

## Dowthwaite MScR Scholarship 2023/24 entry

DEPARTMENT OF PHYSICS

Principal Supervisor: Dr Budhika Mendis

Other Supervisors: Prof Peter Hatton

Project Title/Theme: Electronic structure of the metal-insulator 'Verwey' transition in magnetite

### Project Description

Magnetite ( $\text{Fe}_3\text{O}_4$ ) undergoes a 'Verwey' transition at 120 K temperature, where the electrical conductivity changes from being insulating to metallic with increasing temperature. This is accompanied by a change in crystal structure from monoclinic to cubic. The 'Verwey' transition was the first example of a metal-insulator transition to be discovered, and is still a topic of active research interest [1-2].

Transmission electron microscopy (TEM) is a technique that uses high energy electrons travelling at a fraction of the speed of light to image materials. The short de Broglie wavelength of the high energy electrons enable analysis at length scales far exceeding light microscopy. We have recently used Compton scattering of the high energy electrons in a TEM to measure the electronic structure of materials at ~100 nm spatial resolution [3]. The project will exploit this unique capability to map the electronic structure of the Verwey transition at a microscopic level. Compton scattering results will be complemented with atomic resolution imaging and diffraction analysis of the crystal structure in the TEM.

Apart from TEM the student will also have the opportunity to carry out magnetic property measurements, and collaborate with a theory group on density functional theory simulations of the Verwey transition. Several different sample types are also available for analysis, including single crystals, thin-films and minerals, provided by collaborators. The project will equip the student with a deep understanding of electronic and crystal structure of materials, as well as state-of-the-art characterisation techniques.

### References

[1] Kobayashi H *et al.*, *Phys. Rev. B* (2009) 80 104423.

[2] Li Y *et al.*, *J. Phys. Chem. Solids* (2007) 68 1556.

[3] Talmantaite A *et al.* *J. Microsc.* (2020) 279 185.

### How to apply

You must apply through the University's [applicant portal](#)

You will need to:

- State 'CMP and Electronic structure of the metal-insulator 'Verwey' transition in magnetite' in the 'Field of Study' section.

- On the funding tab select 'yes' you are applying for a scholarship, select 'Other' write DOW235 in the name of the scholarship, and select 1st October 2023 as the start date
- attach a covering letter and CV
- attach degree transcripts and certificates and, if English is not your first language, a copy of your English language qualifications.
- provide 2 referee contact details (specifically email addresses) who we will contact directly.

#### Contact

For enquiries please contact Dr Budhika Mendis [b.g.mendis@durham.ac.uk](mailto:b.g.mendis@durham.ac.uk)