A Tale of Three Atoms Displaying Ferroelectric, Ferrimagnetic and Altermagnetic Order

Juraj Krempaský

Center of Photon Science, Paul Scherrer Institut, Villigen PSI, Switzerland

Corresponding author: juraj.krempasky@psi.ch

Abstract. In this contribution I will discuss a scientific journey with just three atoms: Germanium, Manganese and Tellurium. By doping the simplest room-temperature ferroelectric, GeTe, with Manganese, the system develops complex multiferroic exchange interactions with competing ferromagnetic, antiferromagnetic, and antisymmetric exchange, also known as the Dzyaloshinskii–Moriya interaction, thereby combining magnetism with topological properties inherited from Rashba-type spin-splitting in the host GeTe [1-3]. By substituting Germanium with Manganese atoms, the MnTe "magic" near room-temperature antiferromagnet appears, which we recently addressed in the context of altermagnetism – as a central topic of condensed-matter physics demonstrating lifted Kramers spin degeneracy. Is the altermagnetism proving its place on the magnetic family tree as a 3rd distinct magnetic phase without net magnetization, yet with spin-polarization which combine merits of ferromagnets and antiferromagnets thought to be fundamentally incompatible? The experimental results from spin- and angle resolved photoemission spectroscopy, which I briefly introduce along with the Swiss Light Source beam lines where the photoemission experiments were carried out, provide us a direct evidence: in contrast to ferro- or antiferromagnets, altermagnets have a special combination of the arrangement of spins and crystal symmetries with opposite-spin sublattices connected by rotation rather than translation or inversion [4].

REFERENCES

1. Juraj Krempaský *et al*., "Operando Imaging of All-Electric Spin Texture Manipulation in Ferroelectric and Multiferroic Rashba Semiconductors", Phys. Rev. X **8**, 021067 (2018)
2. Juraj Krempaský *et al.*, "Entanglement and manipulation of the magnetic and spin–orbit order in multiferroic Rashba semiconductors", Nat. Comm. **7,** 13071 (2016)
3. Juraj Krempaský *et al*., "Efficient magnetic switching in a correlated spin glass", Nat. Comm. **14**, 6127 (2023)
4. Juraj Krempaský *et al*., "Altermagnetic lifting of Kramers spin degeneracy", Nature **626,** 517–522 (2024)