

## PhD Position: Cryogenic static and magic-angle spinning NMR on superconductors

Conventional conductors allow electric current to flow through them, although some of the energy is dissipated into heat as the current encounters a resistance. On the other hand superconductors, exhibit no electrical resistance at temperatures below the critical temperature ( $T_c$ ), for DC currents. The lack of energy dissipation makes superconductors very interesting for a wide range of applications. The discovery of new high temperature superconductor (HTS) materials is often accidental, and the accepted theory for superconductivity does not fully describe HTS. Detailed studies relating precise experimental observations to the local structure and to the calculated parameters are therefore very valuable. NMR can provide detailed information on the local structure and dynamics, with atomic resolution, in a wide temperature range. For many nuclei, improved resolution is achieved by rotating the sample about the "magic angle". Magic-angle spinning (MAS) can resolve inequivalent chemical sites. In the UK, a cryoMAS system is available uniquely in Southampton. For superconductors, it is essential to perform experiments in a wide temperature range, but especially at cryogenic temperatures, because much of the interesting physics occurs below 150 K.

This project will be concerned with using a combination of cryogenic MAS NMR experiments to determine structural and electronic properties of HTS materials. Experimental static and MAS NMR data on powdered samples between 2 K and 300 K will be used. First-principles quantum mechanical simulations will be used to obtain structures, energy levels and NMR-related parameters of a variety of materials such as copper oxides, pnictides and alkali fullerides. Problems related to structural disorder, the role of oxidation and doping will be among our targets, and will complement information obtained using other techniques.

The technological impact of this research is significant. Materials with potential commercial interest will be investigated (i.e., magnesium diboride and its carbon-doped variants), and application may follow shortly after.

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The Centre for Doctoral Training in Integrated Magnetic Resonance (*iMR*) is a collaboration between researchers at the Universities of Warwick, St Andrews, Southampton, Aberdeen and Nottingham.