Unconventional Superconductors

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In conventional superconductors the supercurrents are carried by s-wave Cooper pairs. In unconventional superconductors, the pair wave function may be an odd-parity spin-triplet, or perhaps some mixture of even and odd parity. Unconventional superconductivity may be found in materials with noncentrosymmetric structures, i.e. systems which lack a centre of inversion where parity is no longer a good quantum number, and in materials with strong spin-orbit coupling, e.g. those containing 4d and 5d metals. In this experimental project it will be these two groups of superconductors that will be the focus of your work. The unconventional superconducting properties you will investigate include exotic superconducting gap structures (lines or nodes in the superconducting gap), magnetoelectric effects such as a helical phase and upper critical fields exceeding the Pauli limit, time reversal symmetry breaking, and even topological effects. For some of our work in this area please see Refs. 1-3.

Working in the Superconductivity and Magnetism Group (go.warwick.ac.uk/supermag) you will learn how to prepare polycrystalline and single crystal samples. The structural properties of the samples will be studied using a suite of state-of-the-art x-ray diffractometers and electron microscopes. You will then examine the normal and superconducting state properties of these materials at low temperatures and in high magnetic fields. As well as experiments in our laboratories, a range of neutron scattering and muon spectroscopy techniques available at national and international central facilities will also be used to investigate the physics of these materials. This experimental project will offer you an excellent training in many important aspects of modern condensed matter physics.

References

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[2] J. A. T. Barker, D. Singh, A. Thamizhavel, A. D. Hillier, M. R. Lees, G. Balakrishnan, D. M. Paul, R. P. Singh, Physical Review Letters **115**, 267001 (2015).
[3] D. A. Mayoh, A. D. Hillier, K. Götze, D. M. Paul, G. Balakrishnan, M. R. Lees, Physical Review B **98**, 014502 (2018).