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EINLADUNG zum IFP-SEMINAR

Altermagnetism: spin symmetries and unconventional anomalous Hall currents

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Host: Jan Kunes

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Abstract:

Different phases of matter can be distinguished by symmetries, order parameters and topological properties [1]. In this talk, we will discuss the classification of magnetically ordered crystals according to recently studied spin symmetries [2]. Spin symmetries consider pairs of operations in spin and crystal space and remarkably reveal a non-traditional magnetic class. This unconventional class, called altermagnetism, is distinct from ferromagnets and antiferromagnets. It is characterized by an unconventional alternating spin order in electronic momentum space that breaks time-reversal symmetry and is spin compensated and nematic [2]. We show that these properties can arise from ordered and anisotropic spin densities (see figure) and crystal fields, as described for a typical ruthenium dioxide altermagnet [2,3,4,6]. Thus, altermagnetism does not require a Fermi liquid instability and can materialize in a wide range of materials including metals and insulators [2].

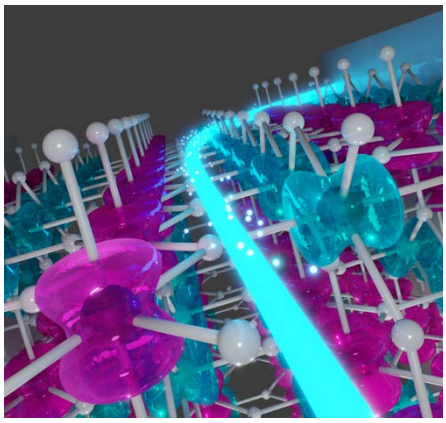

Figure 1 Magnetisation densities in Ruthenium Dioxide and anomalous Hall current in (110) crystallographic plane © Matthias Greber & LŠ

Finally, we show that spin symmetries provide a unifying explanation for the recently predicted and experimentally observed anomalous response [3,5,6,7 and references therein]. For example, all altermagnets generate an unconventional topological Berry curvature that leads to anomalous Hall currents without magnetisation [3,5,6].

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[5] Mazin, I.I et al., *PNAS* **118** (42) e2108924118 (2021)
[6] Feng, Z., Zhou, X., Šmejkal, L. et al. An anomalous Hall effect in altermagnetic ruthenium dioxide. *Nature Electron.* (2022). https://doi.org/10.1038/s41928-022-00866-z
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