

Magnetic impurities in topological materials – computer simulations

In the last decades, the interplay between magnetic and semiconducting properties has led to discoveries of new and surprising phenomena in ferromagnetic semiconductors [such as (Ga,Mn)As], which have opened the doors for various spintronic applications [T. Dietl *et al.*, *Rev. Mod. Phys.* **86** (2014) 187; *ibid* **87** (2015) 1311]. It is increasingly clear that magnetic impurities modify the properties of topological materials in an essential way, resulting also in a cohort of novel phenomena, such as the quantum anomalous Hall effect in ferromagnetic (Bi,Cr)₂Te₃ and related systems. However, in contrast to non-topological semiconductors, the origin of ferromagnetism in topological systems is not known, and various models are being put forward.

The Phd student will perform relativistic *ab-initio* calculations using codes appropriate to study the effects of magnetic impurities in topological systems. We will extract microscopic effective parameters, and use them to elucidate the role of various spin-spin coupling mechanisms, such as van Vleck, Bloemberg-Rowland, and superexchange contributions in several model topological systems such as (Hg,Mn)Te.

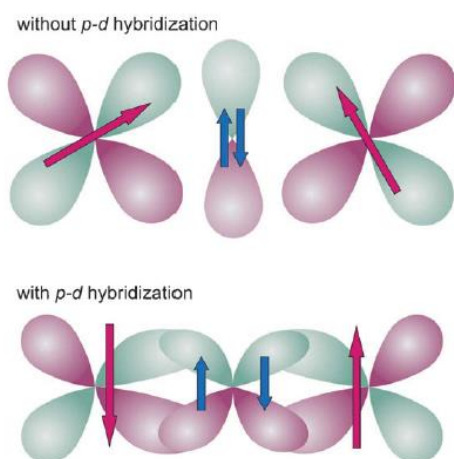


Figure 1 Schematic illustration of the antiferromagnetic superexchange mechanism between spins (red arrows) localised on Mn d-states, mediated via spins on anion p-states (blue arrows).

This is one possible project though the research with us is not limited to just this. To perform the numerical simulations we will use modern supercomputers. The project requires a willingness to learn numerical skills which we will gladly help you with. Proficiency in spoken and written English is required. Female candidates are encouraged to apply. The MagTop group is composed of circa 25 persons and it has many international collaborations. **The stipend of MagTop's PhD students is 3500 (first year) to 4500 PLN (from the second year) per month (830–1060€ per month), no taxes.**

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