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Structure, Control, and Dynamics of Altermagnetic Textures



Altermagnets are collinear magnetically ordered phases with zero net magnetization and alternating spin polarization. These emergent materials combine fast magnetic dynamics with large spin band splitting. Both effects arise from strong (non-relativistic) exchange interactions between local magnetic moments and electron spins. I will present a phenomenological theory of altermagnets that describes their unique magnetization dynamics and magnetic textures. Focusing on prototypical d-wave altermagnets such as RuO_2 , we can intuitively explain the unique lifted degeneracy of their magnon spectra by the emergence of an effective, sublattice-dependent, anisotropic spin stiffness, which arises naturally from the phenomenological theory.

I will discuss a symmetry-based approach to describe altermagnetic textures and dynamics using the altermagnet candidate Mn_5Si_3 as an example. The approach's key point is an altermagnetic order parameter that formalizes the symmetry of the magnetic atoms' local environment and enables the altermagnetic behavior to be distilled [1]. I will demonstrate how this concept enables us to reconstruct the equilibrium magnetic structure of Mn_5Si_3 from the field dependences of the anomalous Hall effect [2]–[4]. Finally, I will discuss the spin wave spectra and dynamics of the altermagnetic domain wall, focusing on a comparison between the altermagnetic and antiferromagnetic phases of the material.

[1] O. Gomonay et al., “Structure, control, and dynamics of altermagnetic textures,” npj Spintronics, vol. 2, art. no. 35, Jul. 2024, doi: 10.1038/s44306-024-00042-3.

[2] J. Rial, et al., “Altermagnetic variants in thin films of Mn_5Si_3 ,” Phys. Rev. B, vol. 110, art. no. L220411, Dec. 2024, doi: 10.1103/PhysRevB.110.L220411.

[3] M. Leiviskä, et al., “Anisotropy of the anomalous Hall effect in thin films of the altermagnet candidate Mn_5Si_3 ,” Phys. Rev. B, vol. 109, art. no. 224430, Jun. 2024, doi : 10.1103/PhysRevB.109.224430.

[4] R. Zarzuela, et al., “Transport theory and spin-transfer physics in d-wave altermagnets,” Phys. Rev. B, vol. 111, art. no. 064422, Feb. 2025, doi: 10.1103/PhysRevB.111.064422.

Short Bio

Olena V. Gomonay obtained the M.Sc. in condensed matter physics in 1985 from the Moscow Institute of Physics and Technology. She was awarded the Ph.D. in 1992 and a further doctoral degree in 2003, both in condensed matter physics, from the Kurdyumov Institute of Metal Physics, National Academy of Sciences of Ukraine, Kyiv. She became Associate Professor in 1995, and Professor in 2002, at the Institute of Physics and Technology, National Technical University of Ukraine – Kyiv Polytechnic Institute. Since 2015 she has been a member of the INSPIRE-SPICE Group at Johannes Gutenberg University of Mainz, Germany. Her research is on antiferromagnetic and altermagnetic spintronics, including magnetism theory, magnetoelasticity, and quantum optics.