TT 22 Transport - Nanoelectronics II: Quantum Dots and Wires, Point Contacts

Zeit: Montag 14:00–17:30 Raum: TU H2053

TT 22.1 Mo 14:00 TU H2053

Elektron-Elektron Wechselwirkung in nanostrukturierten, ferromagnetischen Leiterbahnen unterschiedlicher Dimension — •Mario Brands, Axel Carl und Günter Dumpich — Fachbereich Physik, Experimentalphysik, AG Farle, Universität Duisburg-Essen (Campus Duisburg), Lotharstr. 1, 47048 Duisburg

Es wurden Magnetowiderstandsmessungen an einzelnen, nanostrukturierten Kobalt-Leiterbahnen bei tiefen Temperaturen durchgeführt. Die Leiterbahnen wurden zum Schutz vor Oxidation in-situ mit isolierendem Kohlenstoff abgedeckt. Die Kontaktierung erfolgt über nichtmagnetische Gold- bzw. Platinkontaktpads unter Zuhilfenahme eines aufwendigen Drei-Schritt-Elektronenstrahllithografie-Prozesses. Der Magnetowiderstand der Leiterbahnen kann, für beliebig orientierte Magnetfelder, mit Hilfe des AMR-Effektes erklärt werden. Hingegen zeigt sich in der Temperaturabhängigkeit des Widerstandes ein logarithmischer Beitrag aufgrund von erhöhter Elektron-Elektron-Wechselwirkung. Durch Reduzierung der Leiterbahnbreite kann ein Übergang von zweidimensionalem zu eindimensionalem Verhalten beobachtet werden. Beiträge aufgrund von schwacher Lokalisierung werden nicht beobachtet. Die Arbeit wird gefördert von der DFG im Rahmen des SFB 491.

TT 22.2 Mo 14:15 TU H2053

Giant super-poissonian Fano factors in shuttle devices — •Andrea Donarini[1,2], Tomaš Novotný[2], Christian Flindt[2], and Antti-Pekka Jauho[2] — [1]Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany — [2]MIC - Department of Micro and Nanotechnology,Technical University of Denmark

Shuttle devices are a particular kind of NEMS characterized by a nanometer scale oscillating quantum dot that transfers electrons one-by-one from the source to the drain lead. We study the dynamics of an archetypal model device in the density matrix formalism and represent the numerical results by means of phase space distribution (Wigner function), current and current noise (Fano factor). The device presents tunnelling and shuttling as limiting operating regimes for respectively high and low mechanical damping conditions. In the transition region between the tunnelling and shuttling regime the system is characterized by a giant super-poissonian Fano factor ($F \approx 100$).

This feature is the signature of a coexistence regime: i.e. a slow switching dichotomous process between the tunnelling and the shuttling current modes. For this regime we propose a simplified description in terms of a bistable effective potential. This description captures the main features of the coexistence regime (confirmed by the quantitative agreement with the numerical results) and gives also a more transparent physical insight of the device dynamics.

TT 22.3 Mo 14:30 TU H2053

Quantized Conductance in Atomic-Scale Point Contacts Formed by Local Electrochemical Deposition of Silver — •Stefan Brendelberger[1], Christian Obermair[1], Robert Kniese[1], Fangqing Xie[1], and Thomas Schimmel[1,2] — [1]Institute for Applied Physics, University of Karlsruhe, D-76128 Karlsruhe, Germany — [2]Institute of Nanotechnology, Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany

We report on conductance quantization at room temperature in atomic-scale silver point contacts electrochemically fabricated within a nanoscale gap between two gold electrodes on a glass substrate. The formation of stable contacts exhibiting quantized conductance at integer multiples of the conductance quantum $G_0 = 2e^2/h\,(\approx 1/12.9k\Omega)$ was observed. While transient contacts with other conductance values were also found, a clear preference for values close to integer multiples of G_0 was observed for contacts stable for up to several hours. When applying electrochemical deposition or dissolution potentials, sharp transitions were induced between different quantized conductance levels while between these transitions, horizontal plateaus of constant conductance were found.

[1] Ch. Obermair et al. In: A. S. Alexandrov et al. (eds.) Molecular Nanowires and Other Quantum Objects, NATO Science Series II, Kluwer, Dordrecht, The Netherlands, 233-242, 2004.

[2] F.-Q. Xie, L. Nittler, Ch. Obermair and Th. Schimmel, Phys. Rev. Lett. 93, 128303 (2004).

TT 22.4 Mo 14:45 TU H2053

Conduction Channels of One-Atom Zinc Contacts — •Michael Häfner[1], Patrick Konrad[2], Fabian Pauly[1], Juan-Carlos Cuevas[1,3], and Elke Scheer[2] — [1]Institut für Theoretische Festkörperphysik, Universität Karlsruhe, 76128 Karlsruhe, Germany — [2]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [3]Departamento de Física Teórica de la Materia Condensada C-V, Universidad Autónoma de Madrid, 28049 Madrid, Spain

We have determined the transmission coefficients of atomic-sized Zn contacts using a new type of breakjunction which contains a whisker as a central bridge. We find that in the last conductance plateau the transport is unexpectedly dominated by a well-transmitting single conduction channel. We explain the experimental findings with the help of a tight-binding model which shows that in an one-atom Zn contact the current proceeds through the $4s$ and $4p$ orbitals of the central atom.

TT 22.5 Mo 15:00 TU H2053

Transport properties of single channel quantum wires with an impurity: Influence of finite length and temperature on average current and noise — •Fabrizio Dolcini[1], Björn Trauzettel[2], Inès Safi[3], and Hermann Grabert[1] — [1]Albert-Ludwigs-Universität, Freiburg — [2]Leiden University, The Netherlands — [3]Université Paris-Sud, France

The inhomogeneous Tomonaga Luttinger liquid model describing an interacting quantum wire adiabatically coupled to non-interacting leads is analyzed in the presence of a weak impurity within the wire. Due to strong electronic correlations in the wire, the effects of impurity backscattering, finite bias, finite temperature, and finite length lead to characteristic non-monotonic parameter dependencies of the average current [1]. We discuss oscillations of the non-linear current voltage characteristics that arise due to reflections of plasmon modes at the impurity and quasi Andreev reflections at the contacts. The finite frequency current noise is also investigated in detail. We find that the effective charge extracted in the shot noise regime in the weak backscattering limit depends on the noise frequency ω relative to v_F/gL, where v_F is the Fermi velocity, g the Tomonaga Luttinger interaction parameter, and L the length of the wire [2]. The excess noise is finite even for frequencies larger than the applied voltage, which is a signature of correlation effects.

[1] F. Dolcini, H. Grabert, I. Safi, and B. Trauzettel, Phys. Rev. Lett. **91**, 266402 (2003).

[2] B. Trauzettel, I. Safi, F. Dolcini, and H. Grabert, Phys. Rev. Lett. **92**, 226405 (2004).

TT 22.6 Mo 15:15 TU H2053

Co-tunneling current and shot noise in quantum dots and molecules — •Axel Thielmann[1], Matthias H. Hettler[1], Jürgen König[2] und Gerd Schön[1,3] — [1]Forschungszentrum Karlsruhe, Institut für Nanotechnologie,76021 Karlsruhe, Germany — [2]Institut für Theoretische Physik III, Ruhr-Universität Bochum, 44780 Bochum, Germany — [3]Institut für Theoretische Festkörperphysik , Universität Karlsruhe, 76128 Karlsruhe, Germany

We study current and shot noise up to second-order perturbation theory in the coupling of a mesoscopic object (e.g. quantum dot or molecule) to metallic electrodes. In particular, we discuss the influence of co-tunneling processes for the Anderson-impurity model with finite spin splitting. We show that spin-flip co-tunneling leads to a super-Poissonian Fano factor at a different energy scale than expected from first-order calculations. Furthermore, we find the Fano factor in the Coulomb-blockade regime to be very sensitive to the tunnel-coupling strength, which may serve as a spectroscopic tool for the latter.

TT 22.7 Mo 15:30 TU H2053

Anomalous conductance of a spin-1 quantum dot — •Anna Posazhennikova[1] and Piers Coleman[2] — [1]TKM, Univarsitaet Karlsruhe, 76128, Germany — [2]Center for Materials Theory, Rutgers University, Piscataway, NJ 08855, USA

We interpret the recent observation of a zero-bias anomaly in spin-1 quantum dots in terms of an underscreened Kondo effect. Although a spin-1 quantum dots are expected to undergo a two-stage quenching effect, in practice the log normal distribution of Kondo temperatures leads to a broad temperature region dominated by underscreened Kondo