MA 31: Frustrated Magnets II (joint session MA/TT)

Time: Wednesday 9:30–12:45 Location: POT/0361

MA 31.1 Wed 9:30 POT/0361

Finite-size spectral signatures of order by quantum disorder: A perspective from Anderson's tower of states — •Subhankar Khatua[1], Griffin C. Howson[2], Michel J. P. Gingras[2], and Jeffrey G. Rau[3] — [1]IFW Dresden, Germany — [2]University of Waterloo, Canada — [3]University of Windsor, Canada

In frustrated magnetic systems with a subextensive number of classical ground states, quantum zero-point fluctuations can select a unique long-range ordered state, a celebrated phenomenon referred to as order by quantum disorder (ObQD). While ObQD is well understood in the semiclassical, large spin length limit, its behavior in quantum spin-1/2 systems is less clear. As exact analytical solutions are scarce for frustrated systems, numerical approaches are essential. We show that ObQD can be identified from exact diagonalization (ED) calculations through an analysis akin to the Anderson tower of states associated with spontaneous symmetry breaking. By defining an effective quantum rotor model, we describe the competition between ObQD-induced localization of the rotor and its tunneling between symmetry-related ground states, identifying the crossover lengthscale from the finite-size regime where the rotor is delocalized, to the infinite system-size limit where it becomes localized. This rotor model relates the characteristic splittings in the ED energy spectrum to the ObQD selection energy scale, providing an estimate that can be compared to spin wave calculations. We demonstrate the general applicability of this approach in one-, two- and three-dimensional frustrated spin models that exhibit ObQD.

MA 31.2 Wed 9:45 POT/0361

Magnetic resonance experiments on the quantum spin liquid candidate $YbCuSe_2$ — Madhurima Biswas[1], •Marlis Schuller[3], Khokan Bhattacharya[1], Yoshifumi Tokiwa[2], Mamoun Hemmida[3], Hans-Albrecht Krug von Nidda[3], Norbert Büttgen[3], István Kézsmárki[3], and Mayukh Majumder[1] — [1]Department of Physics, Shiv Nadar Institution of Eminence, IN — [2]Advanced Science Research Center, Japan Atomic Energy Agency, JPN — [3]EPV, Institut of Physics, University of Augsburg, DE

Frustrated magnetism in triangular-lattice delafossites offers a fertile route to realising quantum spin liquids (QSL) beyond conventional ordered phases. Among these materials a new candidate, $YbCuSe_2$, stands out as a QSL candidate from the present study. Magnetisation and ESR measurements on high-quality single crystals of $YbCuSe_2$ reveal easy-plane anisotropy. Furthermore, heat-capacity measurements down to 400 mK and μSR measurements down to 30 mK show no signatures of long-range magnetic ordering, establishing this compound as a promising QSL candidate. To probe the low-energy spin dynamics, we performed ^{63}Cu ($I = 3/2$) NMR measurements down to 20 mK. We document in-plane and out-of-plane spin-lattice relaxation T_1 as a function of temperature in an applied field of approximately 4 T. A dynamical phase separation was observed below 0.7 K, where one phase corresponds to the disorder-induced state, whereas the temperature evolution of the relaxation rate of the other phase exhibits a power-law divergence indicative of some quantum-critical spin fluctuations due to the proximity to a field-induced ordered state.

MA 31.3 Wed 10:00 POT/0361

Fluctuation driven phases in the triangular lattice — •P. Peter Stavropoulos[1], Roser Valentí[1], and Johannes Knolle[2] — [1]Goethe University, Frankfurt, Germany — [2]Technical University of Munich, Garching, Germany

The triangular lattice has proven to be a model platform of frustrated magnetism, with a rich landscape of emergent phases. It is also an experimentally accessible platform, with many family of materials showing quasi-2D triangular arrangements of magnetic ions. Motivated by this, we revisit magnetic exchange models on the triangular lattice. We discuss phases that are stabilized by order by disorder mechanisms, and comment on their observable signatures.

MA 31.4 Wed 10:15 POT/0361

Frustrated spin-1/2 chains in a correlated metal Ti4MnBi2 — •Xiyang Li and Meng Lyu — No.8, 3rd South Street, Zhongguancun, Haidian District, Beijing, China, 100190

Electronic correlations lead to heavy quasiparticles in three-dimensional(3D) metals, and their collapse can destabilize magnetic moments. It is an open question whether there is an analogous instability in one-dimensional (1D) systems, unanswered due to the lack of metallic spin chain materials. We report neutron scattering measurements and density matrix renormalization group calculations establishing spinons in the correlated metal Ti4MnBi2, confirming that its magnetism is 1D. Ti4MnBi2 is inherently frustrated, forming near a quantum critical point that separates different phases at temperature T = 0. One-dimensional magnetism dominates at the lowest T, and is barely affected by weak interchain coupling. Ti4MnBi2 is a previously unrecognized metallic spin chain in which 3D conduction electrons become strongly correlated due to their coupling to 1D magnetic moments.

MA 31.5 Wed 10:30 POT/0361

Low-temperature spin-freezing in frustrated zirconates $Tb_2Zr_{2-x}Ti_xO_7$ — •Frederik Leon Carstens[1], Sujata Singh[2], C. S. Yadav[2], and Rüdiger Klingeler[1] — [1]Kirchhoff Institute for Physics, Heidelberg University, Germany — [2]School of Physical Sciences, IIT Mandi, India

We report on magnetic studies of polycrystalline $Tb_2Zr_{1-x}Ti_xO_7$ ($x = 0, 0.5$). The zironates possess significant cationic disorder due to similar radii of the cations which introduces magnetic frustration. The materials are investigated by means of low-temperature ac and dc magnetization measurements in magnetic fields up to 7 T and down to 400 mK. Long-range magnetic order is not found down to $T = 400$ mK. However, in small magnetic fields, we observe a low-temperature spin-frozen state below $T = 1.4$ K and a slow spin relaxation regime which is significantly enhanced in static magnetic fields, e.g. to 15 K at $B = 2$ T. A similar behavior has been previously reported for the related rare-earth zirconate $Ho_2Zr_2O_7$ and in the hafnate $Tb_2Hf_2O_7$ [1,2].

[1] A. Elghandour et al., Phys. Rev. B **110**, 064408 (2024)
[2] V. K. Anand et al., Phys. Rev. B **97**, 094402 (2018)

MA 31.6 Wed 10:45 POT/0361

Magnetization plateaus, spin-canted orders and field-induced transitions in a spin-1/2 Heisenberg antiferromagnet on a distorted diamond-decorated honeycomb lattice — •Katarina Karlova and Jozef Strecka — Pavol Jozef Safarik University in Kosice, Slovakia

We investigate the spin-1/2 Heisenberg antiferromagnet on a distorted diamond-decorated honeycomb lattice in an external magnetic field. Using density-matrix renormalization group, sign-problem-free quantum Monte Carlo, exact diagonalization, and an effective lattice-gas approach based on localized-magnon physics, we determine the ground-state phase diagram and analyze the finite-temperature magnetization process.

The model hosts a rich variety of frustration-induced quantum phases, including Lieb-Mattis ferrimagnetic states, spin-canted regimes, monomer-dimer and dimer-tetramer phases, and dimensional-crossover states with 0D or 1D character. Depending on the lattice distortion, we identify robust magnetization plateaus at 0, 1/4, 1/2, and 3/4 of the saturation value, originating from competing local singlet clusters, composite spins, and flat-band localized magnons. Finite-temperature QMC data show how thermal fluctuations progressively smear the plateau structure, while the effective lattice-gas description reliably captures the corresponding low-temperature trends.

Funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I03-03-V04-00403.

15 min break

MA 31.7 Wed 11:15 POT/0361

Effect of Ca-doping on the exotic quantum spin liquid states of Y3Cu2Sb3O14 — •Muhammad Usama Akbar[1], Hans-Albrecht Krug von Nidda[1], Mamoun Hemmida[1], Avinash Mahajan[2], and Saikat Nandi[2] — [1]Experimental Physics V, Center for Electronic Correlations and Magnetism, University of Augsburg, D-86135 Augsburg, Germany — [2]Department of Physics, Indian Institute of Technology, Mumbai, 400076, India

The three-dimensional spin S = 1/2 compound Y3Cu2Sb3O14 was re-

cently identified as a promising candidate for novel quantum spin liquid (QSL) behavior, with two inequivalent Cu2+ sites in edge-sharing triangles and no long-range order observed in multiple experiments [1]. NMR detects a transition near 120 K, associated with partial singlet formation, while muSR and DFT indicate frustrated antiferromagnetic interactions around both Cu+2 sites. ESR shows a Lorentzian line (g = 2.16) above 120 K that splits into two components on cooling, with only a part of spins being ESR-active. In the current work, we extend this investigation to Ca-doped Y3-xCaxCu2Sb3O14 (x = 0.05, 0.10, 0.25), to examine how chemical substitution at the Y site influences the spin dynamics of the compound.

[1] S. Nandi et al. (2025), arXiv:2509.15835 [cond- mat.str-el]

MA 31.8 Wed 11:30 POT/0361

Synthesis and H-T phase diagram of $Cu_2(OH)_3HCOO$ — •Issei Niwata[1,2], Kaushick K. Parui[1], Maxim Avdeev[3], Anton A. Kulbakov[1], Dmytro S. Inosov[1], and Darren C. Peets[1] — [1]TU Dresden, Dresden, Germany — [2]Hokkaido University, Sapporo, Japan — [3]ANSTO, Sydney, Australia

$Cu_2(OH)_3X$ (X = monovalent anion) consists of quasi one-dimensional (1D) ferromagnetic (FM) and antiferromagnetic (AFM) chains which alternate to form two-dimensional triangular layers, which are stacked along the c axis. As the interchain interactions are frustrated and interlayer interactions are weak, the system can be regarded as weakly coupled 1D FM and AFM chains. In bulk measurements, these compounds typically show AFM behavior with a Néel temperature (T_N) below 10 K. Because of the coexistence of FM and AFM chains, exotic magnetic excitations are expected. As a matter of fact, for $X = Br^-$, inelastic neutron scattering revealed magnon excitations and a gapped spinon continuum in the same energy range. In addition, for $X = NO_3^-$, the realization of a Tomonaga-Luttinger-liquid state in the AFM chain was suggested in magnetic fields around 20 T, where the magnetization shows a half saturation indicating full polarization of the FM chains. Recently, we grew single crystals of the $X = HCOO^-$ compound. Magnetization measurements showed $T_N = 5.4$ K and a half saturation below 5 T, much lower than $X = NO_3^-$. This suggests that we can explore the excitation structure in relatively low magnetic fields. I will discuss the phase diagram obtained by physical properties measurements.

MA 31.9 Wed 11:45 POT/0361

H–T Phase Diagram of the Frustrated Quantum Magnet Antlerite, $Cu_3SO_4(OH)_4$ — •Darren C. Peets[1], Nikolai S. Pavlovskii[1], Roman Gumeniuk[2], Sergey Granovsky[1], and Dmytro S. Inosov[1] — [1]IFMP, TU Dresden, Germany — [2]IEP, TU Bergakademie Freiberg, Germany

The magnetic copper sites in antlerite, $Cu_3SO_4(OH)_4$, are arranged in three-leg triangular-lattice ladders, a unique magnetic lattice. In the ground state, the outer legs are ferromagnetic and antialigned, while the central leg is antiferromagnetic. This material has four distinct magnetic states in zero field alone, and we show that the phase diagram in applied fields is also remarkably rich.

MA 31.10 Wed 12:00 POT/0361

Magnetic structure of a geometrically frustrated Mn3V2Ge3O12 garnet oxide — •Sagar Mal Kumawat[1], Tsai-Ling Liu[1], Chin-Wei Wang[2], Jia-Xiang Hsu[1,3], En-Pei Liu[3], Wei-Tin Chen[3,4,5], and Chien-Lung Huang[1] — [1]Department of Physics and Center for Quantum Frontiers of Research & Technology (QFort), National Cheng Kung University, Tainan 701, Taiwan — [2]National Synchrotron Radiation Research Center, Hsinchu 30076, Taiwan — [3]Center for Condensed Matter Sciences, National Taiwan University, Taipei 10617, Taiwan — [4]Center of Atomic Initiative for New Materials, National Taiwan University, Taipei 10617, Taiwan — [5]Taiwan Consortium of Emergent Crystalline Materials, National Science and Technology Council, Taipei 10622, Taiwan

We investigated the low-temperature magnetic structure and thermodynamic properties of Mn3V2Ge3O12 (MVGO) using neutron diffraction, magnetic, and heat capacity measurements. MVGO crystallizes in a cubic Ia-3d structure with a minor MnV2O4 impurity. Two successive transitions at TN1 = 4 K and TN2 = 2.4 K indicate noncollinear antiferromagnetic ordering of the frustrated V3+ and Mn2+ sublattices. Field-dependent heat capacity shows suppression of the TN1 anomaly and a shift of TN2, consistent with magnetic frustration and spin reorientation. The total magnetic entropy reaches approximately 51 J/mol K above 20 K, accounting for ~81% of the theoretical entropy for the full spin system. Temperature-dependent measurements reveal noncollinear antiferromagnetic order below TN2, with peak broadening up to TN1 indicating strong spin frustration.

MA 31.11 Wed 12:15 POT/0361

Crystallographic and magnetic structure of Pr_2PdSi_3: a single crystal neutron diffraction study — •Matthias Frontzek — Neutron Scattering Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA

The intermetallic compound series R_2PdSi_3 (R = rare earth metal) exhibits intriguing magnetic properties, including giant magnetoresistance, pronounced anisotropy in its electronic behavior, and a generic field-induced phase. The magnetic structures are complex, with large magnetic unit cells arising from the delicate interplay between competing crystal electric-field effects, magnetic exchange interactions, and geometric frustration. Recently, the discovery of a Skyrmion lattice in Gd_2PdSi_3 has renewed interest in the magnetic properties of this series.

In our contribution, we present a detailed neutron single crystal diffraction study using the WAND^2 diffractometer at the High-Flux Isotope Reactor (HFIR) at ORNL. In heavy rare earth members, Pd/Si ordering lowers the symmetry from hexagonal to monoclinic; in contrast, the Pr_2PdSi_3 compound adopts an orthorhombic structure with a $2*a, 2*b, 4*c$ unit cell relative to the primitive hexagonal cell. Magnetic order setting in at $T_N = 2.1$K is preceded by broad diffuse scattering around the nuclear reflections, and below T_N a long-wavelength spin-density wave is observed coinciding with the short-range order evidenced by the diffuse scattering.

MA 31.12 Wed 12:30 POT/0361

Dynamical heterogeneity and fractal subdiffusive transport in spin-ice — •Malte Bieringer[1], Gianluca Teza[1,2], Claudio Castelnovo[3], and Roderich Moessner[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden, Germany — [2]Department of Physics, University of Trieste, Strada Costiera 11, 34136 Trieste, Italy — [3]TCM Group, Cavendish Laboratory, University of Cambridge, Cambridge CB3 0HE, UK

Spin ice is a paradigmatic model that, despite its simplicity, enables the exploration of rich and robust emergent phenomena in topological magnets. Here we uncover a novel set of spin-ice phenomenology typically associated with vitrification processes in disordered systems.

We identify a pronounced peak in dynamical heterogeneity in a classical spin-ice model on the three-dimensional pyrochlore lattice, in the complete absence of disorder and - remarkably - in thermal equilibrium. At low temperatures, additional dynamical constraints emerge that confine the motion of magnetic monopole excitations to three-dimensional percolation clusters. This gives rise to ergodic subdiffusion, opposing conventional emergent hydrodynamics. The observed dynamical heterogeneity arises without disorder or ergodicity breaking, distinguishing it from conventional glasses and systems with Hilbert space fragmentation, suggesting a generic feature of topological magnets hosting deconfined quasiparticles.

Our results motivate the search for materials and artificial spin-ice realizations of this physics and propose higher-order dynamical correlations as a distinctive experimental signature of topological magnetism.