MA 40: Frustrated Magnets II

Time: Thursday 15:00–17:45 Location: H20

MA 40.1 Thu 15:00 H20

Magnetism of rare-earth A2Ir2O7 pyrochlore single crystals — •Filip Hájek[1], Daniel Staško[1], Kristina Vlášková[1], Jiří Kaštil[2], and Milan Klicpera[1] — [1]Charles University, Faculty of Mathematics and Physics, Department of Condensed Matter Physics,Ke Karlovu 5, 121 16 Prague 2, Czech Republic — [2]Institute of Physics of the Czech Academy of Sciences, Na Slovance 2, 182 21 Prague 8, Czech Republic

The rare-earth A2Ir2O7 pyrochlore iridates form a heavily studied series of materials revealing a plethora of complex properties. Geometrically frustrated lattice, strong spin-orbit coupling comparable to the strength of electron correlations, or f-d exchange between rare-earth and iridium sites lead to, e.g., spin ice state [1], spin liquid [2], topological Mott insulator [3], axion insulator [4] or Weyl semimetal [4,5].

Among the A2Ir2O7 series, we focus on the previously less studied heavy rare-earth members, namely Ho2Ir2O7, Er2Ir2O7, and Lu2Ir2O7 single crystals. In these materials, the Ir sublattice magnetically orders above 100 K, inducing a transition from a (semi-)metal to an insulating state just below the ordering temperature. Our present work is aimed at the magnetism of newly synthesised A2Ir2O7 single crystals, which is discussed in the framework of antiferromagnetic domains and ferromagnetic domain interfaces.

[1] E. Lefrançois et al., Nat. Commun. 8, 209 (2017). [2] M. Kavai et al., Nat. Commun. 12, 1377 (2021). [3] Y. Otsuka et al., Sci. Rep. 11, 20270 (2021). [4] X. Wan et al., Phys. Rev. B 83, 205101 (2011). [5] X. Liu et al., Phys. Rev. Lett. 127, 277204 (2021).

MA 40.2 Thu 15:15 H20

Crystal growth and anisotropic magnetic properties of quasi-one-dimensional zigzag chain antiferromagnet: CaCoP2O7 — •Koushik Chakraborty[1], Aditi Agrawal[1], Isha Isha[1], M. Isobe[2], and Arvind Kumar Yogi[1] — [1]UGC-DAE Consortium for Scientific Research, University Campus, Khandwa Road, Indore-452001, India — [2]Max-Planck-Institut f\"{u}r Festk\"{o}rperforschung, Heisenbergstr. 1, D-70569 Stuttgart, Germany

We report crucible free optical floating zone crystal growth and anisotropic magnetic properties of quasi-one-dimensional zigzag chain antiferromagnetic compound CaCoP2O7. In this quasi one-dimensional zigzag chain compound, magnetic lattice is formed by the Co2+ ions. We have characterized the single-crystals and analyzed them by using x-ray and Laue diffraction which reveals single-phase nature and the as grown single-crystals were found of ultra high quality. Magnetic susceptibility and magnetization measurements reveal antiferromagnetic ordering, evidenced by a pronounced downturn in susceptibility below the Neel temperature (TN =6.6 K) and negative Curie-Weiss temperatures (Theta-CW = -39.4 K). Further, we found clear signature of field-induced phase transition where on application of field AFM order is going to quantum paramagnetic state or maybe liquid phase (which needs further study to confirm).

MA 40.3 Thu 15:30 H20

Ultrasound Investigation of the Magnetic Phase Diagram of Rouaite $Cu_2(OH)_3NO_3$ — •Nikolai Pavlovskii[1], Anton Kulbakov[1], Aswathi M. Chakkingal[1], Justus Grumbach[1], Kaushick K. Parui[1], Ulrike Stockert[1], Maxim Avdeev[2,3], Ramender Kumar[4], Issei Niwata[4], Ellen Häussler[1], Roman Gumeniuk[5], Ross J. Stewart[6], Vladimir Pomjakushin[7], Sergey Granovsky[1], Mathias Doerr[1], Elena Hassinger[1], Sergei Zherlitsyn[8], Andreas Hauspurg[8], Yoshihiko Ihara[4], Darren C. Peets[1], and Dmytro Inosov[1] — [1]TU Dresden, Germany — [2]ANSTO, Sydney, Australia — [3]University of Sydney, Australia — [4]Hokkaido University, Japan — [5]TU Bergakademie Freiberg, Germany — [6]ISIS, United Kingdom — [7]PSI, Villigen, Switzerland — [8]HZDR, Dresden, Germany

Rouaite, $Cu_2(OH)_3NO_3$, is a low-dimensional quantum magnet with alternating ferromagnetic and antiferromagnetic spin chains. Its magnetic phase diagram has been studied using techniques such as magnetization and specific heat, revealing field-induced transitions. This work focuses on ultrasonic investigations, which uncover the coupling between magnetic and elastic properties. New results under hydrostatic pressure further demonstrate the tunability of the magnetic phases, highlighting the material's sensitivity to lattice modifications.

MA 40.4 Thu 15:45 H20

Emergent degeneracies in weakly coupled sawtooth chains: the case of bobkingite — •P. Peter Stavropoulos[1], Aleksandar Razpopov[1], Harrison LaBollita[2], Antia S. Botana[3], Michael R. Norman[4], and Roser Valentí[1] — [1]Goethe University, Frankfurt, Germany — [2]Flatiron Institute, New York, USA — [3]Arizona State University, Tempe, USA — [4]Argonne National Laboratory, Lemont, USA

The sawtooth chain, otherwise known as the Δ chain, has a long history as a minimal model of frustrated magnetism, serving as a realization of Shastry-Sutherland type solitons. While many material candidates, like delafossite, euchroit, atacamite, as well as fluorides, have been investigated, they leave much to be desired in the way of the ideal sawtooth chain. Here we present a proposal for revisiting a copper hydrate, bobkingite. Using ab initio methods we estimate the magnetic exchanges between copper sites, and find a spin model consisting of nearly ideal sawtooth chains, weakly coupled to its neighbors. We analyze the classical model of the coupled sawtooth chains, revealing emergent system size scaling degeneracies.

MA 40.5 Thu 16:00 H20

Trigonal distortion in the Kitaev candidate honeycomb magnet BaCo2(AsO4)2 — •M.M. Ferreira Carvalho[1,2], S. Roessler[1], Z. Hu[1], C.F. Chang[1], S. M. Valvidares[3], P. Gargiani[3], M. W. Haverkort[4], P. K. Mukharjee[5], P. Gegenwart[5], A. A. Tsirlin[6], and L.H. Tjeng[1] — [1]Max Planck Institute for Chemical Physics of Solids,Dresden — [2]Institute of Physics II, University of Cologne — [3]ALBA Synchrotron Light Source, Barcelona, Spain — [4]Institute for theoretical physics, Heidelberg University — [5]Lehrstuhl für Experimentalphysik VI, Universität Augsburg — [6]Felix Bloch Institute for Solid-State Physics, University of Leipzig

We conducted X-ray linear dichroism (XLD) and magnetic circular dichroism (XMCD) measurements on single crystals of the Kitaev candidate honeycomb lattice compound BaCo2(AsO4)2. The measurements employed the bulk sensitive inverse partial fluorescence yield technique, which is ideal for acquiring reliable X-ray absorption spectra from highly insulating samples , enabling precise quantitative analysis. Our experimental results revealed a significant LD signal, indicating strong trigonal distortion in the CoO6 octahedra in BaCo2(AsO4)2. We performed a detailed analysis of the experimental XAS and XMCD spectra using a full-multiplet cluster model within the configuration interaction approach. This analysis indicated that the hole density is predominantly localized in the a1g orbital. Through XMCD sum rules and theoretical calculations, we quantified both the spin and orbital magnetic moments.

MA 40.6 Thu 16:15 H20

Single crystal growth and anisotropic magnetic properties of honeycomb quantum antiferromagnets: Ba2A(PO4)2 (A = Ni, Co, Mn) — •Aditi Agrawal[1], Koushik Chakraborty[1], Isha Isha[1], M. Isobe[2], and Arvind Kumar Yogi[1] — [1]UGC-DAE Consortium for Scientific Research, University Campus, Khandwa Road, Indore-452001, India — [2]Max-Planck-Institut f\"{u}r Festk\"{o}rperforschung, Heisenbergstr. 1, D-70569 Stuttgart, Germany

The magnetic framework (monoclinic-lattice) of the title compounds are composed of the honeycomb-lattice. We present a study of high-quality Ba2A(PO4)2 (A = Ni, Co, Mn) optically floating zone grown single crystals. Sharp anomalies were found in the thermodynamic measurements. The anomalies corresponding to the long-range-ordering (LRO) for all three single-crystals of honeycomb family were evident just below 5 K, reveals a long-range antiferromagnetic order in these single-crystalline samples. The dc-susceptibilities for in-plane and out-of-plane magnetic fields are strongly anisotropic. Our Curie-Weiss analysis for Ni, Co, and Mn suggest strong orbital magnetism but it was found significant for Co2+ case, as it is known due to its Kramers' degeneracy nature. Further, on application of external magnetic field, all compound shows spin-flop transition at moderate field. However, Ba2Co(PO4)2 is interestingly driven to another ordered phase due to the field-induced transition via a field tuned quantum critical point which is expected close to the critical field of Bc ~ 6.5 T, as evident from our phase boundaries analysis on in B-T plane.

15 min. break

MA 40.7 Thu 16:45 H20

Modelling thermal transport in spiral magnets — •Margherita Parodi[1,2] and Sergey Artyukhin[1] — [1]Italian Institute of Technology, Genova — [2]University of Genova, Italy

Magnetic memory and logic devices, including prospective ones based on skyrmions, inevitably produce heat. Thus, controlling heat flow is essential for their performance. Here we study magnon contribution to thermal conductivity in the most basic non-collinear magnet with a spin spiral ground state. Non-collinearity leads to anharmonic terms, resulting in magnon fusion and decay processes. These processes determine the magnon lifetime which can be used to estimate thermal conductivity in single mode approximation. However, by solving the full Boltzmann equation numerically, we find much higher thermal conductivity. This signifies that heat is carried not by individual magnons but by their linear combinations, called relaxons [1]. The thermal conductivity is found to be increasing with the diminishing twist angle, consistent with recent experiments [2]. The results pave the path to understanding magnetic thermal transport in other non-collinear magnets.

References: [1] A. Cepellotti and N. Marzari, Phys. Rev. X 6, 041013 (2016) [2] F. Sekiguchi et al., Nat. Commun. 13, 3212 (2022)

MA 40.8 Thu 17:00 H20

Pressure-tuning $Na_3Co_2SbO_6$ in the Kitaev Quantum Spin Liquid state — •Steven Gebel[1], Swarnamayee Mishra[1], Martin Sundermann[2], Marein Rahn[3], and Jochen Geck[1] — [1]Institute of Solid State and Materials Physics, Technische Universität Dresden, Haeckelstr. 3, 01069 Dresden, Germany — [2]PETRA III, Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [3]Center for Electronic Correlations and Magnetism, University of Augsburg, Universitätsstraße 1, 86159 Augsburg, Germany

Honeycomb cobaltates with Co^{2+} ($3d^7$) ions have been proposed as materials that can host Kitaev's quantum spin liquid state (QSL). Specifically, $Na_3Co_2SbO_6$ has been predicted to exhibit a Kitaev QSL upon reduction of the trigonal ligand and crystal field splitting, which in turn might be possible via the elastic tuning of the lattice structure. This compound hosts edge-sharing CoO_6 octahedra and exhibits antiferromagnetic (AFM) zig-zag ordering below 7 K, reminiscent of other well-known QSL-candidate, α-$RuCl_3$. In this study, a combination of x-ray diffraction (XRD) and spectroscopy (NIXS) in diamond anvil cells (DACs) is used to establish the pressure dependence of the lattice structure and its effect on the electronic 3d-shell. The pressure dependent Co L-edge spectra are compared to multiplet calculations based on the structural data obtained from refinements of the XRD data. Combining elastic tuning of the lattice structure with XRD, Co L-edge spectra and core-level-spectroscopy simulations, is a very promising approach to confirm whether honeycomb cobaltates can be driven into the Kitaev QSL state.

MA 40.9 Thu 17:15 H20

Easy-axis Heisenberg model on the triangular lattice: from supersolid to gapped solid — •Martin Ulaga[1], Jure Kokalj[2,3], Takami Tohyama[4], and Peter Prelovšek[3] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Faculty of Civil and Geodetic Engineering, University of Ljubljana, Ljubljana, Slovenia — [3]Department of Applied Physics, Tokyo University of Science, Tokyo, Japan — [4]Jožef Stefan Institute, Ljubljana, Slovenia

We investigate the easy-axis Heisenberg model on the triangular lattice by numerically studying excitations and the dynamical spin structure factor $S^{\mu\mu}(\mathbf{q},\omega)$. Results are analyzed within the supersolid scenario, characterized by the translation-symmetry-breaking parameter m_z and the supersolid off-diagonal order parameter $m_\perp$. We find very robust $m_z > 0$ in the whole easy-axis anisotropy regime $\alpha = J_\perp/J_z > 0$, even enhanced by the magnetic field $h > 0$. Results also support $m_\perp > 0$ for intermediate $\alpha < 1$ and $h > 0$. Still, at small $\alpha \lesssim 0.2$, relevant for recent experiments on the magnetic material $K_2Co(SeO_3)_2$, we find at $h = 0$ rather vanishing $m_\perp \sim 0$, consistent with numerical evidence of a finite magnon excitation gap

MA 40.10 Thu 17:30 H20

Localized Magnons in the Generalized Model of the Sawtooth Chain with Dzyaloshinskii-Moriya Interactions — •Vadim Ohanyan[1,2], Johannes Richter[3,4], Michael Sekania[5,6], Marcus Kollar[7], and Lucas Giambattista[7] — [1]Laboratory of Theoretical Physics, Yerevan State University, 1 Alex Manoogian, 0025 Yerevan, Armenia — [2]CANDLE, Synchrotron Research Institute, 31 Acharyan Str., 0040 Yerevan, Armenia — [3]Institut für Physik, Universität Magdeburg, P.O. Box 4120, D-39016 Magdeburg, Germany — [4]Max-Planck-Institut für Physik Komplexer Systeme, Nöthnitzer Straße 38, D-01187 Dresden, Germany — [5]Reichenzentrum, University of Augsburg, 86135 Augsburg, Germany — [6]Center for Condensed Matter Theory and Quantum Computations, Ilia State University, 0162, Tbilisi, Georgia — [7]Theoretical Physics III, Center for Electronic Correlations and Magnetism, Institute of Physics, University of Augsburg, 86135 Augsburg, Germany

We consider a generalized model of a spin-S sawtooth chain with three distinct exchange couplings and Dzyaloshinskii-Moriya (DM) interactions. The primary focus of our research is on various scenarios for magnonic flat-band formation and the corresponding properties of localized magnons. A general flat-band constraint is derived, which, due to the large number of parameters in the model, allows for a broad diversity of flat-band scenarios. We provide a detailed analysis of different solutions to the flat-band constraint, construct the associated localized magnon states, and study the properties of the one-magnon spectrum.