TT 21: Transport: Fluctuations and Noise

Time: Tuesday 14:00–16:15 Location: HSZ 304

Invited Talk TT 21.1 Tue 14:00 HSZ 304

Correlated charge detection in quantum dots — •Klaus Ensslin — ETH Zurich, Switzerland

Quantum point contacts placed close to quantum dots can be used as charge detectors with time resolution. This way it is possible to measure the statistics of charge transport through quantum structures or the interference of individual electrons. If the quantum dot or double dot is probed by two charge detectors the detector signals may be correlated or anti-correlated depending on the locations between which a single electron is transported. This allows to fully characterize the tunneling processes of electrons in a double dot systems. For quantum dots tuned off resonance this method allows to also measure co-tunneling rates. These experiments are performed in standard n-type AlGaAs heterostructures, but also in p-type material, InAs nanowire quantum dots as well as in graphene quantum structures.

TT 21.2 Tue 14:30 HSZ 304

Electron counting with a two-particle emitter — •Janine Splettstoesser[1], Sveta Ol'khovskaya[2], Michael Moskalets[1,2], and Markus Büttiker[1] — [1]Département de Physique Théorique, Université de Genève, CH-1211 Genève, Switzerland — [2]Department of Metal and Semiconductor Physics, NTU "Kharkiv Polytechnic Institute", 61002 Kharkiv, Ukraine

Recently an on-demand coherent single-electron source has been realized experimentally giving the possibility of initializing quantum states for, e.g., electronic quantum information. However, a suitable setup for high-speed single-electron detection is still missing. We consider two driven cavities (capacitors) connected in series via an edge state. The cavities are driven such that they emit an electron and a hole in each cycle. Depending on the phase lag the second cavity can effectively absorb the carriers emitted by the first cavity and nullify the total current or the set-up can be made to work as a two-particle emitter. We examine the precision with which the current can be nullified and with which the second cavity effectively counts the particles emitted by the first one.

TT 21.3 Tue 14:45 HSZ 304

Control of the conductance and noise of driven carbon-based Fabry-Perot devices — •Luis E. F. Foa Torres and Gianaurelio Cuniberti — Institute for Materials Science and Max Bergmann Center of Biomaterials, Dresden University of Technology, D-01062 Dresden, Germany.

Here we report on the suppression and revival of the Fabry-Perot conductance interference pattern through a carbon-based three terminal device [1]. By using Green functions techniques in the Floquet replica space as our general framework, we show that control of the interference pattern can be achieved by tuning the ac field strength and frequency. For frequencies matching integer multiples of the level spacing of the system a manifestation of the wagon-wheel effect in the quantum domain takes place as the conductance remains irresponsive to the external field. When this condition is not satisfied, tuning the intensity of the ac gating induces an alternation of suppression and partial revival of the conductance interference pattern. In contrast, the phase sensitive current noise behaves as in the static case only when the frequency is commensurate with twice the mean level spacing. This scenario is tested for the case of carbon nanotubes, where the scaling properties of noise with tube radius and length are also explored.

[1] L. E. F. Foa Torres and G. Cuniberti, arxiv: 0807.4953.

15 min. break.

TT 21.4 Tue 15:15 HSZ 304

Tunable dynamical channel blockade in double-dot Aharonov-Bohm interferometers — •Daniel Urban and Jürgen König — Unversität Duisburg-Essen and CeNIDE

We study electronic transport through an Aharonov-Bohm interferometer with single-level quantum dots embedded in the two arms. The full counting statistics in the shot-noise regime is calculated to first order in the tunnel-coupling strength. The interplay of interference and charging energy in the dots leads to a dynamical channel blockade, resulting in enhanced cumulants. This effect is tunable by the magnetic flux penetrating the Aharonov-Bohm ring.

The origin of the blockade lies in the decoupling of the double dot's Hilbert space into two subspaces, one containing the singlet and one containing the three triplet states: Consequent filling of an empty dot with two electrons from the source results in the singlet state, i.e. the triplet can only be reached by tunneling out to the drain. Since the subspaces differ in their transport properties, this leads to super-Poissonian noise. When the flux assumes integer multiples of the flux quantum, tunneling out is suppressed, so that the subspaces decouple and the second and higher cumulants diverge.

[1] D. Urban and J. König, arXiv:0811.4723

TT 21.5 Tue 15:30 HSZ 304

Phonon assisted noise in molecular junctions — •Federica Haupt[1], Tomas Novotny[2], and Wolfgang Belzig[1] — [1]Fachbereich Physik, Universität Konstanz, D-78457 Konstanz, Germany — [2]Department of Condensed Matter Physics, Charles University, Ke Karlovu 5, CZ-121 16 Praha 2, Czech Republic

Effects due to electron-phonon scattering in molecular junctions are relevant not only because they ultimately affect the characteristics and the stability of the device, but also because they can be used to extract information on the junction itself. In particular, inelastic transport spectroscopy is an important investigation tool for atomic- and molecular devices, and more information is expected to be provided by noise measurements.

In this work we investigate the effects of phonon scattering on the current noise through nanojunctions. Using the extended Keldysh-Green's function formalism we derive an expression for cumulant generating function in the case of weak electron-phonon coupling. We present analytic results for the case of a single broad level and identify, both in the inelastic current and in the noise, physically distinct contributions based on their voltage dependence. We apply our theory to an experimentally relevant set-up [1] and predict the inelastic contribution to current noise in the presence of phonon heating effects.

[1] R. H. M. Smit, Y. Noat, C. Untied, N.D. Lang, M.C. van Hemert, and J.M. van Ruitenbeek, Nature 419, 906 (2002).

TT 21.6 Tue 15:45 HSZ 304

Time-Resolved Counting Statistics for a Quantum Point Contact — •Adam Bednorz[1,2] and Wolfgang Belzig[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [2]Institute of Theoretical Physics, University of Warsaw, Hoza 69, 00-681 Warsaw, Poland

We show that the naive formulation of time-resolved full counting statistics fails for high frequencies and leads to results, which could be interpreted as negative probabilities. We propose to construct a properly time-ordered positive-operator-valued measure, that combines counting statistics with detector backaction parametrized by a characteristic time τ [1]. The standard counting statistics is recovered in long time limit. In high frequency limit, for a weak coupling between the system and detector, the generating functional of counting statistics gains an additional Gaussian white noise component, that saves the positivity of the probability. It agrees with experiments since otherwise at strong coupling the noise measurements would be considerably modified due to the detector backaction. Finally, we also show that with more than one detector these nonclassical correlations can be directly measured.

[1] A. Bednorz and W. Belzig, Phys. Rev. Lett. **101**, 206803 (2008).

TT 21.7 Tue 16:00 HSZ 304

Electron counting statics in transport through double quantum dots — •Clive Emary[1], David Marcos[2], Ramon Aguado[2], and Tobias Brandes[1] — [1]Institut für Theor. Physik, TU Berlin — [2]Departamento de Teoria de la Materia Condensada, CSIC, Madrid

The double quantum dot is an important paradigm of quantum transport, representing a quantum two level system (qubit) connected to leads. We present several new aspects of the transport through a double quantum dot in the Coulomb blockade regime. On the one hand we discuss finite-frequency full counting statistics of the transport electrons and investigate the visibility of coherent effects at finite temperatures and bias; on the other, we study the effects of higher-order electron tunneling process usually neglected in standard treatments.