On-line SPICE-SPIN+X Seminars

Wednesday, 8th June 2022, 15:00 (CET)

The seminar will be via Zoom (Meeting ID: 830 1721 5379) and live streamed in the SPICE YouTube Channel.

HELENA REICHLOVA,
TU Dresden

Spontaneous anomalous Hall response and altermagnetism explored in MnTe and Mn5Si3

Anomalous Hall effect is a prime example of electronic responses commonly associated with the spontaneous time-reversal symmetry breaking in the electronic structure of ferromagnets. More recently, the anomalous Hall effect and other time-reversal symmetry breaking responses were also theoretically and experimentally established in crystals with a vanishing net magnetization and a non-collinear magnetic order [1,2]. The experimental work presented in this talk has been inspired by theoretical predictions that the time-reversal symmetry breaking electronic structure and responses can occur within an abundant family of materials with a compensated collinear magnetic order [2-4]. The underlying unconventional magnetic phase forms in crystals whose opposite-spin sublattices are connected by a rotation symmetry-transformation [5]. Its characteristic feature is an alternating spin polarization in both real-space crystal structure and momentum-space electronic structure, which has suggested to term this emerging phase altermagnetism [5].

We will first present our experimental observation of a spontaneous anomalous Hall response in the absence of an external magnetic field in an epitaxial film of MnTe, which is a semiconductor with a collinear antiparallel magnetic ordering of Mn moments [6]. The anisotropic crystal environment of magnetic Mn atoms due to the non-magnetic Te atoms is essential for establishing the unconventional phase and generating the anomalous Hall effect in MnTe [5,6]. In the second part of the talk, we will present our observation of the spontaneous anomalous Hall effect in epitaxial thin-film Mn5Si3 [7]. We have studied Mn5Si3 epilayers grown on Si(111) substrate. We observe that epitaxial constraints stabilize a hexagonal unit cell in the magnetic state distinct from previously described phases in bulk Mn5Si3 crystals [8]. We observe a sizable spontaneous anomalous Hall conductivity of 5-20 S/cm, accompanied by a negligible net magnetization. Combined with the theoretical symmetry analysis and microscopic ab initio calculations, we conclude that our thin-film Mn5Si3 is a candidate

for a d-wave Fermi-liquid instability form of the altermagnetic phase, generated by a compensated collinear ordering of magnetic moments on the lattice of Mn atoms [4,6].

[1] Nakatsuji and Arita, Annual Review of CMP 13, 119-142 (2022)
[2] Smejkal et al. Nat. Rev. Mater., on-line 30 March (2022)
[3] Smejkal et al. Science Advances 6, 23 (2020)
[4] Mazin et al. PNAS 118 42 (2021)
[5] Smejkal et al. arXiv:2105.05820, arXiv:2204.10844
[6] Gonzales-Betancourt et al. arXiv:2112.06805
[7] Reichlova et al., arXiv:2012.15651
[8] Gottschilch et al., J. Mater. Chem., 22, 15275 (2012)