Experimental report

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Proposal:	**5-42-397**	**Council:**	10/2014
Title:	Measurements of the magnetic vortex lattice in the noncentrosymmetricsuperconductor Ru7B3		
Research area:	Physics		

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Samples: Ru7B3

Instrument	Requested days	Allocated days	From	To
D33	5	5	24/07/2015	29/07/2015

Abstract:

We propose to measure the magnetic vortex lattice (VL) in a single crystal of the non-centrosymmetric (NCS) superconductor Ru7B3 using small angle neutron scattering (SANS). NCS superconductors are of significant interest to the condensed matter community, as the crystal structure breaks inversion symmetry, leading to novel superconducting states with unusual properties [1]. Despite this interest, experimental data on NCS are sparse owing to the difficulty in obtaining high quality samples. We have obtained a large single crystal of Ru7B3, which has been prepared with the enriched 11B isotope, making it ideal for neutron scattering studies. The novel superconducting states associated with NCS superconductors have been predicted to have a significant effect on the VL within these materials, with the s+p-wave order parameter predicted for NCS leading to a strong anisotropy in the electronic states around the vortex [2,3]. Anisotropies in the electronic structure of a vortex lead to structural changes in the VL as the applied field and temperature are varied, allowing us to investigate the unusual superconducting states found in NCS with SANS.

Experimental Report: Measurements of the magnetic vortex lattice in the noncentrosymmetric superconductor Ru_7B_3

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We performed measurements of the magnetic vortex lattice (VL) on a single crystal of the non-centrosymmetric superconductor Ru_7B_3 using the small angle scattering instrument D33. The sample was mounted in a dilution refrigerator and placed within a cryomagnet with the magnetic field parallel to the incoming neutron beam. The crystal was oriented such that the magnetic field could be applied along either the [001] or [100] axis or at any point between them. Magnetic field was applied to the sample at base temperature, and the VL was imaged by rocking the sample and magnetic field around the angles corresponding to the Bragg reflections from the VL. Background measurements were taken in zero field at base temperature, and subtracted from the in-field measurements to leave only the signal from the VL.

We investigated the VL structure and form factor at base temperature for magnetic fields up to 0.75 T, and the VL assumed a hexagonal orientation throughout, typical examples of which can be seen in Fig. 1. The VL underwent a structural re-orientation, concurrent with a slight distortion, as the magnetic field was rotated from the [001] to the [100] direction, corresponding to Fig. 1 (a) and (b), respectively. Whilst the orientation of the VL was always fixed when the magnetic field was applied parallel to the [001] direction, this was not the case with the field applied parallel to the [100] direction. In this experimentally chosen geometry, we observed a re-orientation of the VL which was dependent on the magnetic field history. This behaviour is not well understood, and merits further investigation. We also measured the temperature-dependence of the VL form factor with the magnetic field applied along the [100] direction, which showed *s*-wave-like behaviour.

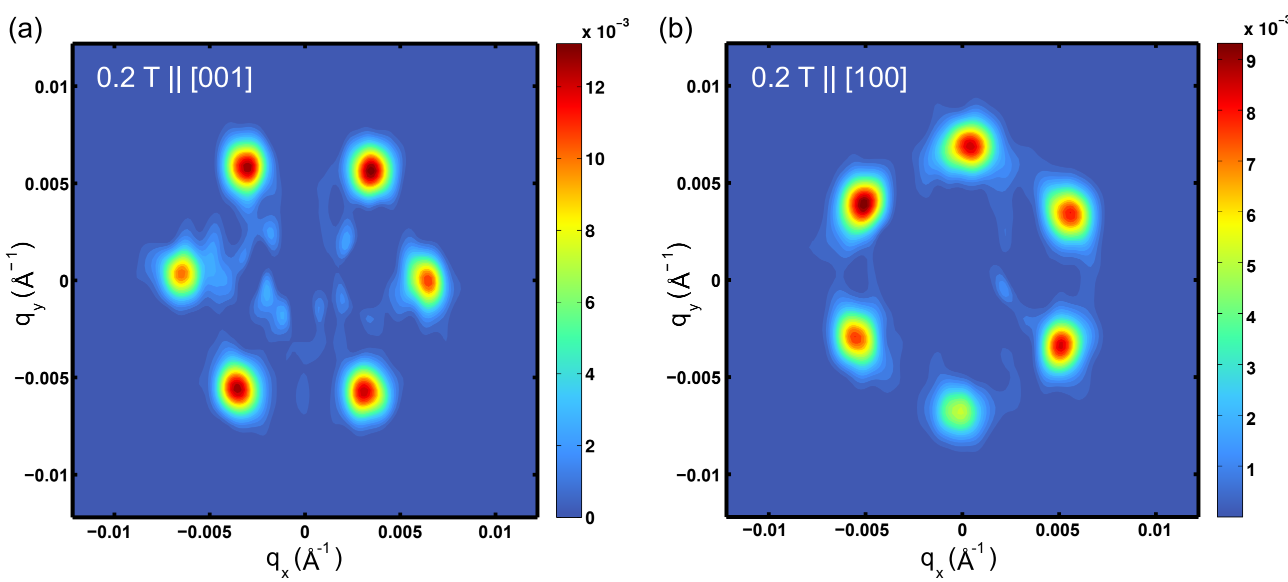

Figure 1: (a) Diffraction pattern from the VL at 0.2 T applied parallel to the [001] crystal axis. (b) The same but for the magnetic field applied parallel to the [100] crystal axis. Diffraction patterns are a sum over all the rocking angles corresponding to the observed Bragg reflections.