Experimental report

20/12/2021

Proposal: 4-01-1734 **Council:** 4/2021

Title: Magnetization-controlled band-sticking of magnons at the zone boundary of field-polarized MnSi

Research area: Physics

This proposal is a new proposal

Main proposer: Tobias WEBER

Experimental team:

Local contacts: Paul STEFFENS

Samples: MnSi
Cu2OSeO3

Instrument	Requested days	Allocated days	From	To
THALES	6	3	17/05/2021	20/05/2021

Abstract:

Non-symmorphic symmetry in combination with time-reversal symmetry conspire to act effectively as a mirror symmetry that is predicted to generate a generic sticking of the band structure of crystals, i.e., degenerate crossing points where band gaps would expected. We propose to search for band-sticking in the magnon-spectrum of the field-polarized phase of MnSi at the Brillouin zone boundary, where we recently observed related band sticking in the electronic bands. As the magnetization breaks time-reversal symmetry, the band sticking is, however, predicted to exist on the surfaces of the Brillouin zone perpendicular to the direction of the magnetization only. Evidence for the magnon-band sticking would establish the generic origin of the band-sticking in the electronic structure and, at the same time provide a new perspective of the properties of a wide range of isostructural siblings such as FeSi or CoSi, crystallizing in the P213 space group. In total we ask for six days of beamtime at ThALES.

Magnetization-controlled band-sticking of magnons at the zone boundary of field-polarised MnSi

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The itinerant-electron compound MnSi features several magnetically ordered phases. These are the helical [1, 2], conical [3], the field-polarised ferromagnetic [4], and the skyrmion phase [5, 6]. In a previous work, we discovered a non-reciprocal magnon propagation in all of these phases, but strictly restricted to reduced momentum transfer components parallel to an applied external magnetic field [7].

For the present work, we investigated the behaviour of the field-polarised magnons in MnSi when approaching the Stoner boundary of non-collective single-particle excitations [8]. We measured the magnon branches around the $G = (111)$ nuclear Bragg peak for field directions parallel, perpendicular, and anti-parallel to G. These three configurations yield non-reciprocal magnon propagations for the first and third case, and reciprocal magnons for the second case, as previously established [7]. Shown in Fig. 1 are a series of constant-energy scans for energies between $E = 0.4\,\mathrm{meV}$ (first panel) and $E = 3\,\mathrm{meV}$ (last panel). Each panel contains three scans corresponding to the three principal configurations. The non-reciprocity between the parallel and anti-parallel configuration is well observed both as an asymmetry in the momentum transfers around $G = (111)$, as well an asymmetry between the two configurations. Furthermore, the individual magnon peaks were observed to quickly disappear in favour of single-particle excitations at $E > 2.5\,\mathrm{meV}$.

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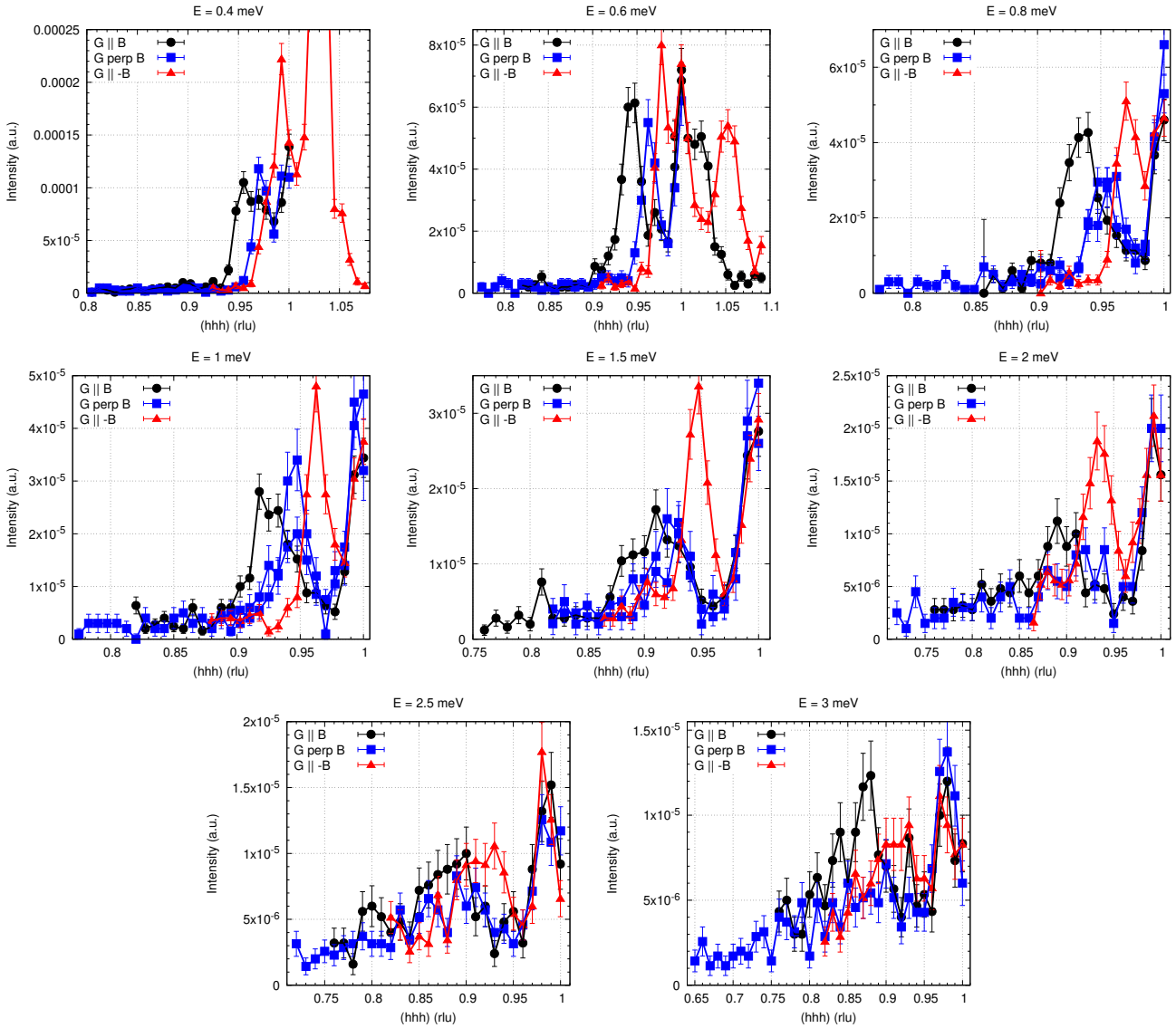

Figure 1. Magnons in the field-polarised phase of MnSi. At an external magnetic field of $|B| = 1\,\mathrm{T}$ and a sample temperature of $T = 5\,\mathrm{K}$, we investigated the the magnon branches around the $G = (111)$ Bragg peak for $G \parallel B$ (black points), $G \perp B$ (blue points), and $G \parallel -B$ (red points).