TT 12: Transport: Nanoelectronics I - Quantum Dots, Wires, Point Contacts 2

Time: Monday 15:00–16:30 Location: BH 334

TT 12.1 Mon 15:00 BH 334

Mesoscopic Stoner instability in metallic nanoparticles revealed by shot noise — •Björn Sothmann[1], Jürgen König[2], and Yuval Gefen[3] — [1]Département de Physique Théorique, Université de Genève — [2]Theoretische Physik, Universität Duisburg-Essen — [3]Dept. of Condensed Matter Physics, Weizmann Institute of Science

The interplay between discrete level spacing and exchange interactions of electron spins in metallic nanoparticles leads to the so called mesoscopic Stoner instability. The nanoparticle becomes partially polarized and its spin depends on the ratio of exchange coupling and level spacing.

We study sequential tunneling through a metallic nanoparticle close to the Stoner instability coupled to parallely magnetized electrodes. Transport channels associated with the excitations of the nanoparticle's total spin open up when increasing the bias voltage. This leads to a steplike increase of the current. The Fano factor, in contrast, shows oscillations between large super-Poissonian and sub-Poissonian values as a function of voltage. We explain the enhanced Fano factor in terms of generalized random-telegraph noise and propose the shot noise as a convenient and robust tool to probe the mesoscopic Stoner instability.
[1] B. Sothmann, J. König, Y. Gefen, arXiv:1110.2589v2.

TT 12.2 Mon 15:15 BH 334

Nanotransformation and current fluctuations in exciton-condensate junctions — •Henning Soller and Andreas Komnik — Institut für Theoretische Physik, Ruprecht-Karls-Universität Heidelberg, D-69120 Heidelberg

We analyse the transport properties of a bilayer exciton condensate that is contacted by four metallic leads. Using a generic model for the exciton condensate we derive the exact full counting statistics, which allows for the calculation of the nonlinear current-voltage characteristics as well as noise and cross correlations. Despite some similarities to other contacted condensates such as superconductors several features specifically show the properties of the correlated electron-hole exciton states. In particular these can be exploited when contacting the exciton condensate to another mesoscopic system (in our case a quantum point contact) which allows for transforming current on the nanoscale.

TT 12.3 Mon 15:30 BH 334

Dynamic production of entanglement in spin blockade quantum dots — •Rafael Sánchez and Gloria Platero — Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC)

Double quantum dots connected in series to source and drain electronic reservoirs can be tuned to show current suppression due to Pauli exclusion principle [1]. This effect is known as spin blockade. Driving the system with time dependent magnetic fields allows the coherent manipulation of the two electron states. Single spin rotations removes Pauli correlations and restitutes the flow of current [2,3]. Analyzing the current spectrum as a function of the driving frequency, we find dark resonances where spin blockade is restored due to collective rotations of the two spins. Furthermore, for such frequencies the system evolves towards a maximally entangled stationary state [4]. There, Rabi oscillations of two positive parity Bell states are robust for weak coupling to the reservoirs at low enough temperatures. We investigate the influence of the magnetic field polarization.
[1] K. Ono, D.G. Austing, Y. Tokura, S. Tarucha, Science 297, 1313 (2002).
[2] F.H.L. Koppens, C. Buizert, K. J. Tielrooij, I. T. Vink, K. C. Nowack, T. Meunier, L. P. Kouwenhoven, L. M. K. Vandersypen, Nature 442, 766 (2006).
[3] R. Sánchez, C. López-Monís, G. Platero, Phys. Rev. B 77, 165312 (2008).
[4] R. Sánchez, G. Platero, in preparation

TT 12.4 Mon 15:45 BH 334

DMRG study of transport in quantum dots out of equilibrium — •Elena Canovi, Alexander Moreno, and Alejandro Muramatsu — Institut fuer Theoretische Physik III, Pfaffenwaldring 57, 70550 Stuttgart

We study electrical transport in quantum dots (QD) out of equilibrium by means of the Density Matrix Renormalization Group (DMRG). This method allows to go beyond linear response theory, i.e. to deal with a finite bias, and to handle large interactions. We concentrate on charge fluctuations in QDs and study the interacting resonant level model (IRLM) which describes spinless fermions. The quantum dots are connected to two fermionic reservoirs, modeled as tight-binding chains. We first study the one-impurity case. We benchmark the correctness of our code against known results for the I-V characteristics, study particle-hole symmetry breaking interactions and the case of generic fillings. We then switch to the case of two impurities, for which we show some new results.

TT 12.5 Mon 16:00 BH 334

Zero-temperature non-linear quantum transport through quantum dots: real-time renormalization-group (RT-RG) calculation of dI/dV stability diagrams — •Roman Saptsov[1,2], Maarten Wegewijs[1,2,3], and Herbert Schoeller[2,3] — [1]Peter Gruenberg Institut, Forschungszentrum Juelich, 52425 Juelich, Germany — [2]JARA- Fundamentals of Future Information Technology — [3]Institute for Theory of Statistical Physics, RWTH Aachen, 52056 Aachen, Germany

The recently developed RT-RG approach was applied to study the non-linear transport through a quantum dot described by the Anderson impurity model. The RT-RG equations were solved numerically including both 1- and 2- loop orders in the limit of zero temperature and non-linear transport voltages where most standard theoretical methods break down. We predict non-perturbative tunneling effects in the transport stability diagram which can be measured experimentally. Moreover, we found the exact functional form of the renormalized spectra of the dot at any loop order. In the non-interacting case we show that the RT-RG recovers the exact solution within our 2 loop approach. In the strong-interacting limit the method breaks down as expected only at very small voltages on the order of the Kondo temperature, which we illustrate by comparison with the Friedel sum rule.

TT 12.6 Mon 16:15 BH 334

Tunneling renormalization of carbon nanotubes cotunneling spectroscopy — •Gediminas Kirsanskas, Karsten Flensberg, and Jens Paaske — Niels Bohr Institute, University of Copenhagen, DK-2100 Copenhagen Ø, Denmark

We examine the effects of cotunneling threshold renormalization due to the tunneling in carbon nanotube quantum dots in Coulomb blockade regime. It is shown that tunneling can induce gate dependant splitting of fourfold degenerate levels. This results in gate dependant g-factor. We also find that asymmetric tunneling couplings introduce the asymmetry between the positive and negative bias cotunneling thresholds.