TT 31: Low-dimensional Systems - Models I

Time: Thursday 17:45–19:15 Location: H19

TT 31.1 Thu 17:45 H19

Spectral broadening due to long-range Coulomb interactions in the molecular metal TTF-TCNQ — •Erik Koch[1], Andreas Dolfen[1], Laura Cano-Cortés[2], Jaime Merino[2], Jörg Behler[3], Karsten Reuter[3], and Bernard Delley[4] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich — [2]Universidad Autónona de Madrid — [3]Fritz-Haber-Institut, Berlin — [4]Paul-Scherrer-Institut, Villigen

We employ density-functional theory to calculate realistic parameters for an extended Hubbard model of the molecular metal TTF-TCNQ. Considering both intra- and intermolecular screening in the crystal, we find that longer-range Coulomb interactions along the molecular stacks, as well as inter-stack coupling are of importance. Contrary to past belief, these terms do not lead to the formation of a Wigner lattice, but simply broaden the spectral function. We show how this can be understood already in perturbation theory. Moreover we calculate the effect of the nearest neighbor repulsion on the Luttinger parameter.

TT 31.2 Thu 18:00 H19

Indirect forces between impurities in one-dimensional quantum liquids — •Peter Wächter, Volker Meden, and Kurt Schönhammer — Institut für Theoretische Physik, Universität Göttingen, Göttingen, Germany

We investigate the indirect interaction between two isolated impurities in a Luttinger liquid modeled by a microscopic lattice model. To treat the electron-electron interaction U the functional renormalization group method is used. For comparison we also study the $U = 0$ case. For all U and generic values of the strength of the impurities we find that the impurity interaction as a function of their separation r oscillates between being attractive and repulsive. For $U = 0$ the amplitude of the interaction energy decays as $1/r$. For $U > 0$ the decay for small separations is governed by a U dependent exponent larger than -1, which crosses over to -1 for large r. The crossover scale depends on the impurity strength and U. We briefly comment on the case of attractive interaction $U < 0$ and the relation between the sign changes of the impurity interaction and transport resonances. In the special case of half-filling and for $U \geq 0$ we find that by fine tuning the impurity parameters one can create a situation in which the impurity interaction becomes purely attractive.

TT 31.3 Thu 18:15 H19

Temperature dependence of Coulomb drag between finite-length quantum wires — •Joël Peguiron, Björn Trauzettel, and Christoph Bruder — Department of Physics and Astronomy, University of Basel,Klingelbergstrasse 82, 4056 Basel, Switzerland

We evaluate the Coulomb drag current in two finite-length Tomonaga-Luttinger wires coupled by an electrostatic backscattering interaction. The drag current in one wire shows oscillations as a function of the drive voltage applied to the other wire, reflecting interferences of the plasmon standing waves in the interacting wires. In agreement with this picture, the amplitude of the current oscillations is reduced with increasing temperature. This is a clear signature of non-Fermi liquid physics because for coupled Fermi liquids the drag resistance is always expected to increase as the temperature is raised.

TT 31.4 Thu 18:30 H19

Correlated electrons with spin-orbit coupling in quantum dots and quantum wires — •Jens Eiko Birkholz and Volker Meden — Institut für Theoretische Physik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

We use the functional renormalization group to investigate correlated electrons with spin-orbit coupling, represented by Rashba and Dresselhaus terms, in quantum dots and quantum wires. The interacting system is connected to semi-infinite leads which are considered to be interaction-free. Such setups are of interest as spin-filters in spintronics applications. As a measure for the electron transport through the dot and wire, we focus on the spin-dependent linear-response conductance. The interplay of electronic correlations and spin-orbit coupling leads to interesting physics.

TT 31.5 Thu 18:45 H19

Probing anomalous longitudinal fluctuations of the interacting Bose gas via Bose-Einstein condensation of magnons — •Andreas Kreisel, Nils Hasselmann, and Peter Kopietz — Institut für Theoretische Physik, Universität Frankfurt, Max-von-Laue Strasse 1, 60438 Frankfurt, Germany

The emergence of a finite staggered magnetization in quantum Heisenberg antiferromagnets subject to a uniform magnetic field can be viewed as Bose-Einstein condensation of magnons. Using non-perturbative results for the infrared behavior of the interacting Bose gas[1], we present exact results for the staggered spin-spin correlation functions of quantum antiferromagnets in a magnetic field at zero temperature. In particular, we show that in dimensions $1 < D \leq 3$ the longitudinal dynamic structure factor $S_{\parallel}(\vec{q}, \omega)$ describing staggered spin fluctuations in the direction of the staggered magnetization exhibits a critical continuum, whose weight can be controlled experimentally by varying the magnetic field [2].

[1] F. Pistolesi, C. Castellani, C. Di Castro, and G. C. Strinati, Phys. Rev. B **69**, 024513 (2004)

[2] Andreas Kreisel, Nils Hasselmann and P. Kopietz, cond-mat/0610575

TT 31.6 Thu 19:00 H19

Cluster approach to magnetic excitations in high-T_c superconductors — •Sascha Brehm[1], Enrico Arrigoni[2], Michael Potthoff[1], Markus Aichhorn[1], and Werner Hanke[1] — [1]Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany — [2]Institut für Theoretische Physik, Technische Universität Graz, Petersgasse 16, A-8010 Graz, Austria

A new scheme is presented for calculating two-particle spin and charge response functions within symmetry-broken, e.g. antiferromagnetic (AF) and d-wave superconducting (dSC), phases. The scheme is based on the variational cluster approach (VCA). Normal and anomalous one-particle Green's functions of the two-dimensional Hubbard model in the thermodynamical limit are obtained from variationally optimized self-energies of finite clusters with up to 10 sites. At zero temperature, a band Lanczos algorithm is used for the cluster diagonalization. Analogous to the one-particle level, the magnetic and charge susceptibilities are then derived from the frequency-dependent two-particle vertex of the isolated cluster. Results are presented for the AF half-filled case, for the underdoped system with microscopically coexisting AF and dSC order as well as for the paramagnetic dSC phase at optimal doping. Characteristic features of the filling-dependent magnetic excitation spectrum (collective modes as well as continuum) are worked out for normal state and AF/dSC symmetry-broken phases.