TT 34 Correlated Electrons - Quantum Impurities, Kondo Physics

Zeit: Mittwoch 09:45–11:15 Raum: TU H104

TT 34.1 Mi 09:45 TU H104

Frequency-dependent transport through a quantum dot in the Kondo regime — •Michael Sindel[1], Walter Hofstetter[2], Jan von Delft[1], and Markus Kindermann[3] — [1]Physics Department and Center for NanoScience, LMU München, 80333 München — [2]Institut für Theoretische Physik A, RWTH Aachen, 52056 Aachen — [3]Department of Physics, Massachusetts Institute of Technology, Cambridge MA 02139, USA

Motivated by experiments of Kogan et al. [1] we study the AC conductance and equilibrium current fluctuations of a Coulomb blockaded quantum dot in the Kondo regime. To this end we apply the nonperturbative numerical renormalization group method in combination with the Kubo formalism [2] suitable for the nonperturbative calculation of finite-frequency transport properties. For frequencies smaller than the charge excitation energy $\min\{|\epsilon_d|, |U+\epsilon_d|\}$ we derive a formula for the frequency dependent current by extending [3]. This formula enables us to relate the spectral function with the linear AC conductance and the frequency-dependent equilibrium current fluctuations, respectively. We demonstrate that AC transport provides a new route to measuring the *equilibrium* spectral density (a key signature of Kondo physics) which so far has defied direct experimental observation.

[1] A. Kogan, S. Amasha, and M.A. Kastner, Science 304, 1293 (2004).
[2] W. Izumida, O. Sakai, and Y. Shimizu, J. Phys. Soc. Jpn. 66, 717 (1997).
[3] A.-P. Jauho, N.S. Wingreen and Y. Meir, Phys. Rev. B 50, 5528 (1994).

TT 34.2 Mi 10:00 TU H104

Non-equilibrium Transport and Approximate Conductance Quantization in Multi-level Quantum Dot Systems — •S. Kirchner[1], J. Kroha[2], and P. Wölfle[3] — [1]Rice University — [2]Universität Bonn — [3]Universität Karlsruhe

Nanoconstrictions or quantum dots with several local levels or channels contributing to the conductance are prototypical systems for numerous quantum point contact devices, markedly for transport through single atoms, molecules or carbon nanotubes, many of them showing the tendency to conductance quantization. We discuss that for several local levels the lead-dot coupling matrix Γ_{nm} is, by principle, not left-right symmetric. As a consequence, within a generalized Landauer-Büttiker approach the conductance is determined by both, the local density of states and the local distribution functions, even in the linear response regime, thus drawing the connection to the Kubo formula. We consider the case of strong Coulomb correlations $U \gg |\Gamma_{nm}|$ within the quantum point contact. While for a single transmission channel the Friedel sum rule strictly enforces quantization of the zero-temperature linear conductance, we show that for several levels there are systematical deviations due to the appearance of multiple Kondo-like resonances near the Fermi level. For the case of two transmission channels, relevant for carbon nanotubes, we give an analytical conductance formula and present results of numerical calculations for the general case both in and out of equilibrium.

TT 34.3 Mi 10:15 TU H104

Spectral Properties and Spin Correlations in the 1D Kondo Box: a DMRG Study — •Th. Hand, J. Kroha, and H. Monien — Universität Bonn

For more than 20 years it has been a mystery why the spin-spin coupling between magnetic impurities embedded in a metal is in general short-ranged, despite the exponentially large spin coherence length $\xi_K = v_F/T_K$ induced by the impurity in the electron sea, with T_K the Kondo temperature and $v_F = \hbar k_F/m$ the Fermi velocity. Only recently it has been found by general physical arguments [1] and by perturbative calculations [2] that the relevant length scale is $\ell = (\pi \xi_K / k_F^{d-1})^{1/d}$, i.e. $\ell \ll \xi_K$ in dimensions $d \geq 2$. This suggests that in $d = 1$ quantum wires long-range coupling between magnetic impurities can be achieved. In the present work we check this expectation by numerically exact density matrix renormalization group (DMRG) calculations, suitable for nanoscopic wires with discrete energy spectrum. Good quantitative agreement with the analytical predictions is found, including powerlaw behavior of the spin correlations for distance $r < \ell$. We correlate the spin structure with Kondo features in the impurity spectrum and analyze their dependence on the parity of the electron number in the system (even/odd effect). The results may be relevant for recent experiments on carbon nanotubes and double quantum dot systems in the Kondo regime coupled through a bath with discrete spectrum.

[1] W. Thimm, J. Kroha, J. v. Delft, PRL **82**, 2143 (1999).
[2] I. Affleck, P. Simon, PRL **86**, 2854 (2001); P. Simon, I. Affleck, PRB **68** 115304 (2003).

TT 34.4 Mi 10:30 TU H104

Structure of Quantum Critical Points in Impurity Models — •Hyun-Jung Lee[1], Ralf Bulla[1], and Ning-Hua Tong[2] — [1]Theoretische Physik III, Universität Augsburg — [2]Institut für Theorie der Kondensierten Materie, Universität Karlsruhe

The numerical renormalization group method is used to investigate zero temperature phase transitions in single-impurity models, where an impurity couples to a non-trivial fermionic bath (Pseudogap Anderson model) or to a (sub)ohmic bosonic bath (Spin-Boson Model). In both cases, zero temperature phase transitions occur between two different phases whose fixed points can be built up of non-interacting single-particle states. These trivial phases are separated by lines of quantum critical points. The structure of these quantum critical points can be understood close to certain values of the bath exponents which turn out to play the role of upper and lower critical dimensions. A complete description of the quantum critical many-particle spectra is achieved using suitable marginal operators.

TT 34.5 Mi 10:45 TU H104

Bosonic Kondo effect of a magnetic impurity in a deconfined magnet — •Lars Fritz[1], Serge Florens[1], Matthias Vojta[1], and Kedar Damle[2] — [1]Institut für Theorie der Kondensierten Materie, Universität Karlsruhe,76128 Karlsruhe — [2]Department of Theoretical Physics, Tata Institute of Fundamental Research, Mumbai, India

Recent works have proposed the occurrence of deconfined $s = \frac{1}{2}$ gapless bosonic degrees of freedom at the quantum critical point separating the Neel state from the valence-bond phase in some two-dimensional quantum antiferromagnets. We propose to couple such systems to a single magnetic impurity. We find within a large-N approach a quenching of the extra moment, which provides a bosonic analog to the Kondo effect in metals. This behavior is in strong contrast to the known Curie susceptibility shown in usual confining critical points, and could serve as a probe for deconfinement in critical antiferromagnets.

TT 34.6 Mi 11:00 TU H104

Quantum two-particle problem in finite systems — •B. Schmidt[1], K. Morawetz[1,2], M. Schreiber[1], A. Ficker[1], and P. Lipavský[3] — [1]Istitute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Max-Planck-Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany — [3]Institute of Physics, Academy of Sciences, Cukrovarnická 10, 16200 Praha 6, Czech Republic

The correlated two-particle problem is solved analytically in the presence of a finite cavity. The method is demonstrated here in terms of exactly solvable models for both the cavity as well as the two-particle correlation where the two-particle potential is chosen in separable form. The two-particle phase shift is calculated and compared to the single-particle one. We find a Fano resonance behavior due to the interference of single- and two-particle channels. The two-particle bound state behavior is discussed and the influence of the cavity on the binding properties is calculated.

[1] K. Morawetz, M. Schreiber, B. Schmidt, A. Ficker, P. Lipavský, Phys. Rev. B submitted, cond-mat/0409325