

Experimental report

14/09/2025

Proposal: 5-54-331

Council: 4/2020

Title: Origin of planar hall effect in epitaxial MnSi/Si(111) samples

Research area: Physics

This proposal is a new proposal

Main proposer: Grace CAUSER

Experimental team: Robert CUBITT

Local contacts: Robert CUBITT

Samples: MnSi

Instrument	Requested days	Allocated days	From	To
D33	6	3	01/06/2021	04/06/2021

Abstract:

Shortly after the first observation of magnetic skyrmion lattice in MnSi, it was established that emergent electrodynamics properties arising from its non-trivial topology, lead to a very efficient coupling to electrical currents through spin transfer torques. This discovery has fueled increasing scientific interest due to its potential application in future spintronics devices, and magnetic storage media. The study of magnetic skyrmions in thin samples is of extreme importance for its technological implementation. Published literature on MBE grown samples of MnSi on a Si substrate, have shown conflicting results. In part the existence of skyrmions in thin samples of MnSi has been proposed on the basis of planar Hall effect measurements. Recently we have measured the planar Hall effect in our samples, and identified a region displaying a finite Hall signal at low temperatures for magnetic fields just below the transition to the field polarized regime. Grazing incidence small angle neutron scattering would provide the missing microscopic information on the magnetic order behind this planar Hall effect signal and clarify where the skyrmion lattice is stabilized in this type of system

Experimental Report: Origin of planar Hall effect in epitaxial MnSi(111) samples

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Instrument Setup:

D33, cryostat with dilution insert and horizontal field magnet.

Measurements Performed:

We proposed a GI-SANS experiment to clarify the origin of the planar hall effect on epitaxial samples of MnSi/Si(111). This information is crucial to understand the effects of dimensionality and surface anisotropies on the magnetic phase diagram of these samples, and thus, obtain the necessary knowledge for the design of skyrmion based spintronic devices.

By obtaining detailed microscopic information with GI-SANS on the magnetic order in the region where a finite contribution to the planar hall effect was observed, we expect to clarify the open question on the existence of Skyrmions in these thin samples, and where in the magnetic phase diagram these can be found, as well as the suitability of planar hall effect for the detection and identification of magnetic Skyrmions in thin samples.

The GI-SANS measurements were performed at various temperatures and fields ranging from 0.1 – 20 K and ± 2 T. The external magnetic field was applied in the plane of the film both parallel and perpendicular to the incident neutron direction (Figure 1(a)). The resulting scattering pattern showed correlations along Q_z (Figure 1(b2)) which shifted to lower Q with increasing field (Figure 2) and vanished by 800 mT (Figure 1(b1)).

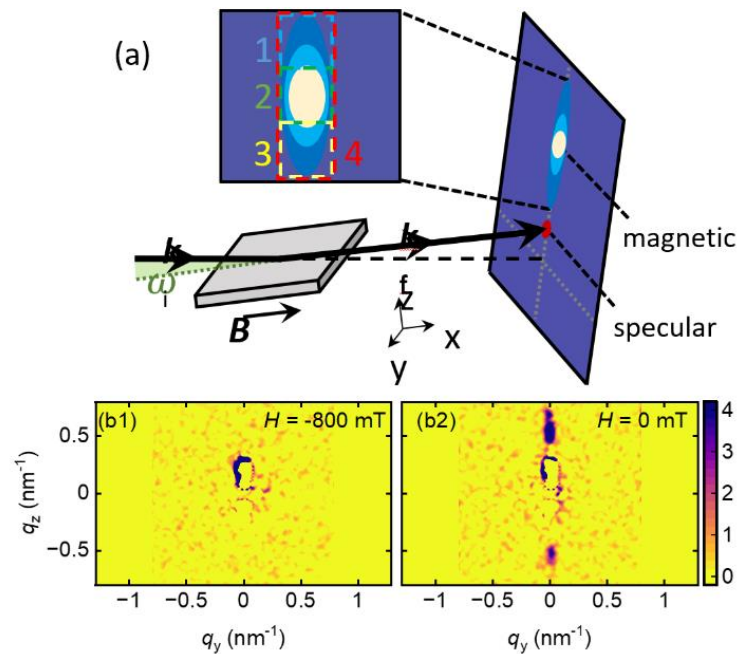


Figure 1: (a) Schematic of the GI-SANS setup used in the experiment. (b) The scattering patterns at (b1) 800 mT and (b2) 0 mT.

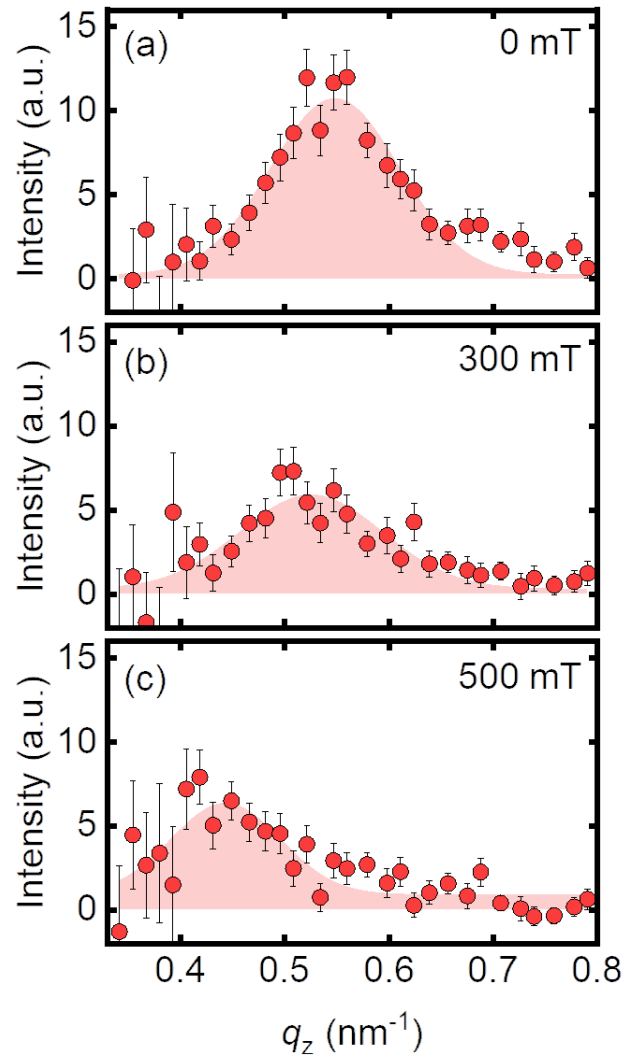


Figure 2: Integrated intensity of the magnetic Bragg peak as a function of external magnetic field at (a) 0 mT, (b) 300 mT, and (c) 500 mT. The intensity and Q-position of the Bragg peak reduces with increasing magnetic field.