The anomalous Hall effect in unconventional antiferromagnets

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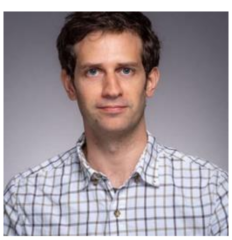
The anomalous Hall effect (AHE) is a Hall effect that arises at zero magnetic field in ferromagnets that have a spontaneous magnetization. In the simplest picture, its magnitude is proportional to the the out-of-plane component of magnetization. Antiferromagnets are magnetically ordered materials with no net magnetization, so by that logic they are not expected to exhibit an AHE. For that same reason, antiferromagnets were considered useless for magnetic memory devices where information is stored by varying the orientation of the magnetization and detected by measuring the electron spin polarization. The recent understanding of how magnetocrystalline symmetry impacts the origin of the AHE challenges this simple picture, raising hopes for the implementation of antiferromagnets as functional magnetic materials that can intrinsically host spin polarization. In this talk, I will present our findings from two unconventional antiferromagnets: $MnBi_2Te_4$ – an antiferromagnetic topological insulator - and α-MnTe – an altermagnet [1]. Both exhibit an AHE stronger than what is expected from their magnetization. Our experimental measurements are done on thin films grown by molecular beam epitaxy. In $MnBi_2Te_4$, we identify an AHE that scales super-linearly with magnetization, and that is unique to a canted magnetic state that appears at intermediate field [2]. In α-MnTe, we systematically measure a strong spontaneous AHE despite the material having a nearly vanishing spontaneous magnetization [3]. The talk will highlight how the AHE has a complex dependence on the magneto-crystalline symmetry of materials beyond the basic picture that holds for collinear ferromagnets.

[1] Smejkal et al, Phys. Rev. X **12** 031042 (2022).
[2] S.K. Bac et al. npj Quantum Materials **7** 46 (2022).
[3] S. Bey et al in preparation.



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