Interplay between magnetism and electronic band topology

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The exploration of magnetic materials with topologically non-trivial electronic band structure has become a key topic of quantum materials physics. The goal of our research is to find novel materials where the electronic states can be controlled by their magnetic order.

We have studied a wide range of materials where the non-trivial topological properties in the electronic band structure are endowed by the corresponding ground state magnetic order. These include Co₃Sn₂S₂, Mn₃Ge, YbMnBi₂, YbMnSb₂, EuMnSb₂, EuCuAs, EuIn₃P₂ [1-7]. Our careful magnetic structure determination of the topological materials with polarised and unpolarised neutron diffraction indicate that ab-initio calculations usually predict the wrong type of magnetic structure. Instead, neutron diffraction remains the most decisive tool to determine the topology of the electronic band structure in these magnetic topological materials.

In my talk, I will give an overview of material systems which display a strong coupling between magnetism and the topology of the electronic bands. I will highlight systems where the magnetic configuration is key to their non-trivial topological properties, from a symmetry perspective. Next, I will outline several of our studies where neutron diffraction has been decisive in the determination of the topology of the electronic bands by the careful study of the magnetic order. Finally, I will discuss some future directions for the field of magnetic topological materials.

Figure 1. Various magnetic configurations of topological materials.