Altermagnetism and spin symmetries

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In the last 90 years, magnetically ordered materials have been divided into two basic classes - ferromagnets and antiferromagnets. They are characterized by s-wave and no spin ordering in momentum space, respectively. In this talk, we will review our recent predictions of unconventional magnetic classes beyond ferromagnets and antiferromagnets[1,2]. Unconventional magnets are characterized by parameters of even (e.g. d-wave altermagnets) or odd (p-wave) wave ordering, which are not found in conventional ferromagnets and antiferromagnets. We show how the unconventional magnets can be identified using spin group theory, which considers - in contrast to conventional magnetic symmetries - pairs of symmetry operations in spin and lattice space. We will discuss the implications of unconventional magnetism in unconventional spin and anomalous Hall phenomena as well as recent experimental observations of d-wave altermagnetism in MnTe[3].

[1] Beyond Conventional Ferromagnetism and Antiferromagnetism: A Phase with Nonrelativistic Spin and Crystal Rotation Symmetry, L. Šmejkal, Jairo Sinova, T. Jungwirth, Phys. Rev. X 12, 031042 (2022).

[2] Exchange spin-orbit coupling and unconventional p-wave magnetism, Anna Birk Hellenes, Tomáš Jungwirth, Jairo Sinova, Libor Šmejkal, arXiv:2310.17280v2.

[3] Altermagnetic lifting of Kramers spin degeneracy, J. Krempaský*, L. Šmejkal*, et al., Nature 626, 517 (2024).