MA 19: Frustrated Magnets I (joint session MA/TT)

Time: Tuesday 9:30–12:30 Location: POT/0361

MA 19.1 Tue 9:30 POT/0361

Spontaneous symmetry breaking in the Heisenberg antiferromagnet on a triangular lattice — •Bastian Pradenas[1,2], Grigor Adamyan[1,3], and Oleg Tchernyshyov[1] — [1]William H. Miller III Department of Physics and Astronomy, Johns Hopkins University, Baltimore, USA — [2]Leibniz Institute for Solid State and Materials Research, IFW, Dresden, Germany — [3]Department of Physics, Massachusetts Institute of Technology, Cambridge, USA

We present a detailed investigation of an overlooked symmetry structure in non-collinear antiferromagnets that gives rise to an emergent quantum number for magnons. Focusing on the triangular-lattice Heisenberg antiferromagnet, we show that its spin order parameter transforms under an enlarged symmetry group, $SO(3)_L \times SO(2)_R$, rather than the conventional spin-rotation group SO(3). Although this larger symmetry is spontaneously broken by the ground state, a residual subgroup survives, leading to conserved Noether charges that, upon quantization, endow magnons with an additional quantum number—*isospin*—beyond their energy and momentum. Our results provide a comprehensive framework for understanding symmetry, degeneracy, and quantum numbers in non-collinear magnetic systems, and bridge an unexpected connection between the paradigms of symmetry breaking in non-collinear antiferromagnets and chiral symmetry breaking in particle physics.

MA 19.2 Tue 9:45 POT/0361

Antiferro octupolar order in the 5d^1 double perovskite Sr_2MgReO_6 and its spectroscopic signatures — •Dario Fiore Mosca[1] and Leonid Pourovskii[2,3] — [1]University of Vienna, Faculty of Physics and Center for Computational Materials Science, Vienna, Austria — [2]CPHT, CNRS, Ecole polytechnique, Institut Polytechnique de Paris, 91120 Palaiseau, France — [3]College de France, Université PSL, 11 place Marcelin Berthelot, 75005 Paris, France

Hidden-order phases governed by high-rank multipolar order parameters have recently been identified in several cubic 5d double perovskites. Because experimental probes often couple weakly to high-rank moments, multipolar orders can remain elusive or be misinterpreted as lower-rank phases. A notable example is the 5d^1 double perovskite Sr_2MgReO_6, originally proposed as a spin glass and later reclassified as a conventional dipolar antiferromagnet.

In this work, we show instead that Sr_2MgReO_6 hosts a hidden antiferroic order of magnetic octupoles. The dominant tetragonal crystal field isolates a doublet carrying octupolar degrees of freedom, while weak dipolar moments arise only through admixture of the excited j = 1/2 spin-orbit multiplet. This octupolar order produces characteristic quasigapless magnetic excitations and superstructural neutron-diffraction intensities that peak at large scattering momenta.

This results highlights the tunability of multipolar interactions in spin-orbit entangled materials and places Sr_2MgReO_6 with unconventional octupolar phases.

MA 19.3 Tue 10:00 POT/0361

Field-dependent CEF excitations in Ce_2Bi — •Nikolai Pavlovskii[1], Alexander Sukhanov[2], Anton Kulbakov[1], Michael Smidman[3], Federico Mazza[4], Darren Peets[1], Kaushick Parui[1], Ross Stewart[5], Ross Piltz[6], and Dmytro Inosov[1] — [1]TU Dresden, Germany — [2]University of Augsburg, Germany — [3]Zhejiang University, China — [4]TU Vienna, Austria — [5]ISIS, UK — [6]ANSTO, Australia

Ce_2Bi is a cerium-based intermetallic compound where crystal-field (CEF) splitting and anisotropic magnetic interactions occur on comparable energy scales. To identify the relevant low-energy degrees of freedom, we investigate the field dependence of CEF-related excitations in single-crystalline Ce_2Bi using neutron-scattering techniques. Single-crystal diffraction establishes the crystallographic symmetry at the Ce site, providing the structural framework required for interpreting the magnetic excitations. The excitation spectrum shows a clear magnetic mode within the $J = 5/2$ manifold whose energy and intensity vary strongly with applied field. Crucially, the mode displays clear dispersion, demonstrating the presence of exchange interactions; as a result, what was previously interpreted as a localized CEF level is revealed to be a dispersive magnetic exciton. The field-induced evolution of this exciton constrains the mixing within the CEF manifold and the anisotropy of the ground-state Kramers doublet.

MA 19.4 Tue 10:15 POT/0361

High-field magnetic excitations in a kagome antiferromagnet — •Yoshihiko Ihara[1], Dmytro Inosov[2], Darren Peets[2], Moyu Kato[1], and Hiroyuki Yoshida[1] — [1]Hokkaido University, Sapporo, Japan — [2]TU Dresden, Dresden, Germany

Magnetic ground states in kagome antiferromagnets have been intensively studied to reveal the quantum mechanically disordered magnetic states. By applying high magnetic fields, further intriguing phenomena have been introduced such as the plateau in magnetization curve at the 1/9 of the full saturation value in $YCu_3(OH)_{6.5}Br_{2.5}$. [S. Jeon et al., Nat. Phys. **20**, 435 (2024), S. Suetsugu et al., PRL **132**, 226701 (2024), G. Zheng et al., PNAS **122**, e2421390112 (2025)]. Although higher magnetic fields induce another magnetization plateau at the 1/3 of the full saturation, the field strength required to access the 1/3 plateau is more than 50 T and is too large to perform most of the microscopic experiments. Thus, we focus on another Cu-based mineral $InCu_3(OH)_6Cl_3$, which shows the 1/3 plateau around 10 T due to smaller energy scale of exchange interactions [M. Kato et al., Commun. Phys. **7**, 424 (2024)]. This allows us to perform NMR experiments in the entire field range reaching the full saturation. The measured nuclear spin-lattice relaxation rate demonstrates that the magnetic excitations are gapped in the 1/3 plateau state and the gap size increases with fields [M. Kato et al., JPSJ **94**, 083704 (2025)]. We will also discuss the magnetic excitations above the 1/3 plateau based on the results obtained in the high-field magnet in Tohoku Univ.

MA 19.5 Tue 10:30 POT/0361

Evidence for a Near-Ideal Jeff = 1/2 Ground State in Triangular-Lattice Na2BaCo(PO4)2 — •Miguel M. F. Carvalho[1,2], Sheng H. Chen[1], Yu C. Ku[3,4], Anagha Jose[5], Ryan Morrow[5], Chang Y. Kuo[3,4], Chun F. Chang[1], Zhiwei Hu[1], Maurits W. Haverkort[6], and Liu H. Tjeng[1] — [1]Max Planck Institute for Chemical Physics of Solids,Dresden — [2]Institute of Physics II, University of Cologne — [3]Department of Electrophysics, National Yang Ming Chiao Tung University, Hsinchu, Taiwan — [4]National Synchrotron Radiation Research Center, Hsinchu, Taiwan — [5]Institut fuer Festkoerperphysik, Leibniz IFW, Dresden — [6]Institute for theoretical physics, Heidelberg University

We investigated the local Co 3d electronic structure of Na2BaCo(PO4)2 using polarization-dependent X-ray absorption spectroscopy (XAS) together with full multiplet cluster calculations. To obtain reliable spectra from this strongly insulating material, we employed the line-fitting inverse partial fluorescence yield (IPFY) method. Our combined experimental and theoretical analysis shows that the CoO6 octahedra exhibit only a very small effective trigonal distortion of about 11 meV, placing the system close to the ideal conditions for a Jeff = 1/2 ground state. Using our cluster model, we are also able to simulate the magnetic susceptibility along different crystallographic directions, . Overall, these results establish Na2BaCo(PO4)2 as a promising platform for investigating exotic magnetic behavior linked to Jeff = 1/2 states on triangular lattices.

MA 19.6 Tue 10:45 POT/0361

Dimensional reduction and fractionalized magnetization plateaus in the scalene-distorted triangular-lattice magnet kobyashevite — •Kaushick Parui[1], Anton Kulbakov[1], Roman Gumeniuk[2], Maria Teresa Fernandez-Diaz[3], Sergey Granovsky[1], Sergei Zvyagin[4], Dmytro Inosov[1], and Darren Peets[1,5] — [1]TU Dresden, Germany — [2]TU Bergakademie Freiberg, Germany — [3]ILL, France — [4]HZDR, Germany — [5]ct.qmat, TU Dresden, Germany

Quantum magnetism intertwined with lattice distortion can give rise to exotic ground states, yet studies on scalene-distorted triangular-lattice antiferromagnets remain scarce. Here, we report the crystal and magnetic structures, as well as magnetic and thermodynamic properties, of kobyashevite, $Cu_5(SO_4)_2(OH)_6{\cdot}4H_2O$. This compound hosts a scalene-distorted triangular lattice and exhibits antiferromagnetic order at 4 K, with a possible second transition at 0.64 K. High-field magnetization and specific-heat measurements reveal a cascade of field-induced states, manifested as magnetization plateaus, suggestive of a rich magnetic phase diagram. Neutron diffraction uncovers a dimensionally-reduced commensurate magnetic structure with propagation vector $\mathbf{k} = (0\,0\,\frac{1}{2})$, consisting of coupled alternating ferromagnetic and antiferromagnetic spin chains, while the Cu4 spins remain idle at 1.5 K. Collectively, these results establish kobyashevite as a promising platform for exploring the interplay of frustration, distortion, and dimensional reduction in quantum magnets.

15 min break

MA 19.7 Tue 11:15 POT/0361

Atomically sharp magnetic solitons for racetrack memory at the spatial limit — K Allen[1], K Du[2], J Bouaziz[3], S Mishra[1], G Bihlmayer[3], Y Zhang[1], Y Hao[4], V Ukleev[5], C Luo[5], F Radu[5], Y Gao[1], Ch Lane[6], J-X Zhu[6], M Yi[1], H Cao[4], S-W Cheong[2], •Stefan Blügel[3], and Emilia Morosan[1] — [1]Dept. of Physics and Astronomy & Rice Center for Quantum Materials, Rice University, Houston, 77005, TX, USA — [2]Dept. of Physics and Astronomy, Rutgers University, Piscataway, 08854, NJ, USA — [3]Peter-Grünberg Institute, Forschungszentrum Jülich, 52425 Jülich, Germany — [4]Neutron Scattering Division, Oak Ridge Natl Lab, Oak Ridge, 37831, TN, USA — [5]Helmholtz-Zentrum Berlin, 14109 Berlin, Germany — [6]Theoretical Division, Los Alamos Nat. Lab., Los Alamos, 87545, NM, USA

We discuss the physics of a metallic square-net lattice rare-earth compound that exhibits RKKY interactions leading to magnetic frustration whose effective exchange interactions competes with the uniaxial anisotropy resulting in a rare ferrimagnetic up-up-down phase. Applying magnetic fields, atomically sharp solitons can be precipitated that have all the foundational credentials for a racetrack memory at the spatial limit. We present DFT calculations relating the RKKY interaction and the magnetic anisotropy to the electronic structure. We performed atomistic spin-dynamics calculations relating the interaction parameters to the soliton formation. A combination of experiments will be presented that provide evidence of the 1D magnetic solitons.

MA 19.8 Tue 11:30 POT/0361

Guest*Controlled Quantum Magnetism in a Flexible Metal-Organic Framework — •Fang Liu[1], Armin Schulz[2], Axel Lubk[4], Alexej Pashkin[3], Sergej Granovski[1], Shuhan Wang[1], Weinel Kristina[4], Herzog Max[4], and Stefan Kaiser[1] — [1]Institute of Solid State and Materials Physic, Dresden University of Technology — [2]Max Planck Institute for Solid State Research, Stuttgart — [3]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Dresden — [4]Leibniz Institute for Solid State and Materials Research, Dresden

Metal-organic frameworks provide an unusual setting where magnetic frustration and structural flexibility coexist. In our system, two distinct states emerge: a guest-stabilized regime with signatures of a potential quantum spin liquid, and a guest-free state exhibiting weak magnetic ordering. Raman and infrared spectroscopy reveal pronounced differences in lattice modes between these phases. Complementary Raman and THz measurements further uncover contrasting magnetic backgrounds. These findings establish a guest-controlled route to tuning magnetic quantum states in MOFs.

MA 19.9 Tue 11:45 POT/0361

Investigation of spin-correlated phases in quasi two-dimensional layered honeycomb oxide — •Aprajita Joshi[1], Anjali Kumari[2,3], Shalini Badola[1], Anup Kumar Bera[2,3], and Surajit Saha[1] — [1]Indian Institute of Science Education and Research Bhopal, 462066, India — [2]Bhabha Atomic Research Centre, Mumbai 400085, India — [3]Homi Bhabha National Institute, Mumbai 400094, India

Honeycomb oxides are an intriguing class of materials characterised by low dimensionality and strong magnetic frustration, which leads to exotic quantum spin correlations. Here, we investigated a quasi-two-dimensional magnetic oxide Na2Co2TeO6, which exhibits several intriguing magnetic phases, including the zigzag antiferromagnetic interaction and Kitaev paramagnetic spin interactions. We explored the intricate relationship between these phases and phonons using temperature-dependent Raman measurements. Our findings reveal the signature of magnetoelastic coupling across the long-range and short-range magnetic ordering temperatures. Furthermore, Na2Co2TeO6, which has a non-centrosymmetric crystal structure, showcases ferroelectric order below 80 K. The evolution of Raman spectra reveals the presence of a ferroelectric order coupled phonon mode in Na2Co2TeO6 below this temperature.

MA 19.10 Tue 12:00 POT/0361

Characterizing entanglement at finite temperature: how does a paramagnet become a quantum spin liquid? — Snigdh Sabharwal[1,2], •Matthias Gohlke[1], Paul Skrzypczyk[2], and Nic Shannon[1] — [1]Okinawa Institute of Science and Technology, Onna, Japan — [2]H. H. Wills Physics Lab., University of Bristol, Bristol, UK

Quantum spin liquids (QSL) are generically many body entangled states of matter that form when quantum fluctuations meet the extensive ground state degeneracy of a classical spin liquid. Entanglement properties have enabled to characterise gapped QSL at zero temperature, however, much less is known about how quantum many body entanglement evolves at finite temperature.

Here, we use entanglement depth and genuine multipartite entanglement (GME) to study how entanglement and its local structure emerge when cooling a frustrated magnet from the high-temperature paramagnet down to the low-temperature QSL state. Within a case study on the Kitaev Honeycomb model, we obtain two characteristic bounds: (1) a lower bound on the upper temperature below which separability breaks and quantum entanglement must be present, while (2) a lower temperature scale is obtained when GME on plaquettes becomes finite signifying the coherent, structured entanglement that is characteristic for QSL ground states [1], i.e. the flux free state of the Kitaev spin liquid. We provide a framework to discuss the relevant temperature scales for QSL in frustrated magnets [2].

[1] L. Lyu, D. Chandorkar, et al., arXiv:2505.18124

[2] S. Sabharwal, M. Gohlke, et al., arXiv:2511.15144

MA 19.11 Tue 12:15 POT/0361

Fate of the Triangular Dirac spin liquid under an external magnetic field — •Sasank Budaraju[1,2], Josef Willsher[3], Federico Becca[4], Johannes Knolle[1,2], and Frank Pollmann[1,2] — [1]Technical University of Munich, TUM School of Natural Sciences, Physics Department, 85748 Garching, Germany — [2]Munich Center for Quantum Science and Technology (MCQST), Schellingstr. 4, 80799 München, Germany — [3]Max-Planck-Institut fur Physik komplexer Systeme, 01187 Dresden, Germany — [4]Dipartimento di Fisica, Universita di Trieste, Strada Costiera 11, I-34151 Trieste, Italy

We investigate the J1-J2 Heisenberg model under an external Zeeman field using the Variational Monte Carlo approach. Simple variational ansatzes are proposed for several candidate ordered states, and their energetics are compared on large clusters to obtain the phase diagram for small/moderate fields. For small J2, we capture a continuous transition from the Y to the "Up-Up-Down" (UUD) states as predicted by spin-wave theory. Additionally, around the highly frustrated region, we demonstrate that the ground state in the presence of a small field is a condensate of monopoles, which are gapless gauge excitations of the U (1) spin liquid. The monopole condensate is shown to be the ground state for a significant region of phase diagram, which we estimate using finite size numerics. Our results imply that the Dirac spin liquid is unstable to a condensation of monopoles in the presence of external fields.