TT 53: Quantum Impurities and Kondo Physics

Time: Wednesday 9:30–11:15 Location: HFT-FT 131

TT 53.1 Wed 9:30 HFT-FT 131

Quench dynamics in correlated quantum dots coupled to ferromagnetic leads — •Kacper Wrześniewski and Ireneusz Weymann — Faculty of Physics, Adam Mickiewicz University, Poznan, Poland.

We investigate the quantum quench dynamics in the single impurity Anderson model with ferromagnetic leads. The real-time evolution at finite temperatures is calculated by means of the time-dependent numerical renormalization group method in the matrix product states framework. In order to suppress the band discretization effects, we use the z-averaging trick and apply an appropriate broadening of data in collected frequency space, which is then Fourier-transformed to the real-time domain.

We study the system's response to two different types of quantum quenches: The first one relies on a sudden shift of the dot's energy level, while the second one is performed in the coupling strength to the leads. We analyze the charge and spin dynamics by calculating the time-dependent expectation values of local variables, such as the impurity's occupation number and its magnetization. We determine the time-dependence of a ferromagnetic-contact-induced exchange field and predict its nonmonotonic build-up. The influence of temperature and quench magnitude on the considered dynamics is also thoroughly discussed.

TT 53.2 Wed 9:45 HFT-FT 131

A pseudogap Anderson impurity model as a continuum limit of a generalized integrable Hubbard model — •Yahya Öz and Andreas Klümper — Bergische Universität Wuppertal

Starting from the integrable Hubbard model by use of Shastry's R-matrix we add an impurity on the lattice. Furthermore, we modify the dispersion relation and hence the density of states of the host characteristic for a pseudogap system. For the thermodynamics of this lattice model we derive a finite set of non-linear integral equations (NLIE) of convolution type. Applying a suitable continuum limit to this integrable lattice model we obtain a pseudogap Anderson impurity model (pAIM). This AIM has vanishing density of states at the Fermi energy with a tunable exponent ($\rho \simeq |\epsilon|^r$). In this way, the new integrable lattice impurity model with interacting host interacting with an impurity yields a new impurity model in the continuum with a non-interacting host that still interacts with the impurity. We describe the screening of the impurity moment. The Hamiltonian of the new pseudogap Anderson impurity model is explicitly specified.

TT 53.3 Wed 10:00 HFT-FT 131

The role of impurities in model correlated fermionic systems — •Banhi Chatterjee[1,2], Jan Skolimowski[1,3], and Krzysztof Byczuk[1] — [1]Institute of Theoretical Physics, Warsaw University, Warsaw, Poland — [2]Institute of Physics, Czech Academy of Sciences, Prague, Czech Republic — [3]Jozef Stefan Institute, Ljubljana, Slovenia

The role of impurities and resulting Friedel Oscillations (FO) in the Fermi liquid phase, Mott insulating phase, and at the Mott transition is studied in fermionic lattice models at zero temperature. We consider the case of two impurities which is aimed to simulate the effect of defects and dopants in real lattices. A comparative picture with the single impurity case is also presented. Electronic correlations are accounted for by including the local self-energy term from the homogeneous dynamical mean-field theory calculations. Interference effects due to the additional impurity on FO is seen which reduces with the interaction and also the relative distance between the impurities. The position of interference maxima and minima are not changed by the interactions. In the metallic phase the amplitudes of FO are damped with increasing the interactions while the period remains unchanged at half-filling. FO almost disappear close to the Mott transition and completely beyond it in all the cases. The screening effects, quantified by the screening charge are discussed. The effects of interference on the spectral functions are also shown.

TT 53.4 Wed 10:15 HFT-FT 131

Numerical Renormalization Group study of Gate Induced Kondo Screening in Graphene — •Daniel May[1], Kira Deltenre[1], Anika Henke[1], Jinhai Mao[2], Yuhang Jiang[2], Po-Wei Lo[3,4], Guohong Li[2], Guang-Yu Guo[3,4], Frithjof Anders[1], and Eva Y. Andrei[2] — [1]Technische Universität Dortmund, Lehrstuhl für Theoretische Physik II, Germany — [2]Rutgers University, Department of Physics and Astronomy, USA — [3]National Taiwan University, Department of Physics, Taiwan — [4]National Center for Theoretical Sciences, Physics Division, Taiwan

Graphene in its pristine form has transformed our understanding of 2D electron systems leading to fundamental discoveries. When graphene's honeycomb lattice is disrupted by single atom vacancies a gate voltage dependent Kondo effect may emerge. We present numerical renormalization group (NRG) calculations for a realistic two-orbital model consisting of a local σ orbital and a localized π orbital induced by the vacancy. Depending on the graphene curvature in the vicinity of the vacancy, we determine three different regimes. The re-entrance regime is characterized by a conventional Kondo effect (p doping), a breakdown of the Kondo peak close to the Dirac point $|\mu| \to 0$, and a underscreened Kondo (n doping) where the π band is screening the magnetic moment of the σ orbital. Changing the hybridization between impurity and band drives the system into a regime where Kondo screening is present for either strong n or p doping.

TT 53.5 Wed 10:30 HFT-FT 131

Restoring the Varma-Jones quantum critical point in absence of local particle-hole symmetry — •Fabian Eickhoff[1], Benedikt Lechtenberg[2], and Frithjof Anders[1] — [1]Technische Universität Dortmund, Lehrstuhl für Theoretische Physik II, 44227 Dortmund — [2]Department of Physics, Kyoto University, Kyoto 606-8502, Japan

The quantum critical point (QCP) in two impurity model established by Varma and Jones marks the transition between an RKKY driven impurity singlet and a extended Kondo singlet and is generically destroyed by particle-hole symmetry breaking. We derive an effective low energy description for the two-impurity Anderson model and extract the marginal relevant operator that drives the system away from the QCP. By adding an additional electron tunneling term with an analytically calculated strength, we prove the restoration of the Varma-Jones QCP using Wilson's numerical renormalization group approach. We show that the antiferromagnetic contribution to the RKKY interaction is given by an analytic function of this hopping amplitude. We analyse the strength and directionality of the RKKY interaction in different spatial dimensions.

TT 53.6 Wed 10:45 HFT-FT 131

Dimensional crossover in molecular Kondo systems — •Marcin Raczkowski and Fakher Assaad — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany

Advances in scanning tunneling microscopy allow nowadays for the atomically precise engineering of Kondo nanosystems ranging from a single impurity to lattice Kondo situations with a dominant Ruderman-Kittel-Kasuya-Yoshida (RKKY) interaction between the individual magnetic atoms. Here, starting with a single magnetic impurity deposited on the metallic surface, we perform auxiliary-field quantum Monte Carlo simulations of the Kondo lattice model and elucidate necessary conditions for the emergence of the Kondo lattice behavior in a nanosystem composed of a few magnetic atoms only.

TT 53.7 Wed 11:00 HFT-FT 131

Two-stage Kondo effect in the presence of induced pairing in T-shaped double quantum dots — •Krzysztof Wójcik[1,2] and Ireneusz Weymann[2] — [1]Institute of Physics, Polish Academy of Sciences, 60-197 Poznań, Poland — [2]Faculty of Physics, Adam Mickiewicz University, 61-614 Poznań, Poland

In this contribution the transport properties of a T-shaped double quantum dot (QD) proximized by a superconductor (SC) are discussed. In particular, the linear response conductance and the Seebeck coefficient, calculated by means of the numerical renormalization group method, are analyzed. In the absence of SC and for relatively small inter-dot hopping matrix element, the two-stage Kondo screening is known to be present in the system [1]. We show that, generally, the effects of coupling of only one QD to SC may be qualitatively understood as a consequence of effective reduction of the Coulomb interactions. In particular, the dependence of the Kondo temperature corresponding to

the two-stage Kondo screening on the coupling to SC lead is explained in this way. Similarly, one can describe the quantum phase transition between the Kondo-like state and the state characterized by the local density of states dominated by the Andreev bound states. However, the coupling of both QDs to SC results in creation and destruction of nonlocal pairs, which tends to additionally enhance the formation of total Kondo singlet. The consequences for transport properties in such a scenario are discussed.

[1] P. S. Cornaglia, D. R. Grempel, Phys. Rev. B **71**, 075305 (2005).