Experimental report number: 28-01-138

The aim of this experiment was to continue the study of $TmNi_2B_2C$ using resonant x-ray diffraction. Our first experiment on this material performed far from resonance [1] suffered badly from the instability of the beam. We decided to study the field and temperature dependence of the magnetisation "on-resonance" to increase the magnetic signal and hence reduce the problems caused by the beam fluctuations. The resonant technique cannot measure the magnetisation densities directly but was used to investigate the behaviour of the magnetisation around T_C. This was realised by measuring the flipping ratio at the Tm L_3 edge (8.468 keV) with the field applied along the *c*-axis, i.e. in the vertical direction (see Figure 1), which is the axis of greatest net magnetisation. In our experiment, the beam was scattered at 71° corresponding to the (220) reflection. The sample's magnetisation was reversed using the XMaS electromagnet in order to produce the necessary difference measurement.
The sample was cooled down with the low temperature displex. The diffracted intensity was recorded with a cyberstar detector, which is linear up to 100,000 cps.

In our experiment, the beam was scattered at 71° corresponding to the (220) reflection. The results are illustrated in Figure 2 for two magnetic field values. First, it can be seen that the flipping ratio is enhanced by a factor of 40 compared to the non-resonant technique [1] with a field of 0.6 T applied along the easy axis. The systematic errors were found to be much larger than the statistical errors. The former were calculated as being the standard deviation from the average flipping ratio. The size of these errors is due to the instability of the beam and the inaccurate reading of the temperature (±800 mK). However, the results suggest that the induced thulium moment exists for all the temperatures, i.e. in the normal and superconducting states. The flipping ratio varies consistently with respect to the susceptibility curve [2]and scales with the field. This suggests that the induced Tm moment is independent of the volume fraction that is superconducting. There does not seem to be anomalous behaviour around T_C. Although the flipping ratio is enhanced working at the Tm L_3 edge, the data prove that the measurements are still affected by beam fluctuations. The smaller the flipping ratio, the bigger the error due to orbit movements.

References:

[1] L. Bouchenoire *et al.* Experimental report 28-01-119 (2001).

[2] B.K. Cho *et al.*, Phys. Rev. B, **52**, 3676 (1995).

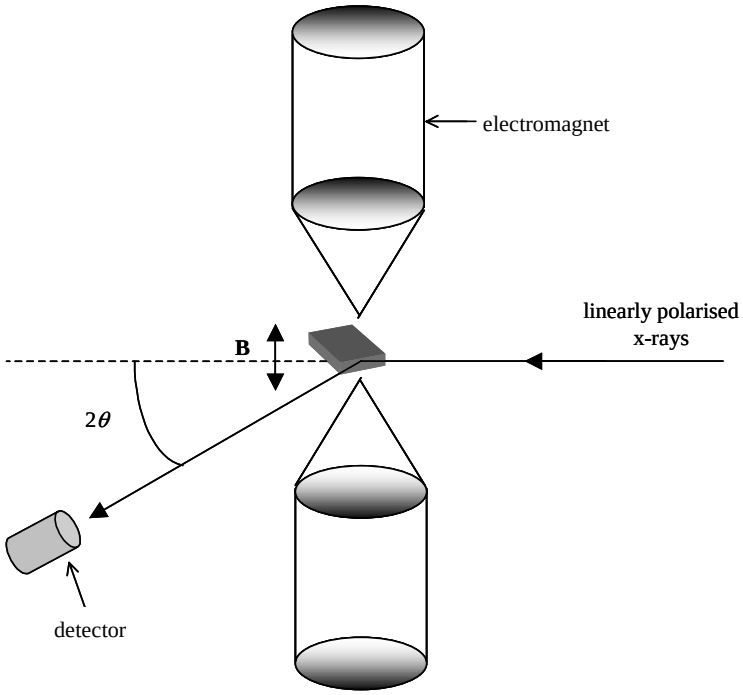
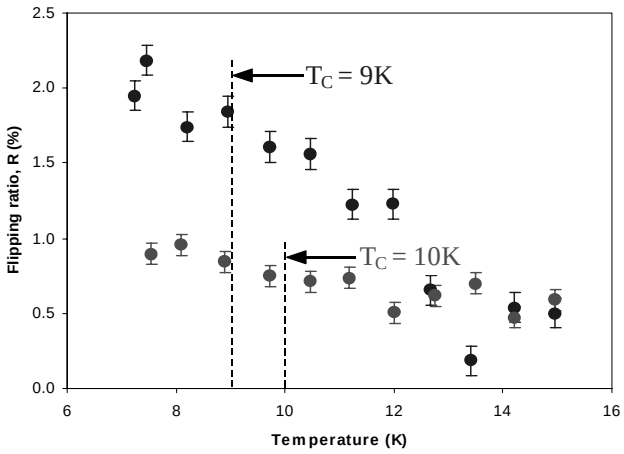


Figure 1: Horizontal 90˚ scattering with vertical applied field.



With $B \perp c$:

0.6T: T_C= 9K
0.3T: T_C= 10K

Figure 2: Flipping ratio of the (220) Bragg reflection around T_C with a 0.3T and 0.6T field applied along the *c*-axis.