Topological Hall effect in tetragonal Heusler thin films

Anastasios Markou,[1] Peter Swekis,[1] Pranava K Sivakumar,[2]
Stuart S.P. Parkin,[2] and Claudia Felser[1]

[1] *Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Str. 40, 01187 Dresden, Germany*
[2] *Max Planck Institute for Microstructure Physics, Weinberg 2, 06120 Halle, Germany*

Magnetic materials that host topological spin textures have come to the forefront of condensed matter physics and material science as potential candidates for future spintronic applications. Of these spin textures, skyrmions and antiskyrmions are mesoscale whirling objects with distinct chiral magnetic boundaries and opposite topological charges. Of particular interest is the antiskyrmion, which was theoretically predicted to exist in certain tetragonal materials with acentric crystal structures as, e.g., D_{2d}. Recently, the tetragonal Heusler compounds [1] show to host antiskyrmions, in addition to other topological spin textures of interest. Spin chirality in metallic materials with noncoplanar spin structure gives rise to a Berry phase induced topological Hall effect (THE), which can be used to distinguish magnetic textures for device applications.

Here, we present the structural, magnetic, and transport properties in epitaxial thin films of the tetragonal Mn_xPtSn and Mn_2RhSn Heusler compounds [2,3]. We tune the Mn content (x) by magnetron sputtering, which allows for microscopic control of the magnetic exchange parameters. Further, we observe topological Hall signatures of two distinct chiral spin textures. With our thin film method, we can access a novel and fundamental understanding of this compound not possible with other methods.

References:

[1] A. K. Nayak et al., Nature 548, 561-566 (2017).
[2] P.Swekis et al., Phys. Rev. Materials 3, 013001(R) (2019).
[3] P. K. Sivakumar et al., ACS Nano 14, 13463 (2020).

The authors acknowledge the European Union's Horizon 2020 research and innovation programme, under FET-Proactive grant agreement no. 824123 (SKYTOP)