Emergent electromagnetic phenomena of magnetic topological insulators and semimetals

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The topology of spin texture either in momentum space or real space can generate emergent electromagnetic fields acting on the conduction electrons in solid, producing emergent electromagnetic responses and functions. One archetypal example is magnetic topological insulators, in which the spin-momentum locking as well as the magnetization-induced mass-gap shows up to form the ideal Weyl fermion system at surface. With independent control of the magnetizations on the top and bottom surfaces, quantum anomalous Hall state, quantum magnetoelectric (axion insulator) state and parity-anomaly (half Hall quantization) state can be realized. Therein, many intriguing phenomena of topological origins show up, such as topological magneto-optical effects, nonreciprocal charge transport, magnetically induced photovoltaic effect, quantized chiral edge conduction on magnetic domain walls, low-current induced magnetization reversal, and emergent electromagnetic induction.

We discuss the topological phase transformations as well as the related topological quantum functions based on magnetic topological insulators and related magnetic Weyl semimetals.