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Altermagnets, Antialtermagnets, and Spin Crystallography

Libor SMEJKAL

Max Planck Institute for the Physics of Complex Systems, Germany

Email: lsmejkal@pks.mpg.de

The discovery of altermagnetism has expanded the landscape of magnetic order, revealing a class of magnetic phases that combine key advantages of ferromagnets and antiferromagnets while exhibiting previously overlooked spin-polarization effects and couplings. More broadly, it has opened a pathway toward a systematic classification of magnetic states based on the symmetries they preserve and break.

In this talk, I will introduce the framework of spin crystallography, which extends crystallographic principles to symmetries arising solely from spin order and independent of spin-orbit coupling—analogous to the classification of superfluids and superconductors according to the symmetries of their order parameters. Spin crystallography has enabled the prediction and classification of d-, g-, and i-wave spin-polarized altermagnets, as well as p-, f-, and h-wave spin-polarized antialtermagnets. These phases are distinguished by the nontrivial ways in which their spin-polarized states break spin-rotational, lattice, and time-reversal symmetries. This framework has enabled the identification of hundreds of realistic material candidates, ranging from metals to insulators.

I will then discuss recent experimental observations of these magnetic states, focusing on their signatures in spin-polarized photoemission spectroscopy and evidence for their distinctive electronic structures in materials such as MnTe. Finally, I will discuss the opportunities that altermagnets and antialtermagnets offer for spintronics, multiferroics, and other functional quantum materials, highlighting how symmetry-guided materials design can enable new device concepts.

References:

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