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(I) MBT for TBM (Topological Band Magnetism)

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MBT for TBM (Topological Band Magnetism)

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Bulk MnBi2Te4 and MnBi2Se4 are antiferromagnetic topological insulators [1], and also van der Waals compounds with weakly-coupled seven-atom-thick (septuple) layers. I will discuss the electronic, magnetic, and topological properties of thin films formed by flexibly stacked septuple layers from a theoretical point of view, with the goal of anticipating properties that are achievable using van der Waals epitaxy. Much of the theoretical analysis will be made using an attractively simplified model [2] that retains only Dirac cone degrees of freedom on both surfaces of each septuple layer. The model can be validated, and its parameters can be estimated, by comparing with ab initio density-functional theory (DFT) calculations. I will use the model to explain when thin films exhibit a quantized anomalous Hall effect (QAHE) and when they do not, and to relate the magnetic-configuration-dependent properties of thin films to the magnetic Weyl semimetal limit of the ferromagnetic configuration. MBT thin films can have gate-tunable transitions between topologically trivial and QAH states [3], and metamagnetic QAH states [4], including ones with perfectly compensated antiferromagnetic configurations [5]. I will comment on the magneto-electric [6], and magneto-optical [7] properties of these materials and how they relate to the topological magneto-electric effect, and on the potential role in spintronics.

[1] M.M. Otrokov et al., Highly ordered wide bandgap material for quantized anomalous Hall effect effect and magnetoelectric effects, 2D Mater. 4, 025082 (2017).
[2] C. Lei, S. Chen, and A.H. MacDonald, Magnetized topological insulator multilayers, Proc. Nat. Acad. Sci. 117, 27224 (2020).
[3] C. Lei and A.H. MacDonald, Gate-Tunable Quantum Anomalous Hall Effects in MnBi2Te4 Thin Films, arXiv:2101.07181.
[4] C. Lei, O. Heinonen, A.H. MacDonald, and R.J. McQueeney, Metamagnetism of few layer topological antiferromagnets, arXiv:2102.11405.
[5] C. Lei, O. Heinonen, R.J. McQueeney and A.H. MacDonald, Quantum Anomalous Hall Effect in Collinear Antiferromagnetic Thin Films, to be submitted.
[6] C. Lei and A.H. MacDonald, Spin and Orbital Magneto-electric Response in Magnetized Topological Insulator Thin Films, to be submitted.
[7] C. Lei and A.H. MacDonald, Magneto-Optical Kerr and Faraday Effects in MBT Thin Films, to be submitted.

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