TT 20 Transport: Nanoelectronics I - Quantum Dots, Wires, Point Contacts - Part 2

Time: Tuesday 14:00–16:00 Room: HSZ 105

Invited Talk

TT 20.1 Tue 14:00 HSZ 105

Theory of inelastic scattering from magnetic impurities — •Gergely Zarand[1,2], Laszlo Borda[1], Natan Andrei[3], and Jan von Delft[4] — [1]Budapest Univ. of Technology and Economics, Ungarn — [2]Institut für Theoretische Festkörperphysik, Universität Karlsruhe — [3]Rutgers University — [4]LM Universität München

Inelastic processes play a crucial role in mesoscopic structures, where these processes destroy quantum interference effects. Recent experiments on quantum wires seem to support that much of these inelastic processes originate from magnetic impurities. Here we provide a framework that - at least at $T = 0$ temperature - allows one to give a precise definition for the inelastic scattering rate and we show how this can be obtained for general quantum impurity models. As an example, we compute the full energy dependence of the inelastic scattering rate for the single channel Kondo problem using the non-perturbative machinery of numerical renormalization group. In contrast to naive expectations, we find a broad plateau of almost constant inelastic scattering rate for energies above the Kondo temperature, $E > T_K$, and a quasi-linear behavior below T_K, which crosses over to the expected Fermi liquid behavior, $\sigma_{\rm inel}(E) \sim E^2/T_K$ only at very small energies. This behavior compares well with recent experimental observations.

TT 20.2 Tue 14:30 HSZ 105

A comment on the universality of transmission distribution of a diffusive conductor — •Mihajlo Vanevic[1] and Wolfgang Belzig[2] — [1]Department of Physics and Astronomy, University of Basel, Switzerland — [2]Department of Physics, University of Konstanz, Germany

We find the distribution of transmission eigenvalues in a series of identical junctions between chaotic cavities using the circuit theory of mesoscopic transport. We show that this distribution rapidly approaches the diffusive limit as the number of junctions increases, independent of the specific scattering properties of a single junction. We obtain the cumulant generating function and the first three cumulants of the charge transfer through the system both in the normal and superconducting case.

TT 20.3 Tue 14:45 HSZ 105

Non-Equilibrium Dynamics in Donor-Bridge-Acceptor Systems: A time dependent Numerical Renormalization Group Study — •Sabine Tornow[1], Ralf Bulla[1], and Frithjof Anders[2] — [1]Theoretische Physik III, Elektronische Korrelationen und — [2]Institut für Theoretische Physik

We investigate the relaxation dynamics of multiple electrons in a donor-bridge-acceptor system (DBA) with a coupling of the electronic degrees of freedom to a common bosonic bath. The model allows to study many-particle effects and the influence of the local and non-local Coulomb interactions. Non-perturbative methods are needed to calculate the non-equilbrium and equilibrium properties in the full parameter space. We are using the time dependent Numerical Renormalization Group to calculate transfer rates. Furthermore we discuss the possibility of many-particle (bipolaronic) and Coulomb-assisted transfer. .

TT 20.4 Tue 15:00 HSZ 105

Linear response conductance of strongly interacting nanostructures using DMRG — •Dan Bohr[1,2], Peter Schmitteckert[2], and Peter Wölfle[2] — [1]MIC, Department of Micro and Nanotechnology, Technical University of Denmark — [2]TKM, Institut für Theorie der Kondensierten Materie, Universität Karlsruhe

In this contribution we present a novel approach for the calculation of transport properties of strongly correlated systems: a direct evaluation of the Kubo expression for the linear conductance by using the states and operator expectation values computed with the Density Matrix Renormalization Group (DMRG). Two different correlation functions are used to evaluate the conductance. The electrons are treated as one-dimensional spinless fermions, and the interactions are confined to a finite line segment which couples to two tight-binding leads. The developed method is benchmarked against the non-interacting limit, where the conductance can be calculated either by Green's functions or by exact diagonalization. In the interacting case we present DMRG data for an extended nanostructure either in the Luttinger liquid regime or in the charge density wave regime. Finally we analyze the strongly interacting conductance using a simple model of hard-core particles on a reduced size lattice and emphasize the difference compared to an effective charging model.

TT 20.5 Tue 15:15 HSZ 105

Differential Conductance using Real-Time Dynamics in DMRG — •Peter Schmitteckert and Günter Schneider — Institut für Theorie der Kondensierten Materie, Universität Karlsruhe, Germany

In this work we apply the Real-Time Density-Matrix-Renormalization Group Method (RT-DMRG) to calculate the differential conductance of an interacting nano-structure attached to one-dimensional, non-interacting leads. We first discuss our approach to extract the differential conductance. We then explain the difficulties arising from finite size effects, and how they can be addressed. Finally, we present results for the linear conductance vs. an applied gate voltage and the non-equilibrium differential conductance vs. source-drain voltage for weakly and strongly interacting nano-structures.

TT 20.6 Tue 15:30 HSZ 105

Fano interference and Kondo correlations in the non-linear regime of simple mesoscopic models. — •Alexandru Aldea, Viorel Dinu, and Mugurel Tolea — National Institute of Materials Physics, Bucharest-Magurele, Romania

The Fano effect in mesoscopic systems consists in the asymmetric shape of electron transmittance peaks due to the interference of electron waves propagating along channels with strongly different properties. The tunneling process is additionally affected by the Kondo-type correlation between the spin of the dot and the spin of the incoming electron. The consequences of correlations can be noticed in the local density of states and in changes of the shape of Fano lines. This effect is known as the Fano-Kondo effect and combines the main ingredients of meso-systems: the geometry and interaction . In this work we analyze simple models like the T-shape and triangle model in order to identify specific contributions of the interaction and geometry for the transport properties in the linear and non-linear regime; the triangle model allows also for the magnetic field effects. We calculate the local DoS and conductance in a large range of relevant parameters by the use of the tight-binding Hamiltonian description [1] and non-equilibrium Green function formalism. The equation of motion method is used along with [2].

[1] V.Moldoveanu, M.Tolea, A.Aldea, and B.Tanatar, Phys. Rev. B **71**, 125338 (2005).
[2] O.Entin-Wohlman et al, Phys. Rev. B **71**, 035333 (2005).

TT 20.7 Tue 15:45 HSZ 105

Transport in disordered quantum wires: the global phase diagram — •Thomas Nattermann[1], Michael Fogler[2], and Sergey Malinin[3] — [1]Institut für Theoretische Physik der Universität zu Köln — [2]Department of Physics, UCSD, USA — [3]Department of Chemistry, Wayne State Univ. Detroit, USA

We calculate the tunnel current in a Luttinger liquid with a finite density of strong impurities using using a combined RG and instanton approach. For very low temperatures T (or electric fields E) the (nonlinear) conductivity is of variable range hopping type as for weak pinning. Rare events - usually important in one dimensions - result in logarithmic corrections. For higher fields but low T the conductivity shows power law behavior corresponding to a crossover from multi- to single-impurity (Kane-Fisher) tunneling. For higher T and small fields rare events lead to a number of new results for the conductivity. The discussion of the the various cross-overs in the T-E plane as well as a function of the pinning strength allow a complete determination of the various relevant regimes, including previously found isolated results.