Experimental report

15/09/2016

Proposal: **5-41-861** **Council:** 4/2016

Title: Evolution of the magnetic structure of MnP with pressure

Research area: Physics

This proposal is a continuation of 5-31-2452

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Samples: MnP

Instrument	Requested days	Allocated days	From	To
D10	0	4	11/07/2016	16/07/2016
D23	5	0		

Abstract:

Manganese phosphide MnP has been investigated for decades because of its rich magnetic phase diagram. The magnetic structure of MnP is ferromagnetic below 291K. It transforms into a helimagnetic structure at 47K with a propagation vector q = 0.117a*. Superconductivity was recently reported under pressures of 8 GPa and there is a need to understand how the magnetism evolve upon doping as the system approaches the superconducting state. Previous D20 and D23 experiment following the evolution of the magnetic structure showed us additional magnetic phases to the pressure-temperature phase diagram with an out of a-b plane propagation vector. We ask for 5 days of beamtime on the single crystal diffractometer D23 with a clamp cell in order to solve the magnetic structure in the new magnetic phase at 1.5 GPa.

Previous experiments with MnP on D20 and D23 using a Paris-Edinburgh pressure cell showed the existence of a new magnetic phase around 1.5GPa (with a narrow pressure range estimated to less than 1 GPa) and that the propagation vector is expected to a a component along c. The goal of this experiment was thus to map the reciprocal space in this new phase using a single crystal and a clamped cell on the diffractometer D10 in order to understand this new phase.

Manganese phosphide MnP has a rich magnetic phase diagram. It has a slightly distorted NiAs structure with the spacegroup of Pbnm (No.62). The magnetic structure of MnP is ferromagnetic below TC =291 K. It transforms into a helimagnetic structure at TS = 47 K with a propagation vector q = 0.117a*. Recently, a canted antiferromagnetic structure with weak ferromagnetic magnetization along the b* axis in the ferromagnetic phase, an alternatively tilted helimagnetic phase structure below Ts was found by neutronscattering experiment.Most importantly, in december 2014, the discovery of superconductivity in MnP was reported under pressures of 8 GPa and with TSC ~1 K.

The sample was a spherical single crystal of MnP of diameter 3.8mm aligned with a and c in the scattering plane. The sample was inserted in the 20Kbar pressure cell and the load was applied in order to be in the 1.7GPa range. At 300K The sample was then inserted on an orange crysotats and mounted on D10. No nuclear peak with resonnable intenistw could be found, and the unloading of the clamp cell showed that the sample had be crushed due either to a fluorinert leak or the piston breaking. Another sample was aligned, loaded and mounted in the same way, and the nuclear alignement could be done. With the lifting detector and taking into account the pressure cell opening, the out of plane direction could be measured for Qk in the range -0.5 to 0.5.

The sample was cooled just below the expected transition temperature for the new phase expected from D23 (220K), but no magnetic peak were found at the expected scattering angles. The sample was further cooled down to base temperature (5K), and the magnetic peak at (1-δ 0 1) was found with reasonable intensity, as shown by figure 1. Fron this we concluded that at base temperature we were in the helimagnetic phase. Figure 2 shows a temperature dependence of the (1-δ 0 1) peak and two nuclear peak with temperature from 5 to 300K. From this we concluded that the applied pressure was lower than necessary to reach the new magnetic phase range, as the transition correspond to a helimagnetic to a ferromagnetic phase around 50K, so that the pressure is expected to be less than 1GPa, according to the pressure tempertaure phase diagram. The time constraints of the beamtime did not allow for an increase of the load on the pressure cell in order to reach the desired narrow pressure range. However, it is clear that the scattering intenisties of the magnetic peaks on D10 for such a sample size are sufficient to allow the succesful mapping of the new magnetic phase providing the right pressure can be reached.

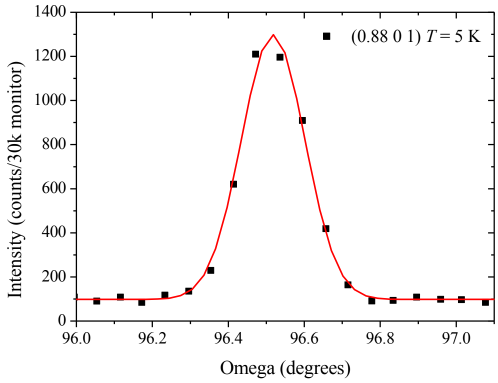

Figure 1 Magnetic peak of the helimagnetic phase measured on D10 with about 7 seconds per point.

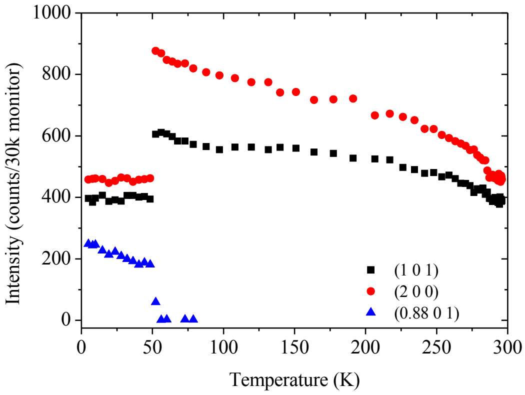

Figure 2 : Intensity as a function of temperature measured on D10 for the nuclear peak (101) and (200) and the magnetic peak (0.88 0 1) showing that the applied pressure is lower than expected, and corresponds to the helimagnetic phase pressure range.