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Single crystals of superconductors, topological insulators and magnetic materials

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To make headway in understanding the physics of materials, high quality single crystals are essential. In this talk, I aim to present an overview of the investigations carried out on single crystals of various superconducting and frustrated magnetic materials obtained by the floating zone technique using optical furnaces at Warwick. I will also describe the study of crystals produced by other techniques and examples of investigations carried out on these crystals.

The availability of large, high quality single crystals has enabled significant progress in the study of geometrically frustrated magnets, for their fascinating magnetic properties (such as spin ice, spin glass, spin liquid or long-range ordered states). In the search for new frustrated magnets that display quantum effects, we have the turned our attention to less studied pyrochlore systems, such as rare earth zirconates and hafnates $R_2M_2O_7$ (R = Rare Earth, M = Zr or Hf). I will show that with the advances we have made in the production of crystals of the rare earth zirconates and hafnates [1-2], it is now possible to investigate these novel classes of pyrochlores in greater depth.

The superconducting crystals of interest include non-centro-symmetric superconductors where the effect of the crystallographic inversion symmetry on the superconducting properties, in particular on the time reversal symmetry breaking, has been investigated [3]. I will also describe the study of crystals of some topological Insulators, including the interest in the Topological Kondo Insulator crystal, SmB_6, produced by the floating zone technique at Warwick [4].

In my more recent involvement in a UK National project on Skyrmions [5] I lead the challenge in the synthesis of skyrmionic crystals at Warwick. I will give a few examples of the study of Zn substituted Cu_2OSeO_3 single crystals [6] and an ongoing detailed examination of magnetic structures of the family of GaV_4S_8/Se_8 single crystals.

1. Nature Commun 9 3786 (2018); Nature Phys. 12 746 (2016); Crystals 6 79 (2016)
2. Nature Commun 8 892 (2017); J. Phys-Cond Matt. 29 075902 (2017)
3. Phys. Rev. Lett. 112 1007002 (2014); Phys. Rev. Lett. 115 267001 (2015)
4. Sci. Reports 3 3071 (2013); Science 349 287 (2015).
5. http://skyrmions.ac.uk
6. *arXiv: 1807.04641*

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