The Ultrafast Student

Henri Ehrke recently received a DPhil from Oxford University, becoming the first Diamond 50% joint funded student to graduate since the facilty became operational. Henri joined Diamond in January 2007 as a joint student between Prof Sarnjeet Dhesi, Principal Beamline Scientist of the Nanoscience beamline I06, and Prof Andrea Cavalleri from the University of Oxford and Max Planck Institute, Hamburg. The studies Henri worked on involved the manganites – a class of transition metal oxides where the energy difference between the electrically conducting and insulating phases is small. Significantly the material is sensitive to photo-excitation, meaning both conductivity and magnetism can be switched on and off by light.

The focus of Henri's thesis work was in the area of X-ray time-resolved science. A femtosecond light pulse was used to trigger an insulator-metal phase transition in the half-doped manganite $La_{0.5}Sr_{1.5}MnO_4$. Picosecond snapshots of the magnetic and electronic order were captured on beamline I06 using a technique called Resonant Soft X-ray Diffraction (RSXD).

RSXD has become a routine probe of static magnetic and electronic order in recent years. However, for these experiments RSXD was extended to allow the separation of ultrafast spin and orbital melting following a photo-excited phase transition. This was achieved by detecting changes in the time dependent diffraction intensity at two different scattering peaks that reflect magnetic and electronic order independently. In order to perform these experiments at such fast timescales Diamond's Machine Physics Group worked with the I06 beamline team to develop a low-mode of the synchrotron to allow time resolution of 10ps.

The results demonstrated that light excitation by the femtosecond pulse completely removed magnetic order (in a non-thermal manner) whilst only weakly perturbing the electronic order. This has wider implications for the study of manganites and similar materials because previously it was not possible to disentangle the spin and orbital degrees of freedom so directly.

Henri says, "This was a really exciting PhD to be involved with – I joined Diamond before the beamline was completed and during my PhD I helped to develop a state-of-the-art capability for time-resolved soft X-ray diffraction."

Prof Sarnjeet Dhesi, Principal Beamline Scientist for I06 adds, "It was definitely a very challenging project to develop time-resolved science at a brand new synchrotron source and Henri worked hard with the beamline team in its development. We will now build on the success of this work by adding a laser laboratory to the side of beamline I06, along with further joint students with Prof Andrea Cavalleri's team at Oxford University and in Hamburg, to study ultrafast dynamics in superconductors."

Further details about the time-resolved work on I06 can be found in the publication H. Ehrke *et al.*, Phy. Rev. Lett. 106, 217401 (2011).

For more information on the Nanoscience beamline, please contact sarnjeet.dhesi@diamond.ac.uk

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Henri Ehrke (left) and Sarnjeet Dhesi (right) on the Nanoscience beamline.