Experimental report

24/02/2021

Proposal: **TEST-3123** **Council:** 4/2020

Title: Gaussian-process-drivenalgorithm for autonomous experiments on ThALES

Research area:

This proposal is a new proposal

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Experimental team: Marina GANEVA

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Samples: MnSi

Instrument	Requested days	Allocated days	From	To
THALES	4	4	21/08/2020	25/08/2020

Abstract:

gpCAM Commissioning Experiment

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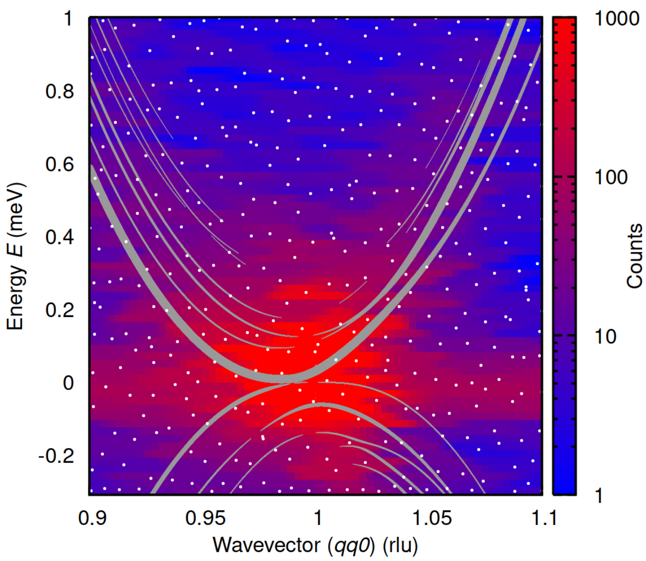

Figure 1. Autonomously measured data (white points) in the skyrmion phase of MnSi and interpolated colour map. The theoretical dispersion by M. Garst and J. Waizner [3–5] is over-plotted as grey lines.

The software *gpCAM* [1][2] is a tool which samples a given function at discrete points and uses statistical processes to reconstruct the original, continuous function. The present experiment served as feasibility test whether *gpCAM* would be able to drive a triple-axis instrument and find the dispersion of a given sample crystal by itself.

For the commissioning run of *gpCAM* at Thales, we chose to re-visit the non-reciprocal dispersion in the skyrmion phase of MnSi, where we had recently performed comprehensive polarization analysis studies [3, 4]. We furthermore re-used the instrumental set-up of our experiment directly before the present one, proposal #4-01-1643. Measurements were performed around the $\boldsymbol{G} = (110)$ Bragg peak with an external magnetic field $\boldsymbol{B} \parallel \boldsymbol{G}$, this yields the non-reciprocal dispersion branches, see [4]. With the spin flipper before the sample permanently switched on and the flipper after the sample permanently off, we only obtained the dispersion channel which has the neutron spins flip from a parallel to an anti-parallel orientation with respect to the lattice vector $\boldsymbol{G}$.

Fig. 1 shows the points (white) in reciprocal space that were picked and measured autonomously by *gpCAM*. The colour map interpolates the measured neutron scattering intensities at the corresponding positions. In this configuration, all data corresponds to purely magnetic scattering. Out of safety concerns, we restricted the possible autonomous measurement positions to the plane and ranges shown in Fig. 1. At $\boldsymbol{Q} = (110)$ and $E = 0$ a spillover signal from the non-spin-flip channel is obtained due to the strong nuclear Bragg peak and imperfect polarisation. Furthermore, at $E = 0$, the spin-incoherent elastic line can be discerned. The expected dispersion obtained from the theoretical linear spin-wave model by M. Garst and J. Waizner [5] is plotted as grey lines, also see [3, 4] for details. The results are in very good qualitative agreement with our main skyrmion study.

Data DOI: 10.5291/ILL-DATA.TEST-3123. *gpCAM* communication module code: `https://code.ill.fr/scientific-software/gpcam-com`. Magnon dispersion source code for Fig. 1: `https://code.ill.fr/scientific-software/takin/plugins/mnsi`. The MnSi crystal was provided by A. Bauer.

[1] M. M. Noack, "gpCAM (software, DOI: 10.11578/dc.20191205.1)," (2019 – 2021).
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[4] T. Weber, P. Steffens, A. Bauer, and P. Böni, "ILL experimental report 4-01-1597 (DOI: 10.5291/ILL-DATA.4-01-1597)," (2019).
[5] M. Garst, J. Waizner, and D. Grundler, Journal of Physics D: Applied Physics **50**, 293002 (2017).

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