Title:

Crossover from 2D ferromagnetic insulator to wide bandgap quantum anomalous Hall insulator in ultra-thin $MnBi_2Te_4$

Speaker:

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Abstract

Van der Waals materials have widely varying electronic properties including topological insulator (TI) behaviour (Bi_2Se_3/Bi_2Te_3), and ferromagnetism in 2D (CrI_3). However, these materials are distinct i.e. they possess topological or magnetic properties but not both. Intrinsic magnetic topological insulators possess both magnetic and topological states, offering the potential for low disorder and large magnetic bandgaps in order to achieve robust magnetic topological phases operating at higher temperatures. By controlling the layer thickness, emergent phenomena such as the quantum anomalous Hall (QAH) effect and axion insulator phases have been realised.[1,2]

Yet, these observations occur at temperatures significantly lower than the Néel temperature of bulk $MnBi_2Te_4$, and measurement of the magnetic energy gap at the Dirac point in ultra-thin $MnBi_2Te_4$ has yet to be achieved. Critical to achieving the promise of this system is a direct measurement of the layer-dependent energy gap and verification of a temperature-dependent topological phase transition from large bandgap QAH insulator to a gapless TI paramagnetic phase.

In this talk I will discuss our efforts to grow ultra-thin $MnBi_2Te_4$ via molecular beam epitaxy (MBE) in order to study the layer-dependent change in electronic bandstructure using low temperature angle-resolved photoelectron spectroscopy (ARPES). I will discuss our observations of a layer-dependent transition from 2D ferromagnetic insulator (>780 meV) to quantum anomalous Hall insulator (>70 meV), and the nature of the bandgap with increasing temperature.[3]

References:

1. Y. Deng et al., Science 367, 895 (2020)
2. C. Liu et al., Nature Materials 19, 522 (2020)
3. C. Trang et al., arxiv:2009.06175v2 (2020)