MA 47: Altermagnets V

Time: Thursday 15:00–18:00 Location: HSZ/0002

MA 47.1 Thu 15:00 HSZ/0002

Electronic correlations and non-colinear spins driving chirality-induced spin selectivity — Jacek Herbrych[1], Nicole Naber[2], and •Maria Daghofer[2] — [1]Wroclaw University of Science and Technology, Wroclaw, Poland — [2]FMQ, Universität Stuttgart, Stuttgart, Germany

Starting from a non-interacting p-orbital model for helical organic molecules, we look at the impact of onsite Hubbard and Hund's-rule interactions. We find that they can induce an orbital-selective Mott transition as well as a block spiral with non-colinear helical magnetic order. We then investigate the resulting chiral bands and find them to be partially spin polarized, a manifestation of p-wave magnetism. Using density-matrix renormalization group, cluster perturbation theory and Monte-Carlo methods, we find that small spin-orbit coupling together with strong correlations robustly leads to spin-polarized bands, even at moderately high temperature and for short correlation lengths. We thus propose this combination as an explanation of chirality-induces spin selectivity and also discuss the interplay of such non-colinear spin patterns with magnetised leads.

MA 47.2 Thu 15:15 HSZ/0002

Chiral phonon-electron interaction in altermagnets — •Armando Consiglio[1], Giancarlo Panaccione[1], and Domenico Di Sante[1,2] — [1]CNR-Istituto Officina dei Materiali (IOM), Unità di Trieste, Strada Statale 14, km 163.5, 34149 Basovizza (TS), Italy — [2]Department of Physics and Astronomy, University of Bologna, 40127 Bologna, Italy

The recent discovery of altermagnetism has opened new frontiers in condensed matter physics, bridging the behaviour of collinear antiferromagnets and ferromagnets. Altermagnetic materials exhibit zero net magnetization while hosting spin-split electronic bands, suggesting novel couplings between lattice and electronic degrees of freedom with potential implications for chiral phonon formation and magneto-phononic effects. In this study, we focus on MnTe and CrSb and present two main results. First, we identify signatures of chiral phonons in the presence of altermagnetic order. Second, we analyze the coupling between these chiral phonon modes and the low-energy electronic states of the compounds, revealing new magneto-phononic interactions. The work provides insight into the interplay between spin order and lattice dynamics in altermagnetic materials, highlighting their potential for novel spintronic and phononic functionalities.

MA 47.3 Thu 15:30 HSZ/0002

Spin polarized optical excitation in altermagnetic RuO_2 — •Paul Herrgen[1], Luca Haag[1], Stephan Wust[1], Marius Weber[1], Akashdeep Akashdeep[2], Mathias Kläui[2], Gerhard Jakob[2], Hans Christian Schneider[1], Benjamin Stadtmüller[3], and Martin Aeschlimann[1] — [1]Department of Physics and Research Center OPTIMAS, RPTU University Kaiserslautern-Landau, 67663 Kaiserslautern, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz, 55099 Mainz, Germany — [3]Institute of Physics, University of Augsburg, 86159 Augsburg, Germany

Altermagnetic materials open new avenues for spintronic applications in compensated magnets due to the spin-split band structure. This unconventional electronic configuration enables access to spin-polarized, all-optical excitation despite the absence of a net magnetization.

In this work, we experimentally probe optically induced spin polarization in the altermagnetic material candidate RuO_2 [1]. The out-of-plane Néel vector of the system allows for the detection of the induced spin polarization via polar magneto-optical Kerr effect (MOKE) measurements. In light of the ongoing debate surrounding the altermagnetic nature of RuO_2, we conducted a systematic study across a range of film thicknesses. Our results show that altermagnetic behavior is observable only in the thinnest films, while increasing thickness leads to a progressive suppression of the characteristic altermagnetic response.

[1]: Weber et al., arXiv:2408.05187 (2024)

MA 47.4 Thu 15:45 HSZ/0002

Non-collinear achiral altermagnetic semiconductor — •Mengli Hu[1], Mikel Iraola[1], Paul McClarty[2], Jeroen van den Brink[1,3], and Maia G. Vergniory[4,5] — [1]Leibniz Institute for Solid State and Materials Research, IFW Dresden, Helmholtzstraße 20, 01069 Dresden, Germany — [2]Laboratoire Léon Brillouin, CEA, CNRS, Université Paris-Saclay, CEA-Saclay, 91191 Gif-sur-Yvette, France — [3]Würzburg-Dresden Cluster of Excellence Ct.qmat, Technische Universitat Dresden, 01062, Dresden, Germany — [4]Département de Physique et Institut Quantique, Université de Sherbrooke, Sherbrooke, J1K 2R1 Québec, Canada. — [5]Donostia International Physics Center, 20018 Donostia-San Sebastian, Spain

Altermangnets (AMs) constitute a novel family of magnetic materials characterized by the absence of net magnetization and the presence of spin-polarized band structures. Whereas AM phases were initially proposed in collinear structures, the recently discovered noncollinear chiral AMs stand out for their distinct hedgehog spin texture and multifunctionality in spintronics. In this work, we deepen the characterization of these systems by constructing a Landau theory for noncollinear achiral AMs. Furthermore, we demonstrate that the achiral symmetry of the crystal is reflected in the spin texture in reciprocal space, which presents only spatial-even multipoles. These multipoles, distinguished from those in collinear AMs via the high-order secondary order parameters, can couple to many phenomena. Our results suggest non-collinear achiral AMs as a promising platform for spintronics applications due to the potential to achieve various spin textures.

MA 47.5 Thu 16:00 HSZ/0002

Circular Dichroism in Resonant Photoelectron Diffraction on Altermagnetic MnTe Films — •Lena Hirnet, Marco Dittmar, Maximilian Ünzelmann, and Friedrich Reinert — Exp. Physik VII and Würzburg-Dresden Cluster of Excellence ctd.qmat, Universität Würzburg, Germany

Altermagnets have lately attracted great attention combining antiferromagnetic spin alignment in real space with a momentum-dependent spin polarization of the electronic states in the band structure. One of the proposed altermagnet work horse materials is MnTe [1,2]. Recently, it has been theoretical predicted that the circular dichroism observed in resonant photoelectron diffraction patterns serves as a direct probe of the altermagnetic sublattice texture [3]. Here, we present resonant photoemission experiments conducted at soft x-ray photon energies corresponding to the Mn $L_{2,3}$ absorption edge. In the corresponding photoelectron diffraction pattern, we can identify the scattering processes of electrons — photoexcited from the Mn-3d states — with the surrounding sublattice atoms. In particular, we find Mn-Mn and Mn-Te forward-scattering peaks and will discuss their dichroic texture which compares very well with the theoretical calculations [3].

[1] L. Šmejkal *et al.*, Phys. Rev. X **12**, 031042 (2022)
[2] J. Krempaský *et al.*, *Nature* **626**, 517-522 (2024)
[3] P. Krüger, Phys. Rev. Let **135**, 196703 (2025)

MA 47.6 Thu 16:15 HSZ/0002

Atomic altermagnetism — •Rodrigo Jaeschke-Uiergo[1], Venkata K. Bharadwaj[1], Warlley Campos[2], Ricardo Zarzuela[1], Nikolaos Biniskos[3], Rafael M. Fernandes[4], Tomáš Jungwirt[5], Jairo Sinova[1], and Libor Šmejkal[2,6,1,5] — [1]Johannes Gutenberg Universität, Mainz, Germany — [2]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [3]Charles University, Prague, Czech Republic — [4]University of Illinois Urbana-Champaign, Urbana, USA — [5]Czech Academy of Sciences, Prague, Czech Republic — [6]Max Planck Institute for Chemical Physics of Solids, Dresden Germany

Altermagnetism has recently been verified experimentally in MnTe and CrSb, which feature two sublattices with antiparallel magnetic dipole moments. In this talk, I will introduce the concept of atomic altermagnetism, a form of ferroic higher-order partial waves of the atomic spin density. Using spin-symmetry analysis and a partial-wave decomposition of first-principles spin densities, we demonstrate such non-dipolar spin order in MnTe, CrSb and KV_2Se_2O, where it coexists with the Néel order. In the Mott insulator Ba_2CaOsO_6, we uncover a striking case of pure atomic altermagnetism, which is entirely absent of dipolar sublattice order. These results show that altermagnetism can occur without Néel order. Finally, I will show that KV_2Se_2O and Ba_2CaOsO_6 are predicted to host giant spin-splitter angles of up to

42° and 26°, respectively demonstrating that strong altermagnetic responses can emerge without requiring the staggered Néel order of local dipole moments.

15 min break

MA 47.7 Thu 16:45 HSZ/0002

High-field magnetotransport and quantum oscillations in altermagnetic CrSb — •Sajal Naduvile Thadathil[1,2], B. V. Schwarze[1], T. Kotte[1], M. Uhlarz[1], C. Muller[3,4], P. Ritzinger[3,4], K. Vyborny[3], T. Speliotis[5], J. Pospisil[4], R. G. Hernandez[6], H. Reichlova[3], D. Kriegner[3], J. Wosnitza[1,2], and T. Helm[1] — [1]Dresden High Magnetic Field Laboratory (HLD-EMFL), HZDR, Germany — [2]Institute of Solid-State and Materials Physics, TU Dresden, Germany — [3]Institute of Physics ASCR, Czech Republic — [4]Charles University, Czech Republic — [5]Institute of Nanoscience and Nanotechnology, Greece — [6]Universidad del Norte, Colombia

Within the family of altermagnets, CrSb is a metallic, collinearly ordered material that exhibits particularly strong symmetry-induced spin splitting in its band structure. In this study, we combine electrical magnetotransport measurements up to 70 T on microfabricated single-crystalline CrSb with first-principles calculations to investigate its Fermi surface. Our experiments reveal a non-saturating magnetoresistance and nonlinear Hall resistivity consistent with multiband charge transport. Notably, we report the observation of Shubnikov-de Haas quantum oscillations in CrSb. Band-structure calculations, when compared with our measurements, accurately reproduce the expected Fermi-surface geometry. These results confirm the predicted electronic band structure of CrSb, establish robust multi-charge-carrier transport at high fields, and highlight the importance of high-field experiments for mapping electronic band structures of altermagnets.

MA 47.8 Thu 17:00 HSZ/0002

Altermagnetism in RuO_2? An experimental study on strain and stoichiometry in heterostructures — •Maik Gaerner[1], Niklas Schmolka[1], Alexander Weissbach[2], Joachim Wollschläger[2], Karsten Rott[1], Jan Schmalhorst[1], Martin Wortmann[3], and Günter Reiss[1] — [1]Bielefeld University, Germany — [2]Osnabrück University, Germany — [3]Bielefeld University of Applied Sciences and Arts, Germany

RuO_2 is a widely studied altermagnetic candidate material, but its magnetic ground state remains actively debated. While some studies find little to no evidence of altermagnetic order in RuO_2 thin films [1,2], others report on clear signatures of altermagnetism [3]. Strain and stoichiometry are widely regarded as key parameters for electronic and magnetic properties of RuO_2 [4,5].
Here, we analyze the impact of strain as well as stoichiometry on the appearance of altermagnetic order in RuO_2. Therefore, we investigate RuO_2 heterostructures, probing e.g. spin-torques and tunnel magnetoresistance. Through an accompanying, systematic X-ray photoelectron spectroscopy study, we analyze the thermal instability of oxidation states in the near surface region to elucidate the role of process temperature in the production of heterostructures.

[1] Akashdeep et al., arXiV:2510.08064 (2025)
[2] Jechumtál et al., arXiV:2508.11481 (2025)
[3] Noh et al. Phys., Rev. Lett. 134, 246703 (2025)
[4] Brahimi et al., J. Phys. Condens. Matter 37 395801(2025)
[5] Smolyanyuk et al., Phys. Rev. B 109, 134424 (2024)

MA 47.9 Thu 17:15 HSZ/0002

Altermagnetic non-reciprocal magnon transport in insulating d-wave orthoferrites — •Jonas Köhler[1], Edgar Galindez-Ruales[1], Shixun Cao[2], Ulrich Nowak[3], Gerhard Jakob[1], and Mathias Kläui[1] — [1]Institute of Physics, Johannes Gutenberg University Mainz, 55099 Mainz, Germany. — [2]Materials Genome Institute, Institute of Quantum Science and Technology, International Center for Quantum and Molecular Structures, Shanghai University, 99 Shangda Road, Shanghai, 200444, China. — [3]Fachbereich Physik, Universität Konstanz, Universitätsstr. 10, Konstanz, 78457, Germany.

Altermagnetic materials have recently been predicted to host unique magnonic phenomena, including chiral magnon modes, anisotropic magnon lifetimes, and spin transport without additional symmetry breaking by magnetic fields [1].

We present non-local transport in the insulating rare-earth orthoferrites $LuFeO_3$ and $YFeO_3$. We observe a non-zero magnon spin-transport signal for the Spin-Hall-injected magnons, indicating a field-free spin-biased magnon transport. Using thermal excitation via the Spin-Seebeck effect, we observe a strong directional dependence. The signal in the $\Gamma - U$ direction has the opposite sign from the one in the $\Gamma - U'$ direction, while it vanishes along and perpendicular to the easy axis, suggesting a suppression along those crystallographic directions. This shows the altermagnetic spin split magnons, and we can reproduce the observation with an atomistic spin dynamics model.

[1] L. Šmejkal, Phys. Rev. Lett., 2023, 131, 256703.

MA 47.10 Thu 17:30 HSZ/0002

Magnetic structure and the detwinning effect under applied magnetic field in the altermagnet α-MnTe — •Feihao Pan[1], Yishui Zhou[1], Sabreen Hammouda[1], Yinghao Zhu[1], Soohyeon Shin[1], Karin Schmalzl[2], Wolfgang Schmidt[2], Eric Ressouche[3], Oscar Ramon Fabelo Rosa[4], and Yixi Su[1] — [1]Jülich Centre for Neutron Science (JCNS) at the Heinz Maier-Leibnitz Zentrum (MLZ), Forschungszentrum Jülich, Lichtenbergstrasse 1, D-85747 Garching, Germany — [2]Jülich Centre for Neutron Science (JCNS) at ILL, Forschungszentrum Jülich, F-38000 Grenoble, France — [3]IRIG, CEA and Université Grenoble Alpes, CEA Grenoble, F-38054 Grenoble, France — [4]Institut Laue-Langevin, 71 avenue des Martyrs, 38042 Grenoble Cedex 9, France

Altermagnetism has garnered significant interest due to spin splitting without relativistic spin-orbit coupling and its promising applications in spintronics. We have recently carried out a detailed single-crystal neutron diffraction study of α-MnTe under applied in-plane magnetic field. We found that a moderate field can generate a strong detwinning effect of magnetic domains. The determination of the magnetic structure of α-MnTe, carried out under both the twined and detwinned conditions, allows us to conclude that the magnetic moment of Mn is indeed colinearly ordered and is uniquely aligned along the crystallographic [1,1,0] direction. This important finding can pave the way for future investigations of altermagnetic phenomena, such as chiral magnon splitting and unconventional spin transport, in α-MnTe under almost detwinned conditions via a wide range of experimental probes.

MA 47.11 Thu 17:45 HSZ/0002

Altermagnetism from the point of view of Mössbauer spectroscopy and other local probes — •Felix Seewald[1], Tillmann Weinhold[1], Cornelius Herrmann[1], Jan Friedrichsen[1], Domenic Nowak[2], Rowena Wachtel[2], Rajib Sarkar[1], Sabine Wurmehl[2], and Hans-Henning Klauss[1] — [1]IFMP, TUD Dresden University of Technology — [2]Leibniz Institute for Solid State and Materials Research, IFW, Dresden

Altermagnetism has emerged as a hot topic of interest in solid state magnetism during recent years. Altermagnets combine a compensated antiferromagnetic structure with spin-split electronic bands. [1, 2]

We want to discuss what one can learn about altermagnetism from (nuclear) local probe spectroscopy, focusing mainly on Mössbauer spectroscopy (MBS) and NMR/NQR.

Depending on the type of altermagnet and the easy axis of the antiferrromagnetic order, local probes can prove or disprove the altermagnetic order. For d-wave altermagnets in Mössbauer spectroscopy and NMR/NQR studies the interplay between the local electric field gradient and the local magnetic hyperfine field may directly differentiate the altermagnetic sites.

We wull discuss Mössbauer spectroscpy as well as NMR/NQR studies on candidates FeF_2, FeF_3, $La_2O_2FeMnOSe_2$ and furthermore highlight the challenges and restrictions they are connected with.

[1] L. Smejkal et al., Phys. Rev. X 12, 031042 (2022)
[2] Fender et al., J. Am. Chem. Soc., 147, 2257-2274 (2025)