Experimental report

11/02/2020

Proposal: **5-41-987**

Council: 10/2018

Title: The low temperature magnetic structure of UNi_4B

Research area: Physics

This proposal is a new proposal

Main proposer: **Stefan SUELLOW**

Experimental team: Jannis WILLWATER
Milan KLICPERA

Local contacts: Bachir OULADDIAF
Ketty BEAUVOIS

Samples: UNi_4B

Instrument	Requested days	Allocated days	From	To
D10	7	6	10/07/2019	16/07/2019

Abstract:

The intermetallic compound UNi_4B has been argued to represent a rare example of a frustrated intermetallic compound undergoing a transition into an allegedly frustrated magnetic state at T_N = 20K. The nature of a second phase transition in UNi_4B observed at a low temperature of T* = 330mK has only been studied by thermodynamic means, though it has been speculated to be also related to the magnetic frustration. Here, we propose to carry out a neutron scattering study on single crystalline UNi_4B (with 11B) at low temperatures <330mK, this way for the first time characterizing this second phase transition at T* by microscopic means.

Experimental report: The low temperature magnetic structure of UNi_4B

Summary

The frustrated intermetallic magnet UNi_4B has been reported to crystallize in a hexagonal crystallographic structure with a magnetic transition at $T_N = 20\,\mathrm{K}$ [1]. Recently, synchrotron x-ray diffraction data have indicated that the structure is orthorhombic and not hexagonal [2]. We carried out different neutron diffraction experiments (proposals 5-41-977, 5-11-433) to verify the structure and found out that UNi_4B crystallizes in an orthorhombic lattice with space group 25 ($a = 14.7908$ Å, $b = 6.9281$ Å and $c = 17.1077$ Å).

It was argued, that below the transition temperature $T_N = 20\,\mathrm{K}$ only 2/3 of the magnetic moments (uranium ions) order antiferromagnetic. The remaining uranium ions order at the second transition temperature $T_2 = 330\,m\mathrm{K}$, discovered in specific heat measurements [3]. However, there is no microscopic proof on this low temperature phase. Therefore, we proposed a low-temperature neutron diffraction experiments to investigate this phase.

Experimental procedure and results

A single-crystal with a mass of 0.8592 g has been used for the experiment, which had already been investigated in the previous neutron diffraction experiment at the D10 diffractometer. The LT1 dilution fridge was installed to reach the required measurement temperatures of 0.1 K. We measured the temperature dependence of several nuclear (see an example in Fig. 1) and magnetic reflections (see an example in Fig. 2) to look for additional magnetic intensity below 330 mK and we searched for additional magnetic reflections.

Surprisingly, no additional magnetic contribution on top of the nuclear or magnetic reflections or new magnetic reflections below 330 mK were measured. Therefore, no microscopic proof for the low temperature phase was found. We proposed a CYCLOPS experiment for further analysis.

References

[1] S. Mentink *et al.*, *Phys. Rev. Lett.* **73**, 1031 (1994)

[2] Y. Haga *et al.*, *Physica B* **403**, 900 (2008).

[3] R. Movshovich *et al.*, *Phys. Rev. Lett.* **83**, 2065 (1999)

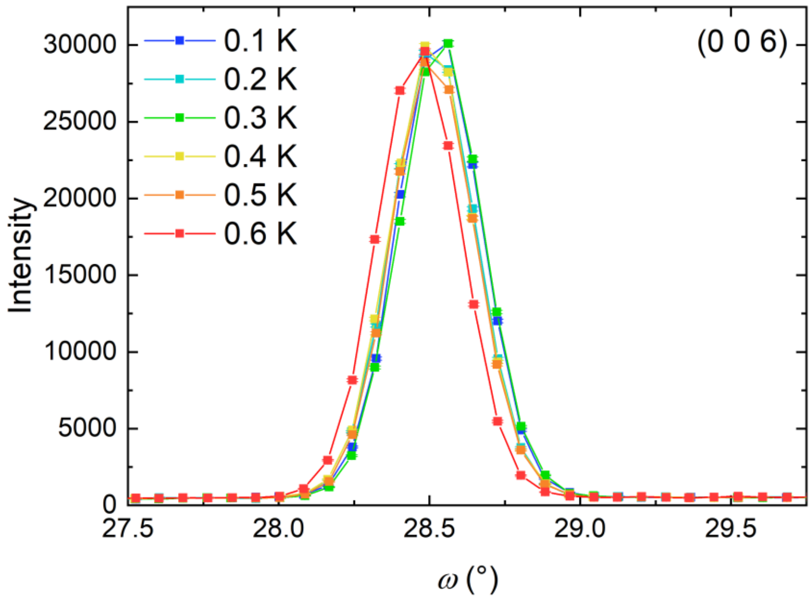

Fig. 1: Temperature dependence of the nuclear $(0\ 0\ 6)$ peak.

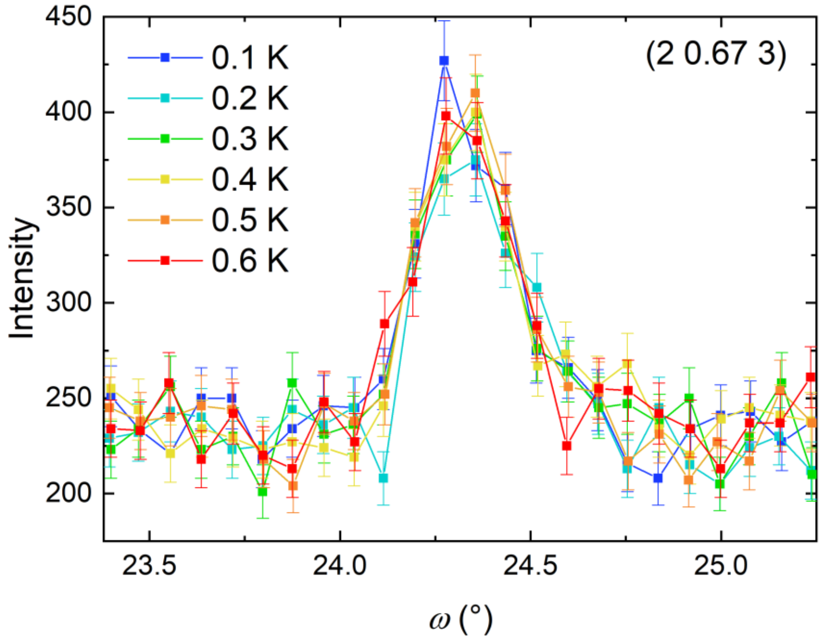

Fig. 2: Temperature dependence of the magnetic $(2\ 0.67\ 3)$ peak.