Topology and quantum matter: from axions to spintronics

The confluence of fundamental symmetries (such as time reversal invariance) and relativistic quantum mechanics is known to produce emergent electronic states in crystalline solids that are accurately described using the language of topology. This talk provides an overview of this relatively young field of research, showing how the synthesis and study of topological quantum matter [1,2] yields a playground for both exotic pursuits at millikelvin temperatures (such as the realization of axion electrodynamics in condensed matter [3]) and pragmatic technologies that work under ambient conditions (such as spintronic devices [4-7]).

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2. J. P. Heremans, R. J. Cava, and N. Samarth, "Tetradymites as thermoelectrics and topological insulators," *Nature Reviews Materials* vol. **2**, art. no. 17049 (2017).
3. Di Xiao *et al*., "Realization of the axion insulator state in quantum anomalous Hall sandwich heterostructures," *Phys. Rev. Lett.* **120**, 056801 (2018).
4. A. R. Mellnik, *et al.*, "Spin-transfer torque generated by a topological insulator," *Nature* **511,** 449 (2014).
5. Hailong Wang *et al.*, "Surface-State-Dominated Spin-Charge Current Conversion in Topological-Insulator–Ferromagnetic-Insulator Heterostructures," *Phys. Rev. Lett.* **117**, 076601 (2016).
6. J. Han *et al*., "Room temperature spin orbit torque switching induced by a topological insulator," *Phys. Rev. Lett.* **119**, 077702 (2017).
7. Hailong Wang *et al.*, "Fermi level dependent spin pumping from a magnetic insulator into a topological insulator," *Phys. Rev. Res.* **1**, 012014 (R) (2019).