Mon 10:30 H20

Spin-induced charge correlations in transport through interacting quantum dots with ferromagnetic leads — •Stephan Lindebaum, Daniel Urban und Jürgen König — Theoretische Physik, Universität Duisburg-Essen and CeNIDE, 47048 Duisburg, Germany

We study the full counting statistics of electronic transport through a single-level quantum dot weakly coupled to two leads, with either one or both of them being ferromagnetic[1]. Starting from a generalized master equation we use a diagrammatic real-time theory to calculate the cumulant generating function to first order in the tunnel-coupling strength. In both considered systems, we find that the interplay of Coulomb interaction and finite spin polarization implies spin-correlation induced charge correlations that give rise to super-Poissonian transport behavior. In the case of two ferromagnetic leads, we analyze the non-trivial dependence of the cumulants on the angle between the noncollinear polarization directions of the leads. We find even diverging second and higher cumulants for spin polarizations approaching unity. But already the system with one ferromagnetic and one normal lead displays super-Poissonian behavior and, in addition, positive cross correlations between the current fluctuations of the two spin species, if the electrons are injected from the normal electrode.

[1] S. Lindebaum, D. Urban, and J. König, Phys. Rev. B **79**, 245303 (2009).

TT 3.3 Mon 10:45 H20

Calculating Shot Noise based on Numerical Time Evolution of Transport States — •Alexander Branschädel[1] and Peter Schmitteckert[2] — [1]Institut für Theorie der Kondensierten Materie, Karlsruher Institut für Technologie, Karlsruhe, Deutschland — [2]Institut für Nanotechnologie, Karlsruher Institut für Technologie, Karlsruhe, Deutschland

A method to calculate shot noise in one-dimensional systems based on the time evolution of transport states using numerical simulation techniques is presented. We consider the single resonant level model, consisting of a single impurity attached to non-interacting leads, with spinless fermions, where we include nearest neighbour interaction between the impurity site and the leads. The time evolution is obtained either using exact diagonalisation for the non-interacting case or by means of time-dependent Density Matrix Renormalisation Group (td-DMRG) algorithms. We present results for the shot noise for finite bias voltage in the low frequency limit as well as the full frequency dependency and compare with analytical calculations.

TT 3.4 Mon 11:00 H20

Quasiprobability and weak measurement of current noise in a quantum point contact — •Adam Bednorz[1,2] and Wolfgang Belzig[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Deutschland — [2]Institute of Theoretical Physics, University of Warsaw, Hoza 69, 00-681 Warsaw, Poland

The charge flow (counting statistics) through mesoscopic junctions is well described by Bernoulli statistics in the long time (low frequency) limit [1] which follows from a projective detection model. The problem becomes more complicated and interesting, when considering the measurement of noncommuting observables, e.g. current and phase or time-resolved current [2]. The latter case can be resolved in terms of the weak measurement [3]. The idea is similar to the concept of weak values [4]. We show that the outcome of the weak measurement can be interpreted in terms of a quasiprobability. Namely, the total probability distribution of the measured values of observables is a convolution of a large, white, Gaussian detection noise and a quasiprobability (independent of the detector). We show that the quasiprobability can take negative values. The negative quasiprobability can be measured, if the Gaussian noise is subtracted, by a measurement of the fourth cumulant at high frequencies.

[1] G.B. Lesovik and L.S. Levitov, Phys. Rev. Lett. 72, 538 (1994).
[2] W. Belzig and Y.V. Nazarov, Phys. Rev. Lett. 87, 197006 (2001).
[3] A. Bednorz and W. Belzig, Phys. Rev. Lett. 101, 206803 (2008).
[4] Y. Aharonov, D.Z. Albert and L. Vaidman, Phys. Rev. Lett. 60, 1351 (1988).

TT 3.5 Mon 11:15 H20

Noise conductance of carbon nanotube transistors — Julien Chaste[1], Emiliano Pallecchi[1], Pascal Morfin[1], Gwendal Fève[1], Takis Kontos[1], Jean-Marc Berroir[1], Pertti Hakonen[2], and •Bernard Plaçais[1] — [1]Ecole Normale Superieure, Laboratoire Pierre Aigrain, 24 rue Lhomond 75005 Paris, France — [2]Helsinki University of Technology, Low Temperature laboratory, Espoo, Finland

The presentation deals with radio-frequency noise and transmission measurements of high-gain single wall carbon nanotube transistors at cryogenic temperatures [1]. The gate capacitance, drain conductance, transconductance and current-noise are analyzed by relying on a ballistic 1-dimensional scattering model whose parameter is the channel quantum capacitance that controls gate coupling. At 4 Kelvin, current and noise are thermally activated. The bias-dependent electronic temperature can be measured from the gate voltage dependence of transconductance. A "noise conductance" can be then deduced which is found to obey a simple law as function of drain conductance and transconductance as predicted by the 1D model. Finally we estimate the charge resolution of nanotube devices for applications as fast single-shot electron detectors.

[1] J. Chaste, E. Pallecchi, P. Morfin, G. Fève, T. Kontos, J.-M. Berroir, P. Hakonen, B. Plaçais, submitted (2009).

TT 3.6 Mon 11:30 H20

Inelastic noise spectroscopy in molecular junctions with multiple electronic states — •Federica Haupt[1], Tomas Novotny[2], and Wolfgang Belzig[1] — [1]Department of Physics, Konstanz University, Konstanz, Germany — [2]Department of Condensed Matter Physics, Charles University, Prague, Czech Republic

Inelastic transport spectroscopy and shot noise measurements are essential investigation tools in the field of molecular electronics. In fact, while the first allows to extract information on the presence and the orientation of a molecule in a junction, the latter can be used to analyze its individual conductance channels. So far noise measurements have been limited to the elastic transport regime, but more information is expected to be provided by inelastic noise spectroscopy.

In this work we investigate the effects due to inelastic phonon scattering on the current noise in molecular junctions with multiple electronic states. This case is particularly interesting because electron-phonon interaction may results in an effective coupling of different electronic states. Using the extended Keldysh-Green's function formalism we derive a general expression for the zero frequency noise in the case of weak electron-phonon coupling. We compare this result to the case in which transport is dominated by a single electronic state. Finally, we apply our theory to an experimentally relevant set-up.