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# Probing nanoscale electronic structure of 2D materials

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Starting with the semi-metallic graphene, the library of two-dimensional materials (2DMs) has expanded rapidly to include metals, semiconductors, insulators and more. Strongly correlated 2D materials are emerging as a fascinating area of research, with reports of 2D superconductors, magnets and even 2D topological insulators (2D TIs). With the award of the Nobel Prize in Physics 2017 for the study of topological phase transitions and topological phases of matter, and the continued rise of 2DMs, this highlights exciting new avenues of research. The ability to simply stack different 2DMs to create complex heterostructures with new functional properties adds not only important degrees of freedom in designing devices, but also great hope for achieving real technological advances. The (opto)electronic properties of these heterostructures depend on the electronic structure of the individual 2DMs and the complex interactions that can occur between layers, and can be controlled by external electrostatic and magnetic fields. It is a fascinating new playground to explore.

This project will use novel microscopy and spectroscopy techniques to interrogate electronic structure of 2D materials and 2D heterostructures, with nanoscale resolution. We will apply a combination of scanning probe microscopy (SPM) and angle resolved photoemission spectroscopy (ARPES) to gain new insight into how electronic structure can be manipulated at the atomic scale in 2DMs, and how this can lead to new functional properties. A particular focus will be on direct measurement of electronic structure changes in operating 2DM devices, an area we are pioneering at Warwick.

This is an exciting opportunity for an ambitious student. It will use international synchrotron facilities for spatially resolved ARPES and a unique SPM facility currently being commissioned at Warwick for low temperature atomic force microscopy with vectoral magnetic field. Although some of the 2D heterostructure samples will be fabricated in-house, others will be sourced from our international collaborators. As such, this project will require a student with excellent technical and communication skills who is keen to work in an international team.

The student will be part of the Materials Physics Doctorate scheme (go.warwick.ac.uk/MPDOC). This gives access to a tailored research degree to help you exploit our outstanding materials growth, fabrication, characterisation and computational capabilities, and those at central facilities. A broad education in Condensed Matter Physics is provided through dedicated modules under the Midlands Physics Alliance Graduate School, and external courses.

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