TT 52: CE: Low-dimensional Systems - Models 1

Time: Thursday 14:00–16:15 Location: HSZ 105

TT 52.1 Thu 14:00 HSZ 105

Spectral functions with the DMRG in frequency space — •Piet Dargel and Thomas Pruschke — Institut für theoretische Physik, Universität Göttingen, Deutschland

Standard methods for calculating spectral functions with the DMRG in frequency space have to include an artificial broadening (Correction vector) or will have bad resolution for low energies (Fourier transform of TDMRG data). We use an adaptive Lanczos method to calculate iteratively the coefficients of the continued fraction expansion of the spectral function. We show that the spectral weights and poles for the discrete system can be extracted by this method and compare this method to other DMRG methods for calculating spectral functions in frequency space.

TT 52.2 Thu 14:15 HSZ 105

Disordered groundstate phase for 2D-lattice models of hard-core bosons — •Ansgar Kalz, Andreas Honecker, Sebastian Fuchs, and Thomas Pruschke — Institut für Theoretische Physik, Universität Göttingen

We present Quantum Monte-Carlo data for frustrated models on 2D-lattices. The spin-1/2-Heisenberg model with antiferromagnetic S^z-interaction and ferromagnetic interactions in the x-y–plane can be rewritten as model of hard-core bosons with repulsive density-interactions. Longer-range interactions, i.e., next-nearest neighbor interactions introduce frustration for the square lattice as well as for the hexagonal lattice. Depending on the strength of the frustration we find different classical groundstates which are seperated by a critical point. The frustration yields a large degeneracy that hinders the classical ordering process in the vicinity of the critical point.

For the square lattice with nearest neighbor and competing next-nearest neighbor interactions we calculated magnetic observables and higher-order correlation functions. We show finite temperature phase diagrams and the groundstate phase diagram where we identified a finite region without any order.

On the honeycomb lattice we included interactions up to third nearest neighbors and find a similar scenario as for the frustrated square lattice. In the vicinity of the ciritical point of the model we find a region without classical order and present measurements of higher-order correlation functions.

TT 52.3 Thu 14:30 HSZ 105

Ground states with spontaneous breaking of translational symmetry in orthogonal-dimer chain with Ising and Heisenberg bonds — •Vadim Ohanyan[1] and Andreas Honecker[2] — [1]Department of Theoretical Physics, Yerevan State University, Alex Manoogian 1, 0025, Yerevan, Armenia — [2]Institut für Theoretische Physik Universität Göttingen, Friedrich-Hund-Platz 1 37077 Göttingen, Germany

Considering the exactly solvable model of orthogonal-dimer chain with Ising and Heisenberg bond we investigate the issue of vast variety of its ground states, especially ones with spontaneous breaking of translational symmetry. Analyzing ground states properties we obtain several $T = 0$ ground states phase diagrams corresponds to different sets of parameters. We demonstrate the appearance of magnetization plateaus at $M/M_{sat} = 0, 1/4$ which are connected with the breaking of translational symmetry of the lattice, more precisely, with the doubling of unit cell. The general mechanism of unit cell doubling in the lattice models with block structure and left-right asymmetry is discussed. Calculation the partition function exactly we also obtain analytic expressions for free energy and all thermodynamic function, presenting the plots of magnetization processes for finite temperature displaying magnetization plateaus at $M/M_{sat} = 0, 1/4, 1/2$.

TT 52.4 Thu 14:45 HSZ 105

Low-energy spectral weights of the 1D Hubbard chain — •Stefan Söffing[1,3], Imke Schneider[2], Alexander Struck[1], and Sebastian Eggert[1] — [1]Fachbereich Physik und Forschungszentrum Optimas, Technische Universität Kaiserslautern, Deutschland — [2]Universität Dresden, Deutschland — [3]Graduiertenschule MATCOR/MAINZ

We investigate the low-energy spectral weights of the 1D Hubbard chain by means of Density Matrix Renormalization Group (DMRG) calculations in comparison with Bosonization results. We identify the bosonic excitations of the underlying Luttinger liquid and analyze their evolution upon increasing the interaction strength in terms of their density of states (DOS). Comparing analytical and numerical results we point out the competition of spin/charge degrees of freedom vs. non-interacting spin up and down particles, which here become important due to the lattice nature of the model and higher order operators. Furthermore, we discuss the spatially resolved (local) DOS that can be calculated analytically by a recursive formula vs. numerically using DMRG.

15 min. break

TT 52.5 Thu 15:15 HSZ 105

A study of coupled spin-orbital physics in a one-dimensional model — •Alexander Herzog[1,2], Andrzej Michal Oles[1,3], Peter Horsch[1], and Jesko Sirker[2] — [1]Max Planck Institut für Festkörperforschung, Stuttgart, Germany — [2]Department of Physics and Research Center Optimas, University of Kaiserslautern, Kaiserslautern, Germany — [3]Marian Smoluchowski Institute of Physics, Krakow, Poland

We study the dynamics and thermodynamics of a one-dimensional spin-orbital model relevant for transition metal oxides. For antiferromagnetic superexchange we investigate how spin-wave excitations are affected by coupled spin-orbital excitations using a boson-fermion representation. We contrast a mean-field decoupling approach with results obtained by treating the spin-orbital coupling perturbatively. Within the latter approach we find a significant broadening and additional structures in the dynamical spin structure factor caused by the coupling of spin excitations to orbital fluctuations leading to a Kohn anomaly in the spin-wave dispersion. Moreover the spin-orbital coupling induces a redistribution of entropy from low to intermediate temperatures as is confirmed by comparing our perturbative results for the specific heat with a numerical solution of the model obtained by the density-matrix renormalization group.

TT 52.6 Thu 15:30 HSZ 105

Finite-size scaling analysis of the spatially anisotropic frustrated $S = 1/2$ Heisenberg model — •Mohammad Siahatgar, Burkhard Schmidt, and Peter Thalmeier — Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden

We investigate the ground-state properties of the $S = 1/2$ frustrated Heisenberg model on a 2D lattice with orthorhombic symmetry. This model, known as the $J_{1a,b} - J_2$ model, is studied using exact diagonalization technique on finite clusters, as well as introducing a systematic way to construct finite clusters to tile the square lattice. For this low symmetry model, a controlled procedure for the finite-size scaling analysis is defined for the tiles which are compatible with corresponding magnetic phase. We calculate the ground-state energy, structure factors and ordered moment, and compare these numerical results with spin-wave calculations as well. In particular, the finite-size behavior of the system in the disordered regions between ordered ferromagnetic and Néel and columnar antiferromagnetic phases is discussed more carefully. We conclude that the effect of spatial anisotropy $J_{1a,b}$ is stabilizing the columnar antiferromagnetic order for all frustration parameters, notably in the spin-nematic phase of the isotropic model.

TT 52.7 Thu 15:45 HSZ 105

Non-equilibrium effects of open boundary in spin chains — suppression of magnon propagation. — •Masud Haque — Max Planck Institut - Physics of Complex Systems Dresden

In the open XXZ spin chain, I will present boundary-induced structures in the energy spectrum. A dramatic series of dynamics-suppression effects arise due to these spectral structures.

TT 52.8 Thu 16:00 HSZ 105

Energy dynamics out of equilibrium in low dimensional quantum magnets — •Stephan Langer[1], Markus Heyl[1], Ian McCulloch[2], and Fabian Heidrich-Meisner[1] — [1]Physics Department, Arnold Sommerfeld Center for Theoretical Physics, and Center for NanoScience, LMU München, Germany — [2]School of physical Sciences, The University of Queensland, Brisbane, Australia

We investigate the real-time dynamics of the energy density in spin-1/2 chains and ladders, starting from initial states with an inhomogeneous profile of bond energies, extending our previous work on the dynamics of spin-density wave packets [1]. These simulations are carried out using the adaptive time-dependent density matrix renormalization group algorithm. We analyze the time-dependence of the spatial variance of the bond energies which yields necessary criteria for ballistic or diffusive energy dynamics. In the case of the XXZ chain, our results are consistent with ballistic behavior, both in the massless and the massive phase. For the massless regime, we compare our numerical results to predictions from bosonization for, e.g., the velocity that the initial perturbation spreads with. In the case of ladders, we find an involved dynamics whose qualitative interpretation is still under scrutiny.

[1] Langer et al. Phys. Rev. B 79, 214409 (2009)