Experimental report

25/04/2024

Proposal: 5-54-393 **Council:** 10/2022

Title: Is the incommensurate magnetic order in Mn3Sn cycloidal or cosine?

Research area: Physics

This proposal is a new proposal

Main proposer: Henrik JACOBSEN

Experimental team: Christian VEDEL
Henrik JACOBSEN
Kristine KRIGHAAR
Jeppe CEDERHOLM

Local contacts: Jose Alberto RODRIGUEZ VELAMAZAN
Anne STUNAULT

Samples: Mn3Sn

Instrument	Requested days	Allocated days	From	To
ORIENTEXPRESS	1	2	07/09/2023	08/09/2023
			15/03/2024	16/03/2024
D3 CPA	4	10	08/09/2023	12/09/2023
			14/03/2024	17/03/2024
			31/03/2024	04/04/2024

Abstract:

Hexagonal Mn3Sn displays a large Anomalous Hall Effect (AHE) at room temperature, which can easily be controlled, and is therefore an excellent candidate material for spintronic applications. The AHE is closely linked to the magnetic structure.

In some samples, the AHE vanishes upon cooling below 270 K, when the magnetic structure changes from a 120 degree type structure, to some kind of spiral or helix. The precise nature of this magnetic structure is presently unknown. With this proposal, we wish to use spherical neutron polarimetry to determine this magnetic structure.

Is the incommensurate magnetic order in Mn_3Sn cycloidal or cosine?

This is a report of the experiment on Mn_3Sn which was carried out at D3 on 14/3-18/3 2024. Present for the experiment were Henrik Jacobsen, Jeppe Jon Cederholm and Christian Vedel. Navid Qureshi joined discussions online. The instrument responsible was Jose Alberto Rodriguez Velamazan. The proposalID is 5-54-393, and the experiment was a continuation of a previous experiment with the same ID.

The sample was a $3 \times 0.8 \times 0.8$ mm^3 single crystal of Mn_3Sn, grown by Yanfeng Guo (Shanghai).

We used the standard cryopad setup.

We first measured the sample in the low temperature incommensurate phase at 160 K. For this part of the experiment, the sample was inserted in a standard orange cryostat, and the sample was aligned with (100) and (001) in the scattering plane. Several measurements of the incommensurate peaks were carried out. The goal of this part of the experiment was to determine which of two possible structures were correct. We tried to align the domains in the sample by applying a 1 T magnetic field in the high temperature phase and cooling (it was already known that the domains cannot be aligned in the incommensurate phase), but did not succeed. Because of the domains, most of the measurements yielded negligible diagonal terms. It therefore seems that we cannot determine which of the two structures are correct, but more analysis is required to fully confirm this initial analysis.

We next measured the sample in the high temperature commensurate phase at 295 K. The orange cryostat could not reach this temperature, and the sample was therefore measured in ambient conditions.

We first measured several magnetic peaks with (100) and (001) in the scattering plane. Next, we re-oriented the sample to place (100) and (010) in the scattering plane. With the combined results, we were able to unambiguously determine the magnetic structure of the sample in the high temperature phase. The result was surprising, as the magnetic structure is different from that of the sister compound Mn_3Ge.

We believe these results will form the basis of a publication about the magnetic behaviour of Mn_3Sn. Furthermore, the results will form part of the M.Sc. thesis of Jeppe Jon Cederholm

An example of our data and model is given in the figure.

The sample will be stored at D3 until it is safe to return in to Henrik Jacobsen.

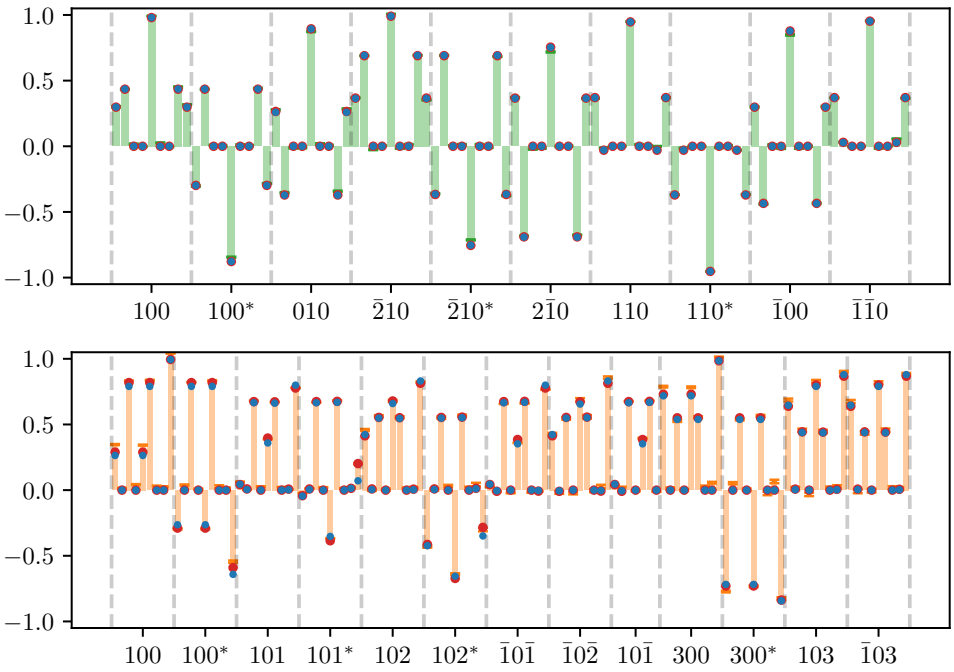

Figure 1: Data (lines) and model (points) for the present experiment. The agreement is excellent.