TT 35: Low-Dimensional Systems: 2D - Theory

Time: Tuesday 14:00–15:30 Location: HSZ 304

TT 35.1 Tue 14:00 HSZ 304

Weathervane modes of dipoles on the kagome lattice — •Mykola Maksymenko[1], Roderich Moessner[2], and Kirill Shtengel[3] — [1]Institute for Condensed Matter Physics of NAS of Ukraine, Lviv-79011, Ukraine — [2]Max-Planck-Institut für Physik Komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden, Germany — [3]Department of Physics and Astronomy, University of California at Riverside, Riverside, CA 92521, USA

We investigate the nature of excitations in a narrow spin-wave mode of the Kagome lattice antiferromagnet in the presence of dipolar interactions. While this case is qualitatively different from the nearest-neighbour model and lacks the Heisenberg spin-rotational symmetry, even moderately strong long-range dipolar interactions preserve the narrow mode, which remains dispersionless (flat) to a good approximation.

We provide a microscopic model underpinning this phenomenon and discuss its applicability to other lattices and its stability to additional interactions.

TT 35.2 Tue 14:15 HSZ 304

Competing mass terms in Dirac fermions — •Toshihiro Sato, Martin Hohenadler, and Fakher F. Assaad — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Germany

We numerically study the honeycomb-lattice Hubbard model at half filling coupled to a transverse Ising field. The coupling to the Ising field is such that it favors a Kekule mass term when it orders. This Kekule mass breaks translation symmetry and corresponds to a complex order parameter. The Hubbard interaction favors an antiferromagnetic state characterized by an O(3) order parameter. Using the auxiliary field quantum Monte Carlo method, we are able to map out the phase diagram in the transverse field versus Hubbard U plane so as to investigate the competition between the two aforementioned mass terms.

TT 35.3 Tue 14:30 HSZ 304

Interaction induced gap of magnetic Graphene — •zhenjiu wang and fakher. f. assaad — Institut für Theoretische Physik und Astrophysik , Universität Würzburg, Germany

We investigate the interaction induced ordered state of relativistic Landau Levels by means of unbiased lattice quantum Monte Carlo simulations. The model we consider is a Hubbard hamiltonian on the honeycomb lattice in the presence of an orbital magnetic field and supplemented by a nearest neighbor interaction such that at the classical level charge density wave and spin density wave states are degenerate. Our calculations show that the magnetic field induced flat band is unstable towards magnetic ordering. As one approaches Gross-Neveu quantum criticality the single particle gap shows a crossover behavior from linear to square root scaling as a function of magnetic field.

TT 35.4 Tue 14:45 HSZ 304

Comparison Between the Hybrid and Auxiliary Field Quantum Monte Carlo Algorithms in Condensed Matter — •Stefan Beyl, Florian Goth, and Fakher F. Assaad — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Deutschland

The Hybrid Quantum Monte Carlo (HQMC) is an established and successfully used algorithm in the lattice gauge community. A better scaling and lower memory requirements awake the hope to access larger system sizes than with the auxiliary field methods, which are generically used in condensed matter. We present results of a detailed comparisons between HQMC and auxiliary field Quantum Monte Carlo simulations on the Hubbard model. Furthermore, we show HQMC results for electron phonon simulations.

TT 35.5 Tue 15:00 HSZ 304

Spontaneous particle-hole symmetry breaking of correlated fermions on the Lieb lattice — •Martin Bercx[1], Johannes S. Hofmann[1], Fakher F. Assaad[1], and Thomas C. Lang[1,2] — [1]Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Germany — [2]Institute for Theoretical Physics, University of Innsbruck, Austria

We study spinless fermions with nearest-neighbor repulsive interactions (t-V model) on the two-dimensional three-band Lieb lattice. At half-filling, the free electronic band structure consists of a flat band at zero energy and a single cone with linear dispersion. The flat band is expected to be unstable upon inclusion of electronic correlations, and a natural channel is charge order. However, due to the three-orbital unit cell, commensurate charge order implies an imbalance of electron and hole densities and therefore doping away from half-filling. Our numerical results show that below a finite-temperature Ising transition a charge density wave with one electron and two holes per unit cell and its partner under particle-hole transformation are spontaneously generated. Our calculations are based on recent advances in auxiliary-field and continuous-time quantum Monte Carlo simulations that allow sign-free simulations of spinless fermions at half-filling. It is argued that particle-hole symmetry breaking provides a route to access levels of finite doping, without introducing a sign problem.

TT 35.6 Tue 15:15 HSZ 304

Field Theoretical Aspects of Quantum Hall States — •Christian Tutschku, Jan Böttcher, and Ewelina M. Hankiewicz — Institut für Theoretische Physik und Astronomie, Uni Würzburg, 97074 Würzburg, Germany

In condensed matter physics the family of Quantum-Hall (QH) states is one of the most fascinating examples for macroscopic measurable quantum effects. Moreover, the integer, the fractional, the anomalous and the quantum spin Hall effect are of special interest due to their topological origin [1]. All these effects could be described via 2+1 dimensional gauge theories, including topological Chern-Simons (CS) tensor structures of characteristic level [2]. Even if the bare Lagrangian of a theory does not include a CS term, it could be generated at one loop level via contributions of the vacuum polarization operator [3]. If the bare Lagrangian is invariant under a certain symmetry transformation, the one loop correction may also induce an anomaly, which could be related to nonzero off-diagonal eigenvalues of the conductivity tensor [4]. We analyze the formation of CS terms in quantum field theories, describing the different QH states, and show that these terms characterize their topological invariant, their conductivity tensor and their (fractional) statistics. Moreover, we illustrate that the parity anomaly leads to an anomalous QH current.

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[2] G. V. Dunne, arXiv:hep-th/9902115 (1999)
[3] V. R. Khalilov, Theor. Math. Phys. 125 (2000)
[4] A. N. Redlich, Phys. Rev. D 29, 2366 (1984)