MA 18: Frustrated Magnets - General 2 (joint session TT/MA)

Time: Tuesday 14:00–16:00 Location: Theater

MA 18.1 Tue 14:00 Theater

Strong quantum interactions prevent quasiparticle decay — •Ruben Verresen[1,2], Roderich Moessner[1], and Frank Pollmann[2] — [1]Max-Planck-Institute for the Physics of Complex Systems — [2]Technical University of Munich

Quantum states of matter typically exhibit collective excitations known as quasiparticles. Known to be long-lived at the lowest energies, common wisdom says that quasiparticles become unstable when they encounter the inevitable continuum of many-particle excited states at high energies. Whilst correct for weak interactions, we show that this is far from the whole story: strong interactions generically stabilise quasiparticles by pushing them out of the continuum. This general mechanism is straightforwardly illustrated in an exactly solvable model. Using state-of-the-art numerics, we find it at work also in the spin-1/2 triangular lattice Heisenberg antiferromagnet (TLHAF) near the isotropic point—this is surprising given the common expectation of magnon decay in this paradigmatic frustrated magnet. Turning to existing experimental data, we identify the detailed phenomenology of avoided decay in the TLHAF material Ba3CoSb2O9, and even in liquid helium—one of the earliest instances of quasiparticle decay.

MA 18.2 Tue 14:15 Theater

Spin-1/2 Heisenberg antiferromagnet on the star lattice: Competing valence-bond-solid phases studied by means of tensor networks — •Saeed Jahromi and Roman Orus — Donostia International Physics Center (DIPC) Paseo Manuel de Lardizabal 4 20018 Donostia - San Sebastian (Guipuzkoa), Spain

Using the infinite projected entangled pair states algorithm, we study the ground-state properties of the spin-1/2 quantum Heisenberg antiferromagnet on the star lattice in the thermodynamic limit. By analyzing the ground-state energy of the two inequivalent bonds of the lattice in different unit-cell structures, we identify two competing valence-bond-solid (VBS) phases for different antiferromagnetic Heisenberg exchange couplings. More precisely, we observe (i) a VBS state which respects the full symmetries of the Hamiltonian, and (ii) a resonating VBS state which, in contrast to previous predictions, has a six-site unit-cell order and breaks C3 symmetry. We also studied the ground-state phase diagram by measuring the ground-state fidelity and energy derivatives, and further confirmed the continuous nature of the quantum phase transition in the system. Moreover, an analysis of the isotropic point shows that its ground state is also a VBS as in (i), which is as well in contrast with previous predictions.

MA 18.3 Tue 14:30 Theater

Quantum Monte-Carlo simulation of SU(2N) Spin systems — •Jonas Schwab, Francesco Parisen Toldin, and Fakher F. Assaad — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Germany

We consider the spin-S, SU(2N) Heisenberg model corresponding to the irreducible representation of SU(2N) consisting of a Young tableau of N rows and 2S columns. In the large-S limit the spin wave approximation leads to spin ordering, whereas in the large-N limit a saddle point approximation favors dimerization. We show that this generalized SU(2N) spin model can be solved with sign-problem free determinantal quantum Monte-Carlo methods on any bipartite lattice so that the phase diagram in the S versus N plane can in principle be mapped out.

MA 18.4 Tue 14:45 Theater

Doping a 2d Mott insulator - Study of a quantum dimer model — •Sebastian Huber[1], Fabian Grusdt[2,3], and Matthias Punk[1] — [1]Arnold Sommerfeld Center, Ludwig-Maximilians University, 80333 Munich, Germany — [2]Department of Physics, Harvard University, Cambridge, MA 02138, USA — [3]Department of Physics and Institute for Advanced Study, Technical University of Munich, 85748 Garching, Germany

Experiments with quantum gas microscopes have started to explore the antiferromagnetic phase of the Fermi-Hubbard model and effects of doping with holes away from half filling [1]. We show in this talk that the system averaged local two-spin density matrix enables to distinguish magnetically ordered and interesting topologically ordered spin-liquid phases, which might occur in the Hubbard model close to half filling.

Fractionalized Fermi liquids (FL*) are a promising candidate for this parameter regime. The generalized quantum dimer model introduced in Ref. [2] is an effective lattice realization of such an FL* with a Hilbert space spanned by configurations of fermionic and bosonic short-range bound states. We construct a rather unconventional dynamical cluster approximation (DCA) by making explicit use of the dimer Hilbert space and show first results of spectral data for a minimal cluster of two lattice sites.

[1] A. Mazurenko, C. Chiu et al., Nature 545, 7655 (2017)
[2] M. Punk, A. Allais and S. Sachdev, PNAS 112, 31 (2015)

MA 18.5 Tue 15:00 Theater

The evolution of spin – orbital entanglement in the approximate SU(2)⊗SU(2) model — •Dorota Gotfryd[1,2], Ekaterina Paerschke[3], Andrzej M. Oles[2,4], and Krzysztof Wohlfeld[1] — [1]Institute of Theoretical Physics, University of Warsaw, Warsaw, Poland — [2]Marian Smoluchowski Institute of Physics, Jagiellonian University, Krakow, Poland — [3]Department of Physics, University of Alabama at Birmingham, Birmingham, USA — [4]Max Planck Institute for Solid State Research, Stuttgart, Germany

In insulating states of transition metal oxides with orbital degeneracy spin – orbital superexchange describes the effective interactions [1]. In such a frustrated environment the quasi – empirical Goodenough – Kanamori rules may be violated leading to inter – site spin – orbital entanglement [2]. In this talk we analyse the phase diagram of an SU(2)⊗SU(2) symmetric model [3, 4] perturbed with a less symmetric term. Even though such conditions create more complicated type of entanglement, interestingly the underlying physics becomes much simpler. We present extensive numerical studies supported also by analytical calculations.

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[1] A.M. Oles, J. Phys.: Condensed Matter **24**, 313201 (2012)
[2] A.M. Oles *et al.*, Phys. Rev. Lett. **96**, 147205 (2006)
[3] S.K. Pati, R.R.P. Singh, D. Khomskii, Phys. Rev. Lett. **81**, 5406 (1998)
[4] W.-L. You, P. Horsch, A.M. Oles, Phys. Rev. B **92**, 054423 (2015)

MA 18.6 Tue 15:15 Theater

Asymptotical high-field saturation in spin-1/2 systems with XYZ spin-anisotropy and/or Dzyaloshinskii Moriya interactions — •Stefan-Ludwig Drechsler[1], Rolf Schumann[2], Richter Johannes[3], Ullrich Roessler[1], Roman Kuzian[4], Helge Rosner[5], Alexander Tsirlin[6], and Satoshi Nishimoto[1,2] — [1]ITF at the IFW-Dresden, Dresden, Germany — [2]TU Dresden, Theoret. Phys., Germany — [3]Universität Magdeburg, Inst. Theo. Phys. — [4]Inst. f. Material Sciences, Kyiv, Ukraine — [5]MPI-CPfS. Dresden, Germany — [6]Exp. Physik, Augsburg, Germany

We consider the high-field saturation of longitudinal and transversal magnetizations $M(B)$ of a wide class of spin-1/2 systems with low lattice symmetry leading to XYZ spin anisotropy and/or the presence of Dzyaloishnskii-Moriya (DM) interaction between nearest neighbor (NN) spins. Exact analytical, exact doagonalization and DMRG results are presented for small and large clusters as well as extended 1D and 2D systems. Above the last inflection point of the longitudinal magnetization only a power-law universal magnetization $\propto 1/B^2$ in leading order is found. We provide also higher order terms and focus on the influence of boundary conditions and the cases of staggered magnetizations and transversal DM components. Applications to various spin-chain compounds such as linarite and qubit/qutrit quantum dots being of interest in the field of quantum computing are discussed and compared critically with results published so far. Fitting experimental data within improper spin-symmetries, such as XXZ, may lead to unphysical large DM terms overestimated by an order of magnitude.

MA 18.7 Tue 15:30 Theater

Nonlocal probes for topological phase transitions from worldline braiding in path-integral quantum Monte Carlo — •Wei Wang[1], Fabio Lingua[2], Liana Shpani[2], and Barbara Capogrosso-Sansone[2] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Department of Physics,

Clark University, Worcester, U.S.A.

We propose non-local probes to study quantum and topological phase transitions in bosonic lattice spin-1/2 models. These probes can be explained as certain properties of braids of bosons' world-lines in configurations of path-integral quantum Monte Carlo (PIQMC). These new probes have been demonstrated to be good alternatives to order parameters for topologically trivial quantum phase transitions, and also have been shown to be efficient methods in studying topologically nontrivial phase transition. Furthermore, numerical results indicate that the world-line braids in configurations of PIQMC give a concrete meaning of so called "patterns" of short and long-range entanglement.

MA 18.8 Tue 15:45 Theater

Multi-loop contributions in the pseudo-fermion functional renormalization group for quantum spin systems: implementation and consequences — •Tobias Müller[1], Yasir Iqbal[2], Johannes Reuther[3,4], and Ronny Thomale[1] — [1]Institute for Theoretical Physics and Astrophysics, Julius-Maximilians University of Würzburg, Am Hubland, D-97074 Würzburg, Germany — [2]Department of Physics, Indian Institute of Technology Madras, Chennai 600036, India — [3]Dahlem Center for Complex Quantum Systems and Institut für Theoretische Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [4]Helmholtz-Zentrum für Materialien und Energie, Hahn-Meitner-Platz 1, 14019 Berlin, Germany

We extend the pseudo-fermion functional renormalization group (PFFRG) treatment of quantum spin systems by including diagrammatic higher loop contributions into the renormalization group flow. This allows us to consistently account for all contributions of parquet-type diagrams in the two-particle vertex and self-energy derivatives within the two-particle truncated PFFRG flow. We will discuss the impact of these corrections in different quantum spin models within PFFRG, especially in the light of the Mermin-Wagner theorem.