Magneto-thermal transport in Mn-based complex magnetic materials

Helena Reichlova
Technische Universität Dresden

To harvest the omnipresent waste heat and exploit it as a driving force instead of an electric current in electronic devices is one of the goals of the field called spin-caloritronics. Although the application potential is tremendous, very fundamental scientific questions related to coupling of spin, charge and heat still remain to be answered. The lack of elementary understanding is even more obvious when thinking beyond simplest ferromagnets. Many emerging magnetic materials with non-trivial topology of the band structure exhibit record large spin-caloritronic responses[1] including materials with zero net magnetic moment (antiferromagnets)[2]. In this talk I will introduce the ongoing spin-caloritronics research at TU Dresden and FZU Prague.

The ferromagnetic Heusler compound Co_2MnGa is a promising Weyl semimetal with the Fermi energy in the vicinity of the Weyl nodes. Beside others, the non-trivial topology of the band structure leads to large anomalous Nernst coefficient in Co_2MnGa thin films - up to -3μV/K[3]. The experimental setup and qualitative evaluation of the magneto-transport coefficients in thin films will be also discussed.

Another interesting Weyl semimetal, non-collinear antiferromagnet Mn_3Sn, exhibits clear anomalous Hall and Nernst effects in bulk crystals despite its negligible net magnetic moment[4]. The anisotropy of these effects, however, complicates the anomalous Hall effect detection in epitaxial Mn_3Sn thin films. The versatility of the thermal gradient, however, enabled to detect the anomalous Nernst effect in thin films. Unlike the global thermal gradient applied in the sample plane in Co_2MnGa (Fig.1a), our approach was to generate the thermal gradient locally by laser (Fig.1b). By scanning the laser over the sample surface, spatially resolved magnetic contrast of Mn_3Sn films was achieved.

The most exciting consequence of non-trivial magnetic textures is the existence of unexpected phenomena. The complex spin texture of Mn_5Si_3 antiferromagnet allows for macroscopic time reversal symmetry breaking. Experimental demonstration of the anomalous Hall effect in collinear Mn_5Si_3 phase[5] and the outlook for further magneto-thermal transport experiments will be presented.

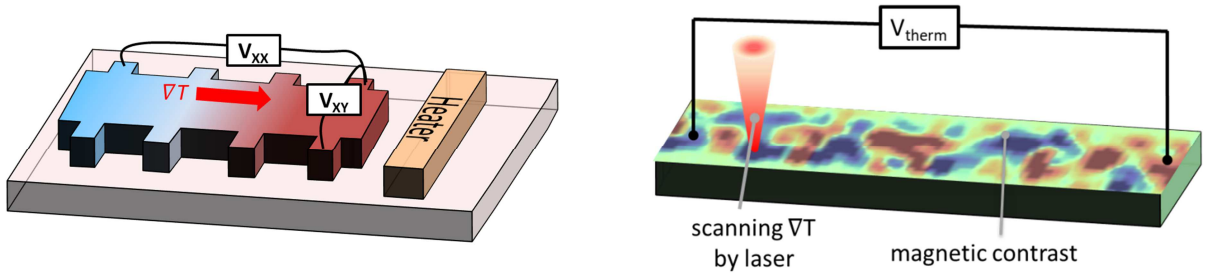

Figure 1- Experimental setup for magneto-thermal transport measuremenst. (a) Thermal gradient applied globally in the sample plane. (b) Thermal gradient applied locally by laser beam enabling a spatially resolved magnetic characterization.

[1] H. Reichlova et al., APL 113, 212405 (2018)
[2] H. Reichlova et al., Nature Commun. 10, 5459 (2019)
[3] G. H. Park, H.R. et al. PRB 101, 060406(R) (2020)
[4] M. Ikhlas, Nature Phys 13, 1085–1090 (2017)
[5] H. Reichlova et al., arXiv preprint arXiv:2012.15651 (2020)