TT 34: Postersession Matter at Low Temperature: Quantum Liquids, Bose-Einstein Condensates, Ultra-Cold Atoms

Time: Wednesday 14:00–18:00 Location: P1A

TT 34.1 Wed 14:00 P1A

Phase Diagram of a Bosonic Model on a Square Lattice with Competing Interactions — •Ansgar Kalz, Andreas Honecker, Sebastian Fuchs, and Thomas Pruschke — Institut für Theoretische Physik, Georg-August-Universität Göttingen

The analysis of frustrated spin systems reveals a variety of interesting phenomena as for example quantum criticality and ordering processes in exotic phases. The antiferromagnetic spin-1/2-Heisenberg model with nearest and next nearest neighbour interaction J_1 and J_2 shows a strong frustration near the critical point $J_2 \approx J_1/2$. The simulation of this frustrated spin system via Quantum Monte Carlo methods is limited by the sign problem. Therefore we simulated a closely related bosonic model which can be applied to cold atoms in optical lattices. We present phase diagrams for the classical Ising limit and the quantum case at finite and zero temperature.

TT 34.2 Wed 14:00 P1A

Quantum Monte Carlo Simulation of Suprafluidity with Fermions in a Two Dimensional Optical Lattice — •Klaus Ferdinand Albrecht and Alejandro Muramatsu — Institut für Theoretische Physik III, Universität Stuttgart, D-70550 Stuttgart, Germany

Based on a Projector Quantum Monte Carlo Simulation, we examine the ground state properties of the attractive 2D fermionic Hubbard model. The main focus is on the supersolid phase, where in a periodic system it is known that the superfluid phase coexists with a crystalline structure (CDW-phase) at density n=1. We obtain the conditions for such a phase when the system is confined in a harmonic trap. Furthermore, we consider the BCS-BEC crossover region in a periodic system.

TT 34.3 Wed 14:00 P1A

Real-space DMFT for inhomogeneous strongly correlated fermionic systems — •Irakli Titvinidze[1], Michiel Snoek[1], Csaba Toke[1], Krzysztof Byczuk[2], and Walter Hofstetter[1] — [1]Institut für Theoretische Physik, Goethe-Universität, D-60438 Frankfurt, Germany — [2]Institute of Theoretical Physics, Warsaw University, ul. Hoża 69, 00-681 Warszawa, Poland

We introduce the real-space dynamical mean-field theory (R-DMFT) method to describe strongly interacting lattice fermions in the presence of an external, position dependent potential. This method relies only on the assumption that the self-energy is a local quantity, and is exact in infinite dimensions. Using R-DMFT we study an ultracold spin 1/2 fermionic atomic gas in an optical lattice. Using the numerical renormalization group (NRG) as an impurity solver we show that antiferromagnetic order is stable in spatial regions with total particle density close to one, but persists also in parts of the system where the local density significantly deviates from half filling. In systems with spin imbalance, we find that antiferromagnetism is gradually suppressed and phase separation emerges beyond a critical value of the spin imbalance.

TT 34.4 Wed 14:00 P1A

Bosonic Dynamical Mean Field Theory for the Bose-Hubbard model — •Andreas Huberer, Michiel Snoek, and Walter Hofstetter — Institut für Theoretische Physik, J. W. Goethe-Universität, D-60438 Frankfurt, Germany

We study the physics of strongly correlated bosonic particles in optical lattices. The conventional bosonic Gutzwiller approximation, in which the hopping is treated in mean field, is exact in infinite dimensions and qualitatively reproduces the phase diagram. However, it does not include the effect of the hopping of normal particles and underestimates the size of the Mott insulating domains. We therefore take into account the leading 1/z corrections (z being the lattice coordination number) to the Gutzwiller approximation, which corresponds to Bosonic Dynamical Mean Field Theory. We derive the self-consistency relations for the superfluid order parameter and the Green's function. In order to solve them we use Exact Diagonalization as an impurity solver. Using this method we calculate the phase diagram for a single species of bosons at zero and nonzero temperature and calculate corrections to the mean-field results for various quantities. Furthermore we investigate the phase diagram for a mixture of two different spin states with unit filling at both zero and nonzero temperature. We apply this model to the experimental relevant case of a Rubidium-Potassium-mixture.

TT 34.5 Wed 14:00 P1A

Entanglement Dynamics of Ultra-Cold Atoms in Optical Superlattices — •Andreas Wagner, Thomas L. Schmidt, and Christoph Bruder — Universität Basel

We study the dynamics of ultra-cold atoms in optical superlattices and entanglement in such multipartite systems. We investigate and compare different ways to quantify and manipulate entanglement of three to four atoms, which are trapped in such a lattice and form a subsystem of a larger amount of trapped atoms. By manipulating the lattice we get information about the dynamics of entanglement distribution.

TT 34.6 Wed 14:00 P1A

Mean-field dynamics of a non-hermitian Bose-Hubbard dimer — •Astrid Elisa Niederle[1], Hans Jürgen Korsch[2], and Eva Maria Graefe[2] — [1]Theoretical Physics, Saarland University, D-66041 Saarbrücken — [2]FB Physik, TU Kaiserslautern, D-67653 Kaiserslautern

We investigate an N-particle Bose-Hubbard dimer with an additional effective decay term in one of the sites. A mean-field approximation for this non-hermitian many-particle system is derived, based on a coherent state approximation. The resulting nonlinear, non-hermitian two-level dynamics, in particular the fixed point structures showing characteristic modifications of the self trapping transition, are analyzed. The mean-field dynamics is found to be in reasonable agreement with the full many-particle evolution.

TT 34.7 Wed 14:00 P1A

Spectral functions in one-dimensional quantum systems at T>0 — •Thomas Barthel[1], Ulrich Schollwöck[1], and Steve R. White[2] — [1]Institute for Theoretical Physics C, RWTH Aachen — [2]Department of Physics and Astronomy, University of California, Irvine, USA

We demonstrate how a combination of finite-temperature time-dependent density-matrix renormalization-group (t-DMRG) calculations and time-series prediction allows for an easy and very accurate calculation of spectral functions in 1d quantum systems, irrespective of their statistics, for arbitrary temperatures.

This is illustrated with spin structure factors of XX and XXZ spin-1/2 chains where we compare, in the first case, against an exact solution and, in the second case, against Bethe ansatz (BA) at T=0 and Quantum Monte Carlo (QMC) for T>0. [arXiv:0901.2342]