Experimental report

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Proposal: **5-32-819** **Council:** 4/2015

Title: Incommensurate magnetism and possible skyrmion phase in the tetragonal Heusler system Mn2PtSn

Research area: Physics

This proposal is a new proposal

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Samples: Mn2PtSn
Mn2PtSn-crystal

Instrument	Requested days	Allocated days	From	To
D11	7	6	08/06/2016	14/06/2016
D33	7	0		

Abstract:

In contrast to the known skyrmion-lattice compounds (e.g. B20 compounds or Cu2OSeO3, characterized by a chiral cubic structure), the Heusler system Mn2PtSn is tetragonal, crystallizing in the noncentrosymmetric I-42m structure. There are strong indications that it could exhibit a skyrmion-lattice phase, as follows from the observation of topological Hall effect in thin films of this material and Lorentz-microscopy images showing a pronounced magnetic spiral structure. If the skyrmion ordering is revealed directly in a diffraction experiment, it could become the first example of a skyrmion lattice in a tetragonal system, allowing for future studies of crystalline anisotropy effects on the spin texture under various directions of applied magnetic fields. Moreover, dc magnetic measurements indicate that a complex incommensurate magnetic state exists in our samples in a broad range of temperatures and magnetic fields, characterized by a spin-reorientation transition around 180 K, which requires SANS measurements to be clarified. We propose a systematic SANS study of the recently synthesized single-crystalline Mn2PtSn in magnetic fields < 1 tesla across the whole magnetic phase diagram.

Experimental Report: Incommensurate magnetism and possible skyrmion phase in the tetragonal Heusler system $Mn_{2-\delta}PtSn$

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We performed small angle neutron scattering measurements on the magnetic structure of single crystal samples of $Mn_{1.4}PtSn$ and $Mn_{1.4}Pt_{0.6}Ir_{0.4}Sn$ using the D11 instrument. The ORTF cryomagnet was used with a standard sample insert, with the magnetic field applied either parallel or perpendicular to the incoming neutron beam. Samples were mounted in the (HHL) scattering plane such that the magnetic field could be applied either along the (110) or (001) directions through rotation of the sample stick. A mean neutron wavelength of 10 Å was selected.

In general, the low-temperature magnetic signal was seen to consist of three components, all of which can be seen in Fig. 1, which displays data from the $Mn_{1.4}Pt_{0.6}Ir_{0.4}Sn$ sample. Firstly, we observed the low-**q** tails of the ferromagnetic component of the magnetic structure, seen emanating from the beamstop in both panels of Fig. 1. This signal was observed in zero field, and seen to be enhanced along the direction of an applied magnetic field at the expense of spectral weight in the corresponding perpendicular directions. Secondly, Bragg spots from the spin-spiral structure were observed along the (001) directions. In zero applied field, these were seen to appear below a critical temperature, which for the Ir-doped sample was around 100 K. Thirdly, a Skyrmion-like signal was observed along (110) directions perpendicular to the applied field, which can be seen in panel (b) of Fig. 1. This signal was not seen in the zero-field cooled measurements, but appeared in the perpendicular direction to an applied magnetic field, with a maximum intensity at around 0.6 T and 40 K. It also possessed a parasitic relationship to the spin-spiral component, with spectral weight clearly being transferred from the spin-spiral Bragg peaks to this perpendicular component as the field was increased. From this we can determine that this signal originated from a Skyrmion phase.

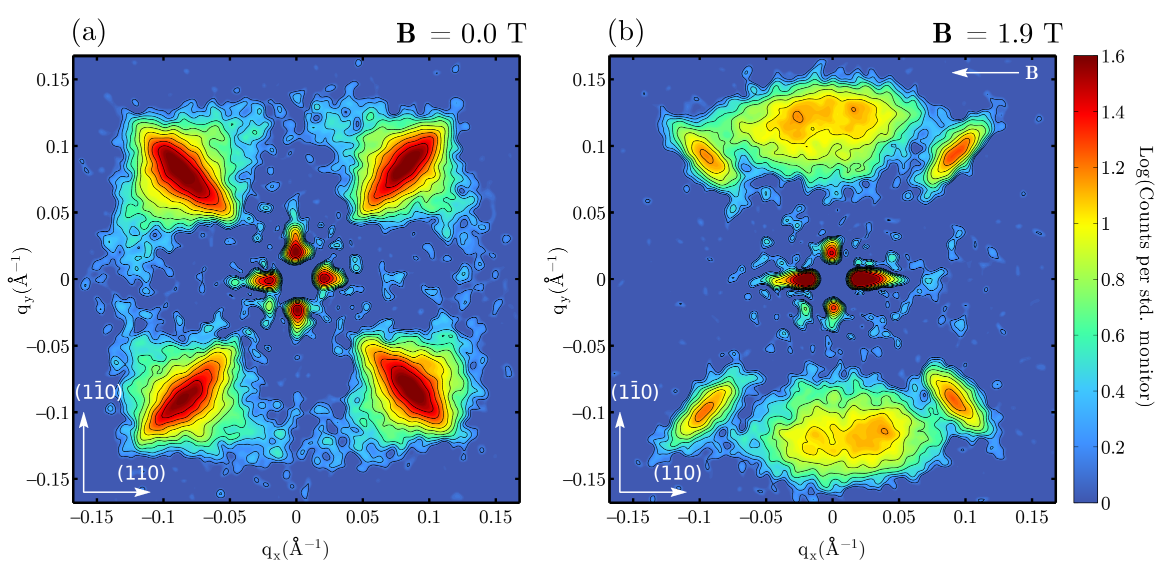

Figure 1: (a) Diffraction pattern from MnIrSn, cooled in zero field, showing the signal from the spin-spiral phase and low-**q** ferromagnetic component. (b) Diffraction pattern from MnIrSn, after the application of 1.9 T in the horizontal direction. The development of the Skyrmion signal can clearly be seen along the $(1\bar{1}1)$ direction. The data were taken at a temperature of 40 K, and both images are presented on the same logarithmic intensity scale.