TT 30: Correlated Electrons: Spin Systems and Itinerant Magnets 2

Time: Thursday 10:30–11:30 Location: EB 202

TT 30.1 Thu 10:30 EB 202

Quantum phases of the anisotropic Shastry-Sutherland model
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We present results from quantum Monte Carlo simulations of the anisotropic spin-1/2 XXZ model on the orthogonal dimer lattice of the Shastry-Sutherland model, in the sign-problem free parameter region with ferromagnetic transverse spin exchange. In this regime, the model also corresponds to a system of repulsive hard-core bosons. In the absence of a magnetic field, we find solid, superfluid and a dimer triplet phase, and study the various quantum phase transitions between these phases. We also study the magnetization process out of the dimer triplet phase and explore the possibility of triplon supersolidity in this system. Implications of our results for the Heisenberg antiferromagnet on the Shastry-Sutherland model and the compound $SrCu_2(BO_3)_2$ are discussed.

TT 30.2 Thu 10:45 EB 202

Topological excitations of correlated spinless fermions: slave boson approach
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We study the general problem of spinless electrons on a periodic lattice, with a nearest neighbor exchange t and a nearest neighbor Coulomb repulsion V. Following the approach of the slave boson approximation, we introduce auxiliary bosons and fermions; a site with one electron corresponds to a site occupied by an auxiliary fermion, and an empty site is represented by a boson. The fermionic degrees of freedom are then formally integrated, providing an effective action for the bosonic field. This effective action is solved analytically in the specific case of a square lattice at half filling in the regime $t \ll V$. The ground state is a charge ordered insulator. We show analytically that in the continuum limit the low energy excitations are collective solitonic excitations. Our results confirm some results which have been previously obtained from numerical simulations [1]. They also provide a systematic analytical scheme which might allow us to describe fractional charge excitations of frustrated electronic systems [2].

[1] P.M.R. Brydon, J.X. Zhu, and A.R. Bishop, cond-mat/0509764
[2] P. Fulde, K. Penc, and N. Shannon, Ann. Phys. (Berlin) 11, 892 (2002)

TT 30.3 Thu 11:00 EB 202

Heisenberg Spin-1 Chains and Ladders with Bilinear-Biquadratic Interactions in a Magnetic Field
— •Salvatore R. Manmana[1], Tamás A. Toth[1], Andreas Läuchli[2], and Frédéric Mila[1] — [1]Institute of Theoretical Physics (CTMC), EPF Lausanne, CH-1015 Lausanne, Switzerland — [2]IRRMA, PPH-Ecublens, CH-1015 Lausanne, Switzerland

We investigate the magnetic properties of Heisenberg spin-1 chain and ladder systems with bilinear-biquadratic interactions in a magnetic field by applying the density matrix renormalization group method (DMRG) and a variational wavefunction ansatz. For the chains, the magnetization and the dominating spin and quadrupolar correlation functions are computed in the various regions of the zero-field phase diagram. In the critical quadrupolar phase ($\pi/4 < \theta < \pi/2$), the magnetization curve is dominated by a pronounced kink at finite values of the field and the magnetization. After giving a sketch of the zero-field phase diagram of the ladder systems, we present results for various sets of parameters, aiming to gain insight into magnetization properties in the presence of frustration.

TT 30.4 Thu 11:15 EB 202

Quantum fluctuations in high field magnetisation of 2D squarelattice J_1-J_2 antiferromagnets (exchanged with TT 8.8)
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The square lattice J_1–J_2 Heisenberg model with spin $S = 1/2$ has three magnetic and two nonmagnetic phases. It describes a number of recently found layered vanadium oxide perovskites. We discuss the magnetisation curve and high-field susceptibility using spin-wave theory and exact diagonalisation in the whole J_1–J_2 plane. We compare both results and find good overall agreement in the sectors of the phase diagram with magnetic order. Close to the nonmagnetic regions the magnetisation curve shows strong deviations from the classical linear behaviour caused by large quantum fluctuations and spin-wave approximation breaks down. On the FM side ($J_1 < 0$) where one approaches the quantum gapless spin nematic ground state this region is surprisingly large. We find that inclusion of second order spin-wave corrections does not lead to fundamental improvement. Quantum corrections to the tilting angle of the ordered moments are also calculated. They may have both signs, contrary to the always negative first order quantum corrections to the magnetisation. Finally we investigate the effect of the interlayer coupling and find that the quasi-2D picture remains valid up to $|J_\perp/J_1| \sim 0.3$.