MA 40: Frustrated Magnets II

Time: Thursday 15:00–17:45 Location: H 1058

MA 40.1 Thu 15:00 H 1058

Emergent chiral metal near a Kondo breakdown quantum phase transition — •Tom Drechsler and Matthias Vojta — Institut für Theoretische Physik and Würzburg-Dresden Cluster of Excellence ct.qmat, Technische Universität Dresden, 01062 Dresden, Germany

The destruction of the Kondo effect in a local-moment metal can lead to a topological non-Fermi-liquid phase, dubbed fractionalized Fermi liquid, with spinon-type excitations and an emergent gauge field. If the latter displays an internal π-flux structure, a chiral heavy-fermion metal naturally emerges near the Kondo-breakdown transition.

Utilizing a parton mean-field theory describing the transition between a conventional heavy Fermi liquid and a U(1) fractionalized Fermi liquid, we find a novel intermediate phase near the transition whose emergent flux pattern spontaneously breaks both translation and time-reversal symmetries. This phase is an orbital antiferromagnet, and we discuss its relevance to pertinent experiments.

MA 40.2 Thu 15:15 H 1058

Influence of defects produced by He-ion irradiation on the magnetic properties of the pyrochlore $Ho_2Ti_2O_7$ — •Ena Osmic[1,2], Sumanta Chattopadhyay[1], Thomas Herrmannsdörfer[1], Marc Uhlarz[1], Shavkat Akhmadaliev[3], Uta Lucchessi[3], Stephan Winnerl[3], Geetha Balakrishnan[4], Stefan Facsko[3], Maria Eugenia Toimil-Morales[5], and Joachim Wosnitza[1,2] — [1]Hochfeld-Magnetlabor Dresden, HZDR — [2]Institut für Festkörper- und Materialphysik, TU Dresden — [3]Institut für Ionenstrahlphysik und Materialforschung, HZDR — [4]Department of Physics, University of Warwick, Coventry UK — [5]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

We report on the investigation of changes on the magnetic properties induced by defects produced by He^+-ion irradiation of the spin-ice compound $Ho_2Ti_2O_7$. We irradiated the samples using He^+-ions of 18 MeV energy and different doses. Magnetization $M(H)$ and $M(T)$ measurements revealed that the hallmark of spin-ice compounds, i.e., the appearance of a plateau in $M(H)$, for the irradiated samples looks more defined and can be observed at even higher temperatures compared to the virgin sample. We have also observed systematic changes in the saturation magnetization and the Curie-Weiss temperature T_{CW} compared to the virgin samples. Confocal Raman measurements reveal that the irradiation has induced considerable changes in the oxygen atoms tetrahedrally bonded to the holmium cations. Therefore, we conclude that the changes induced by irradiation are mostly due to the defects produced in the positions of the oxygen atoms.

MA 40.3 Thu 15:30 H 1058

Observation of the spiral spin liquid in a triangular-lattice antiferromagnet $AgCrSe_2$ — •Nikita Andriushin[1], Stanislav Nikitin[2], Øystein Fjellvåg[2,3], Jonathan White[2], Andrey Podlesnyak[4], Dmytro Inosov[1,5], Marcus Schmidt[6], Michael Baenitz[6], and Aleksandr Sukhanov[1] — [1]TU Dresden, Germany — [2]PSI, Switzerland — [3]IFE, Norway — [4]ORNL, USA — [5]ct.qmat, Germany — [6]MPI CPfS, Germany

The spiral spin liquid (SSL) is a highly degenerate state characterized by a continuous contour or surface in reciprocal space spanned by the spiral propagation vector. Although the SSL state has already been discussed for a number of theoretical models, only a very few materials were so far experimentally identified to host such a state. We report an observation of SSL in the quasi-two-dimensional delafossite $AgCrSe_2$, which is an ideal realization of the Heisenberg J_1–J_2–J_3 bond-frustration model on the triangular lattice. To demonstrate this, we combined single-crystal neutron diffraction measurements and microscopic spin-dynamics simulations. Our results show how exotic correlated magnetic states can be induced by a combination of thermal fluctuations and frustration, and establish $AgCrSe_2$ as a model system to study the SSL state.

MA 40.4 Thu 15:45 H 1058

Crystal and magnetic structure changes in $Cu_3SO_4(OH)_4$ under hydrostatic pressure — •Anton Kulbakov[1], Steven Gebel[1], Lukas Keller[2], Denis Cheptiakov[2], Gediminas Simutis[2], Darren Peets[1], and Dmytro Inosov[1] — [1]IFMP, TU Dresden, Germany — [2]PSI, Villigen, Switzerland

A combination of frustration, low-dimensionality, and quantum spin fluctuations in spin-$\frac{1}{2}$ chain systems can introduce extremely high degeneracy and prevent the system from readily selecting a unique ground state. The magnetic order becomes exquisitely sensitive to the balance among the interactions and can be easily tuned among novel magnetically ordered phases. In antlerite, $Cu_3SO_4(OH)_4$, Cu^{2+} ($S = \frac{1}{2}$) quantum spins populate three-leg zigzag ladders in a highly frustrated quasi-one-dimensional structural motif. Previously we presented the magnetic structures at ambient pressure. The application of a hydrostatic pressure on the order of 1 GPa leads to a qualitative change in the magnetic ground state in response to weak structural modifications.

MA 40.5 Thu 16:00 H 1058

Complex magnetic order and inverse magnetic melting in Ce3TiSb5 — •Simon Flury[1,3], Wolfgang Josef Simeth[2], Marc Janoschek[1,3], and Yongkang Luo[4] — [1]University of Zurich, Zurich, Switzerland — [2]Los Alamos National Laboratory, Los Alamos, New Mexiko — [3]Paul Scherrer Institut, Villigen, Switzerland — [4]Huazhong University of Science and Technology, Wuhan, China

We report high-resolution neutron diffraction on the new heavy fermion material Ce3TiSb5. Ce3TiSb5 exhibits an antiferromagnetic order below TN = 5.5 K. Our specific heat and magnetic susceptibility measurements reveal a phase diagram with three distinct magnetic phases. Using neutron diffraction we study the magnetic structure throughout the phase diagram, and uncover a multi-k spin structure in the intermediate field phase. Magnetic multi-k structures are of current interest because they are an important ingredient for topologically non-trivial properties. Finally, our measurements demonstrate that the high-field magnetic phase exhibits inverse melting, where the magnetically ordered state becomes disordered upon cooling. This is a highly unconventional behavior and suggests that the complex magnetic order of Ce3TiSb5 is driven via the competition of several degrees of freedom.

MA 40.6 Thu 16:15 H 1058

Magnon boundstates versus Ising anyons in Kitaev materials — •Tim Bauer[1,2], Lucas R. D. Freitas[2,1], Eric C. Andrade[3], Reinhold Egger[1], and Rodrigo G. Pereira[2] — [1]Institut für Theoretische Physik, Heinrich-Heine-Universität, Düsseldorf, Germany — [2]International Institute of Physics, Universidade Federal do Rio Grande do Norte, Natal, Brazil — [3]Instituto de Física de São Carlos, Universidade de São Paulo, São Carlos, Brazil

We recently predicted that Majorana zero modes (MZMs) near vortices in the quantum spin liquid (QSL) phase of Kitaev materials can be detected in a scanning tunnelling spectroscopy (STS) experiment in terms of a sequence of conductance steps at voltages below the continuum gap [1]. To ensure that the signals of MZMs can be distinguished from trivial excitations, we consider the same experimental setup in the partially polarized phase and the presence of disorder. The excitations of this phase are topological magnons and known to mimic other experimental signatures of the QSL. We report subgap magnon bound states near magnetic impurities modelled by an antiferromagnetic Kondo coupling and studied within spin-wave theory. The bound state energy vanishes only for a critical coupling that flips the impurity or bulk spin. We thus expect these states to behave differently to MZMs in STS when varying the external magnetic field or tunnelling probe position.

[1] Bauer, Tim, et al. Phys. Rev. B 107.5 (2023): 054432

15 min. break

MA 40.7 Thu 16:45 H 1058

Irrational moments and higher-rank gauge theories in diluted classical spin liquids — •Rafael Alvaro Flores Calderon[1], Owen Benton[2], and Roderich Moessner[1] — [1]Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Strasse 38, 01187 Dresden, Germany — [2]School of Physical and Chemical Sciences, Queen Mary University of London, London, E1 4NS, United Kingdom

Classical spin liquids (CSLs) have proved fruitful for the emergence of exotic gauge theories. Vacancy clusters in CSLs can introduce gauge

charges into the system, and the resulting behavior in turn reveals the nature of the underlying theory. We study these effects for a series of CSLs on the honeycomb lattice. We find that dilution leads to the emergence of effective free spins with tuneable, and generally irrational, size. For a specific higher-rank CSL, described by a symmetric tensor gauge fields, dilution produces *non-decaying* spin textures with a characteristic quadrupolar angular structure, and infinite-ranged interactions between dilution clusters.

MA 40.8 Thu 17:00 H 1058

Magnetic Phase Diagram of Rouaite, $Cu_2(OH)_3NO_3$ — •Darren C. Peets[1], Aswathi Mannathanath Chakkingal[1], Anton A. Kulbakov[1], Maxim Avdeev[2,3], Ramender S. Kumar[4], Issei Niwata[4], Ellen Häussler[5], Roman Gumeniuk[6], J. Ross Stewart[7], Vladimir Pomjakushin[8], Sergey Granovsky[1], Yoshihiko Ihara[4], and Dmytro S. Inosov[1] — [1]Institut für Festkörper- und Materialphysik, TU Dresden, Dresden, Germany — [2]ANSTO, Lucas Heights, NSW, Australia — [3]University of Sydney, Sydney, NSW, Australia — [4]Hokkaido University, Sapporo, Japan — [5]Anorganische Chemie II, TU Dresden, Dresden, Germany — [6]Institut für Experimentelle Physik, TU Bergakademie Freiberg, Freiberg, Germany — [7]ISIS Neutron and Muon Source, Rutherford Appleton Laboratory, Didcot, UK — [8]Paul Scherrer Institute, Villigen, Switzerland

Spinon-magnon mixing was recently reported in botallackite $Cu_2(OH)_3Br$ with a uniaxially compressed triangular lattice of Cu^{2+} quantum spins. Its nitrate analogue rouaite, $Cu_2(OH)_3(NO_3)$, has a highly analogous structure and might be expected to exhibit similar physics. To lay a foundation for research on this material, we report rouaite's magnetic phase diagram and identify both low-field phases. The low-temperature magnetic state comprises alternating ferro- and antiferromagnetic chains as in botallackite, but with some additional canting, while the higher-temperature phase is a helical modulation of this, where the spins rotate from one Cu plane to the next.

MA 40.9 Thu 17:15 H 1058

Kitaev-Heisenberg model on the star lattice – from chiral Majoranas to chiral triplons — •Peru d'Ornellas[1] and Johannes Knolle[1,2,3] — [1]Blackett Laboratory, Imperial College London, London SW7 2AZ, United Kingdom — [2]Department of Physics TQM, Technische Universitat Munchen, James-Franck-Straße 1, D-85748 Garching, Germany — [3]Munich Center for Quantum Science and Technology (MCQST), 80799 Munich, Germany

The interplay of frustrated interactions and lattice geometry can lead to a variety of exotic quantum phases. Here we unearth a particularly rich phase diagram of the Kitaev-Heisenberg model on the star lattice, a triangle decorated honeycomb lattice breaking sublattice symmetry. In the antiferromagnetic regime, the interplay of Heisenberg coupling and geometric frustration leads to the formation of valence bond solid (VBS) phases – a singlet VBS and a bond selective triplet VBS stabilized by the Kitaev exchange. We show that the ratio of the Kitaev versus Heisenberg exchange tunes between these VBS phases and chiral quantum spin liquid regimes. Remarkably, the VBS phases host a whole variety of chiral triplon excitations with high Chern numbers in the presence of a weak magnetic field. We discuss our results in light of a recently synthesized star lattice material and other decorated lattice systems.

MA 40.10 Thu 17:30 H 1058

Electric field driven flat bands in S=1/2 sawtooth chain. — Johannes Richter[1,2], •Vadim Ohanyan[3,4], Jörg Schulenburg[5], and Jürgen Schnack[6] — [1]Institut für Physik, Universität Magdeburg, P.O. Box 4120, D-39016 Magdeburg, Germany — [2]Max-Planck-Institut für Physik Komplexer Systeme, Nöthnitzer Straße 38, D-01187 Dresden, Germany — [3]Laboratory of Theoretical Physics, Yerevan State University, 1 Alex Manoogian, 0025 Yerevan, Armenia — [4]CANDLE, Synchrotron Radiation Institute, 31 Acharyan Street, 0040 Yerevan, Armenia — [5]Universitätsrechenzentrum, Universität Magdeburg, D-39016 Magdeburg, Germany — [6]Fakultät für Physik, Universität Bielefeld, Postfach 100131, D-33501 Bielefeld, Germany

We consider one of the paradigmatic models of frustrated spin system, a S=1/2 sawtooth chain with magnetoelectric coupling, realized due to Katsura-Nagaosa-Baladsky (KNB) mechanism. While the magnetic field acts on the spin system via the ordinary Zeeman term, the coupling of an applied electric field with the spins given by the KNB mechanism is effectively realized as a Dzyaloshinskii-Moriya interaction. One can drive the spin system into a flat-band scenario by applying an appropriate electric field, thus overcoming the restriction of fine-tuned exchange couplings. Particularly, if the direction of the electric field coincides with the basal line of the chain, the value of the saturation magnetic field can be reduced. We find a magnetization jump driven by the electric field as well as a jump of the electric polarization driven by the magnetic field, the system exhibits a strong magnetoelectric effect and an enhanced electrocaloric effect.