MA 54: Altermagnets VI

Time: Friday 9:30–12:30 Location: HSZ/0002

MA 54.1 Fri 9:30 HSZ/0002

A metallic p-wave magnet with commensurate spin helix — Rinsuke Yamada[1], •Jan Masell[2,3], Moritz M. Hirschmann[3], and Max Hirschberger[1,3] — [1]The University of Tokyo, Tokyo, Japan — [2]Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany — [3]RIKEN Center for Emergent Matter Science (CEMS), Wako, Japan

Antiferromagnetic states with a spin-split electronic structure give rise to spintronic, magnonic and electronic phenomena despite (near-)zero net magnetization. Even-parity spin-split magnets (d, g-wave) can be collinear and are known as altermagnets. Odd-parity magnets (p, f-wave) may be termed antialtermagnets and need co-planar magnetic order.[1] In this talk, we present our recent experimental realization of a metallic p-wave magnet, the simplest odd-parity spin-split magnet. [2] The magnetic texture is a coplanar spin helix whose magnetic period is an even multiple of the chemical unit cell, as revealed by X-ray scattering experiments. This texture breaks space-inversion symmetry but approximately preserves time-reversal symmetry up to a half-unit-cell translation, thereby fulfilling the symmetry conditions for p-wave magnetism. Consistent with theoretical predictions, our p-wave magnet shows a characteristic anisotropy in the electronic conductivity. Spin-orbit coupling and a tiny spontaneous net magnetization further break time-reversal symmetry, resulting in a giant anomalous Hall effect.

[1] A. B. Hellenes et al. arXiv2309.01607 (2024). [2] R. Yamada et al. Nature 646, 837 (2025).

MA 54.2 Fri 9:45 HSZ/0002

Giant Faraday Effect of magnon-polarons in the magnetoelectric altermagnet Fe2Mo3O8 — •Kirill Vasin[1], Sandor Bordács[2], Lilian Prodan[1], Vladimir Tsurkan[3], Istvan Kézsmárki[1], and Joachim Deisenhofer[1] — [1]University of Augsburg, Augsburg, Germany — [2]Budapest University of Technology and Economics, Budapest, Hungary — [3]Moldova State University, Chisinau, Republic of Moldova

We investigate magnetic circular dichroism of magnon-polarons in the polar altermagnet candidate $Fe_2Mo_3O_8$ using time-domain terahertz magnetospectroscopy. From linearly polarized measurements in Faraday geometry we reconstruct right- and left-circular transmission, revealing hybrid magnon-phonon branches which are fully circularly polarized below the Néel temperature. These magnon-polarons are both electric- and magnetic-dipole active and produce exceptionally large Faraday rotations in the terahertz range, with Verdet constant up to $\sim 4100°/T/cm$. A suggested minimal circular-birefringent dielectric model captures both the magnitude and field dependence of the response.

MA 54.3 Fri 10:00 HSZ/0002

Mn4As3: a structure-search prediction of altermagnetism in a tetragonal Mn-As compound — •Bo Tai[1], Yu Zhu[1], Weikang Wu[2], and Xiaolong Feng[1] — [1]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Straße 40, 01187 Dresden, Germany — [2]Key Laboratory for Liquid-Solid Structural Evolution and Processing of Materials, Ministry of Education, Shandong University, Jinan 250061, China

We predict that 2D Mn4As3 is a dynamically stable altermagnetic Mn-As compound obtained from an ab initio structure search. The search identifies a tetragonal P4/mmm structure as the lowest-energy configuration, and confirming its dynamical stability. Using first-principle calculation, we find 2D Mn4As3 (P4'/mm'm) breaks PT symmetry while preserving zero net magnetization, realizing an altermagnetic state. Spin-resolved band structures reveal characteristic momentum-dependent spin splitting: spin-up and spin-down bands are split along Γ-X and Γ-Y but remain degenerate along Γ-M, leading to a Fermi-surface spin texture with a d-wave-like pattern of spin splitting. Berry-curvature and transport calculations further show that rotating the magnetic moment (Néel vector) direction provides effective control over both the anomalous Hall conductivity and the positions of band crossings near the Fermi level. These results establish structure-searched Mn4As3 as a dynamically stable altermagnet and a promising platform for magnetization-direction control of Berry-phase transport in Mn-pnictides.

MA 54.4 Fri 10:15 HSZ/0002

Antichiral surface states in altermagnets — •Sopheak Sorn — Institute for quantum materials and technology, Karlsruhe Institute of Technology, Karlsruhe, Germany — Institute of theoretical solid state physics, Karlsruhe Institute of Technology, Karlsruhe, Germany

Altermagnets host symmetry-protected nodal lines and nodal planes in their band structures. In this talk, I will show how nodal lines in d-wave altermagnets give rise to unusual surface states that are antichiral. Antichiral surface states on two opposite surfaces of a slab geometry propagate parallel to one another, in contrast to the antiparallel propagation direction of chiral surface states. I demonstrate the presence of antichiral surface states using a tight-binding model. The antichiral character and many important features of the antichiral surface states are explained using a mapping from the altermagnetic model to Su-Schrieffer-Heeger chains: the topological index and the bulk-boundary correspondence of the latter explain the antichiral surface states. This work indicates that altermagnets are one of the few quantum materials that can support such antichiral surface states.

Reference [1] Sopheak Sorn, Antichiral surface states and Su-Schrieffer-Heeger physics in rutile altermagnets, Phys. Rev. B 111, L161109 (2025).

MA 54.5 Fri 10:30 HSZ/0002

Quantum Entanglement Signatures of Altermagnetism — •mahsa seyed heydari, wolfgang belzig, and sebastián a. díaz — Universität Konstanz

In two-sublattice magnets in an antiferromagnetic configuration, the notion of two-mode squeezing is equivalent to quantum entanglement between the sublattice spins[1]. It has been shown that the logarithmic negativity is linearly related to the squeezing parameter. Altermagnets are a particular class of magnets which have a vanishing total magnetisation but a peculiar spin-polarization texture in momentum space. Using a simple model an altermagnet [2], we determine the magnon spectrum of an altermagnet and show that particular entanglement features witness the altermagnetic nature. Hence, we show that quantum magnonics offers a route towards distinguishing altermagnets from simple antiferromagnets, which is a difficult experimental task to date.

[1] Kamra, A.; Belzig, W. Phys. Rev. Lett. 2016, 116, 146601.

[2] Brekke, B.; Brataas, A.; Sudbø, A. Phys. Rev. B 2023, 108, 224421.

MA 54.6 Fri 10:45 HSZ/0002

Persistent altermagnetic spin polarisation — •Wallley H. Campos[1], Florette C. F. Mbognou[1], Anna B. Hellenes[2,3], Jan Priessnitz[1], and Libor Šmejkal[1,3] — [1]Max Planck Institute for the Physics of Complex Systems, 01187 Dresden, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz, 55099 Mainz, Germany — [3]Institute of Physics, Czech Academy of Sciences, 162 00 Praha 6, Czech Republic.

Altermagnets exhibit d-, g-, or i-wave collinear spin polarisation of non-relativistic exchange origin [1]. Relativistic spin-orbit coupling (SOC) is commonly considered to generate noncollinear spin textures in reciprocal space. Here, we demonstrate that collinear, persistent altermagnetic spin polarisation (PASP) in the full Brillouin zone is possible even in the presence of strong SOC. By combining spin and magnetic layer group analysis, we identify two distinct classes of PASP: one materialising on top of strong exchange spin splitting, and the other accompanying a typically weaker [2], relativistic spin splitting. We then perform *ab initio* calculations to realise the strong and weak types in Lieb-lattice [3-5] and cuprate altermagnets [1], respectively. Finally, we discuss experimental indication of weak PASP in MnTe [2]. PASP could enable strong spintronics currents with long spin lifetimes and efficient spin accumulation [5].

[1] L. Šmejkal *et al.*, Phys. Rev. X **12**, 031042 (2022). [2] Krempasky *et al.*, Nature (2024); A. Dal Din *et al.*, arXiv:2511.01690. [3] R. Jaeschke-Ubiergo *et al.*, arXiv:2503.10797. [4] N. Parthenios *et al.*, arXiv:2502.19270. [5] L.E. Golub *et al.*, arXiv:2503.12203.

15 min. break

MA 54.7 Fri 11:15 HSZ/0002

Spin Orbit Coupling Affecting the Presence of Altermagnetism in $La_2O_2TM_2OSe_2$, TM={Fe, Mn, $Fe_{0.5}Mn_{0.5}$} — •Tillmann Weinhold[1], Cornelius Herrmann[1], Domenic Nowak[2], Rowena Wachtel[2], Felix Seewald[1], Rajib Sarkar[1], Sabine Wurmehl[2], and Hans-Henning Klauss[1] — [1]Institute of Solid State and Materials Physics, IFMP, TUD Dresden University of Technology — [2]Leibniz Institute for Solid State and Materials Research, IFW, Dresden

Altermagnets are a recently discovered type of solid with magnetic order leading to zero net magnetization while providing spin-splitting effects of electron bands of up to multiple eV.

While hundreds of possible candidates have been found by analyzing proposed crystal and magentic structures, only few of them could be experimentally proven to be altermagnets by now.

By the use of local probe techniques we were able to precisely determine the magnetic structure of $La_2O_2Fe_2OSe_2$, a compound isostructural to two proposed altermagnets, namely $La_2O_2FeMnOSe_2$ and $La_2O_2Mn_2OSe_2$.

A comparison of these conclusions with upcoming results of the other two compounds can give strong indications or possibly even experimental verification of whether the magnetic phase of these materials is altermagnetic.

MA 54.8 Fri 11:30 HSZ/0002

Ultrafast carrier dynamics in the g-wave altermagnet $CoNb_4Se_8$ — •Alexander Schmid[1], Gregor Zinke[1,2], Resham B. Regmi[3], Luca Haag[2], Tobias Eul[1], Hans C. Schneider[2], Nirmal J. Ghimire[3], Martin Aeschlimann[2], and Benjamin Stadtmüller[1] — [1]University of Augsburg — [2]RPTU University Kaiserslautern-Landau — [3]University of Notre Dame, USA

Altermagnets have sparked considerable interest as a new type of compensated magnet with an unconventional spin splitting in momentum space that is rooted in the crystal and spin group symmetries of these materials.

In the manifold of altermagnetic candidates, intercalated transition metal dichalcogenides such as $CoNb_4Se_8$ have been identified as altermagnetic materials with characteristic g-wave spin splitting below 168 K. [1]

In our work, we used time- and momentum-resolved photoemission to gain insight into the ultrafast dynamics of the layered altermagnetic $CoNb_4Se_8$. Specifically, we focus on the ultrafast carrier dynamics near the characteristic spin-split bands at the M-point of the band structure, both in the altermagnetic and paramagnetic phases. This direct comparison allows us to uncover the impact of the spin and nodal plane structure of altermagnets on the ultrafast charge and spin carrier scattering. Our findings will be a vital first step toward understanding the optical response of altermagnets on ultrafast timescales.

[1] R. B. Regmi et al., Nat. Commun. 16, 4399 (2025)

MA 54.9 Fri 11:45 HSZ/0002

Emergent d-wave surface altermagnetism in G-type Heusler antiferromagnets V_3Al and V_2TiSi — •Ersoy Sasioglu, Ingrid Mertig, and Samir Lounis — Institute of Physics, Martin Luther University Halle-Wittenberg, 06120 Halle (Saale), Germany

Antiferromagnets that preserve combined inversion and time-reversal symmetry (PT) necessarily exhibit spin-degenerate electronic bands in the absence of spin-orbit coupling. Using density-functional theory, we show that asymmetric surface terminations of centrosymmetric G-type Heusler antiferromagnets lift the PT symmetry and give rise to an exchange-driven, nonrelativistic d-wave spin splitting, a mechanism we term *surface altermagnetism.* In the antiferromagnetic semimetal V_3Al, an experimentally established compound with $T_N \approx 700$ K, and in the antiferromagnetic semiconductor V_2TiSi, the interior layers of the slab retain the conventional compensated G-type order and spin-degenerate electronic structure, whereas inequivalent surface terminations induce pronounced d-wave spin splittings and metallic surface states localized on the outer transition-metal layers that decay exponentially toward the bulk. These results demonstrate that surface altermagnetism arises purely from lattice-symmetry breaking at asymmetric terminations, providing a robust, exchange-driven route to engineer spin-polarized metallic surface states in high-temperature G-type antiferromagnets without invoking spin-orbit coupling.

MA 54.10 Fri 12:00 HSZ/0002

P-wave magnetism with helical order — •Jaafar Ansari[1] and Libor Šmejkal[1,2,3] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [3]Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic

The emergent class of magnetic materials exhibiting p-wave [1] spin polarization represents a critical frontier in condensed matter physics for holding considerable promise for advanced spintronic architectures. Examples have been studied in commensurate and incommensurate p-wave structures with asymmetric spin polarizations [2-4]. This work presents a systematic theoretical classification of systems capable of realizing this unique band-structure symmetry, which is rooted in spin group theory. Our study focuses on helimagnets that do and do not generate p-wave order. By ab initio calculations we investigate the role played by broken inversion symmetry, noncollinearity of the spins, and the robustness of the p-wave polarisation against spin-orbit interaction. Our analysis characterizes the conditions under which the nominal p-wave symmetry is maintained, partially suppressed or entirely lost, and identifies material candidates. [1] Hellenes, A. B., et. al, arXiv.2309.01607 (2023), [2] Chakraborty, A., et al., Nat Commun 16, 7270 (2025), [3] Kim, S.-J, et. al., Adv. Sci. 11, 2307306 (2024), [4] Alvarez, N., Phys. Rev. B 112, 024404 (2025)

MA 54.11 Fri 12:15 HSZ/0002

Evidence for spin split bands in RuO_2 investigated by ultrafast magnetization dynamics — •Kevin Jäckel[1], Holger Grisk[1], Niklas Dornquast[1], Jakob Walowski[1], Markus Münzenberg[1], Maik Gaerner[2], Günter Reiss[2], and Timo Kuschel[2,3] — [1]University of Greifswald, Germany — [2]Bielefeld University, Germany — [3]Johannes Gutenberg University Mainz, Germany

In the search for new materials suitable for spintronic applications, the recently discovered altermagnets open up novel paths of research. In our work we focus on the proposed d-wave altermagnetic material RuO_2 by measuring its magnetic response to circularly polarized ultrashort laser pulses. Hereby we propose a way to link its ultrafast demagnetization dynamics, which are accessed by employing time-resolved magneto-optical Kerr effect measurements, to other, well established material systems such as semiconducting GaAs or topological insulators [1]. Therefore, we measure both the real and imaginary parts of the Kerr rotation, which are the Kerr angle and the Kerr ellipticity related to magnetic circular birefringence and dichroism. We see a strong, transient response, which scatters on a femtosecond timescale and can be described by the Raman coherence time.

[1] https://doi.org/10.1038/srep15304