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Magnetoelectric Responses from Topological Magnets

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Intriguing magnetoelectric responses can be anticipated to emerge from topological magnets characterized by topological indexes either in real space (Fig.1) or in momentum space. One such example is magnetic skyrmions[1] (Fig.2) and emergent monopoles (Fig.3) in noncentrosymmetric, e.g. chiral-lattice[2], magnets as protected by skyrmion number and endowed with real-space emergent magnetic flux (Fig.1). Dynamical responses of skyrmions and monopoles coupled with electron transport and dielectric characteristics are investigated in terms of Lorentz transmission electron microscopy/holography, small-angle neutron/x-ray scattering, microwave spectroscopy, magneto-transport and magnetoelectric characteristics.

One other important example of topological magnets is magnetic topological insulators (Fig.4), in which the spin-momentum locking as well as the magnetization-induced mass-gap shows up to form the ideal 2D Weyl fermion system at surface. With control of the magnetizations on the top and bottom surfaces of the thin film, quantum anomalous Hall state and quantum magnetoelectric (axion insulator) state can be formed (Fig.5) and the topological magneto-optical effects show up therein.

The magnetoelectric responses from these topological magnets as revealed by recent studies are overviewed.

References

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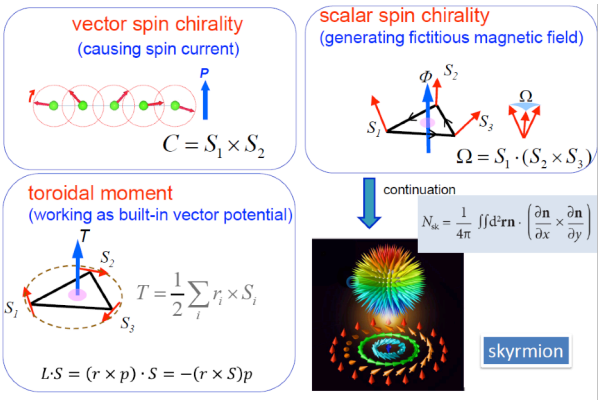

Fig. 1: Spin textures generating emergent electromagnetic fields.

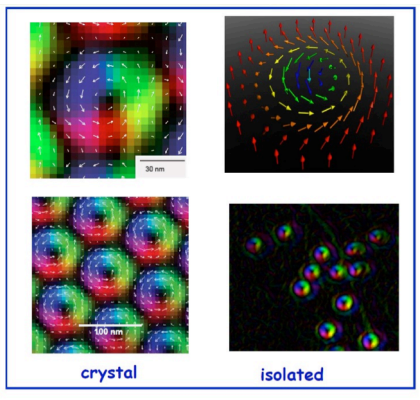

Fig. 2: Real space images of skyrmions in B20-type magnets.

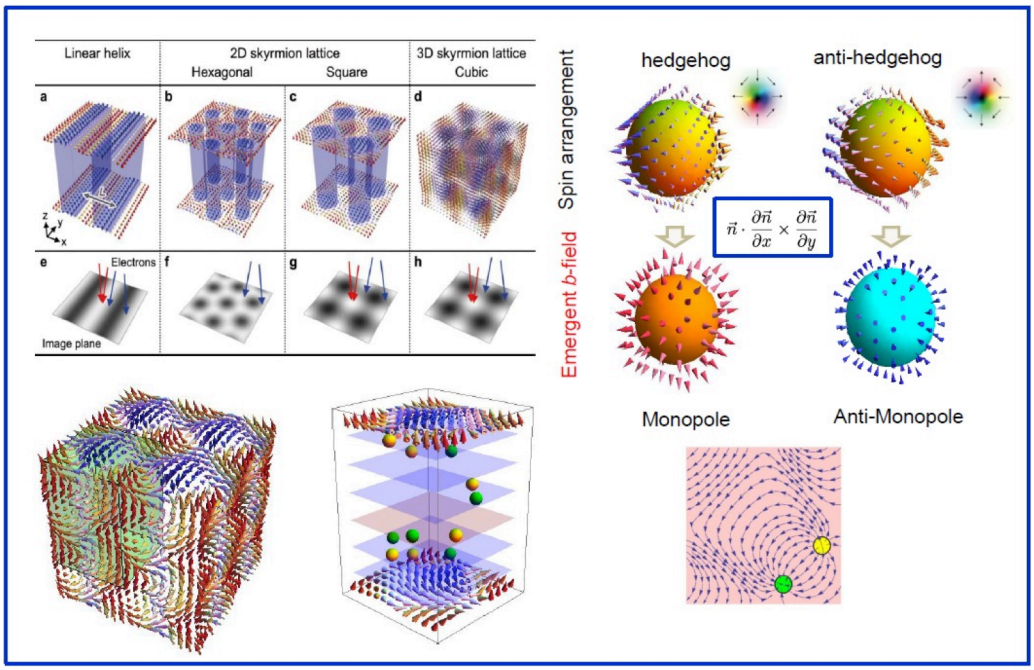

Fig. 3: 2D and 3D topological spin textures (crystal form) in chiral magnets. 3D hedgehog-antihedgehog crystal is viewed as the emergent magnetic monopole-antimonopole crystal.[2]

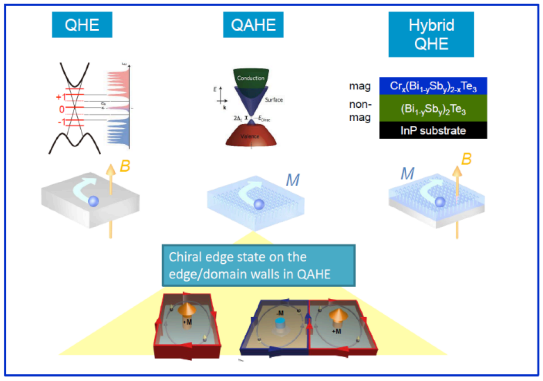

Fig.4: Quantum anomalous Hall effect (QAHE) in magnetic topological insulators.

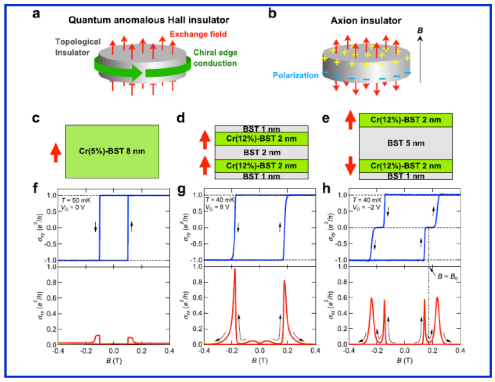

Fig. 5: Quantum anomalous Hall and axion insulators.