# Experimental report

18/09/2024

**Proposal:** 4-05-880 **Council:** 4/2023

**Title:** mueV spin dynamics of the directorstate in frustrated hyperkagome systems

**Research area:** Physics

**This proposal is a resubmission of 4-05-859**


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**Samples:** Gd3Ga5O12
Gd3Al5O12

| Instrument | Requested days | Allocated days | From | To |
|---|---|---|---|---|
| IN16B | 7 | 4 | 11/09/2023 | 15/09/2023 |


## Abstract:

In this proposal we wish to explore the magnetic dynamics of magnetically frustrated hyperkagome systems at mK temperatures. We wish to investigate Gd3Al5O12, which is isostructural to the more well-known Gd3Ga5O12, which has been shown to exhibit an exotic type of long-range correlations, the so-called director state. The two compounds have similar structures and dynamics on the meV scale.

Despite the similarities between the two compounds, our AC susceptibility measurements indicate that they differ greatly on the mueV energy scale. We wish to investigate this difference in detail by measuring the dynamics of Gd3Al5O12 using IN16b. In addition, we wish to look for signatures of spin diffusion in Gd3Al5O12.

# $\mu$eV spin dynamics of the director state in frustrated hyperkagome systems

This is a report of the experiment on $Gd_3Al_5O_{12}$ (GAG) which was carried out at IN16b on 11th sep. – 15th sep. 2024. Present for the experiment were Henrik Jacobsen, Asbjørn B. Preuss, and Jeppe Jon Cederholm. The instrument responsible was Tilo Seydel. The proposalID is 4-05-880. The sample was 1.6 g of isotope enriched $Gd_3Al_5O_{12}$-powder, previously used in e.g. PRB **104**, 054420.

The main goal of this experiment was to measure the magnetic dynamics of GAG in the µeV energy range to understand how they differ from the dynamics of $Gd_3Ga_5O_{12}$ (GGG) a more well-known compound with the same structure of two interpenetrating hyperkagome lattices.

Despite the similarities between the two compounds, our AC susceptibility measurements indicate that their differ greatly on the µeV energy scale. In this experiment, we investigated this difference in detail by measuring the dynamics of $Gd_3Al_5O_{12}$.

The instrument was used in its standard setup with a dilution refrigerator to measure the sample at 50 mK, 200 mK, 300 mK, 400 mK, 450 mK, 500 mK, 600 mK, 800 mK, 1000 mK, and 1250 mK. Due to issues with the cryostat, the measurements at 450 mK ended up being half as long as the rest of the measurements, rendering the results as outliers during the data treatment.

We used vanadium to determine the resolution, which is well described using a Gaussian with a small Lorentzian tail. We model the signal as a delta function from incoherent elastic scattering, plus a Lorentzian from the magnetic scattering. In our fit, we convoluted the signal with the resolution, and added a background term fig. 1. The fitted area of the magnetic scattering shows a peak around 1.1 $Å^{-1}$, consistent with previous elastic measurements (PRB **104**, 054420), indicating short range magnetic order, c.f. fig. 2.

Furthermore, 4 fixed window scans were performed at energy transfers 0 µeV, 0.9 µeV, 2.5 µeV, and 5 µeV.

We believe these results will form the basis of a publication about the spin dynamics of the director state in $Gd_3Al_5O_{12}$.

An example of our data and model is given in fig. 1.

The sample has been returned to Pascale Deen.

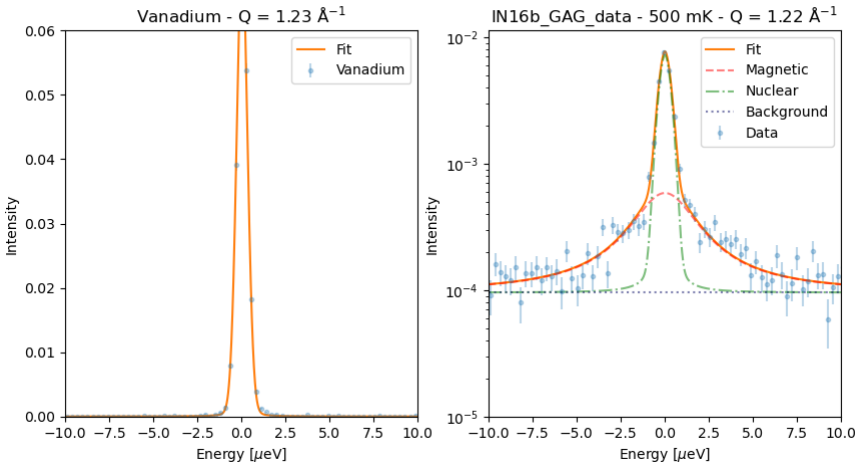


Figure 1: Fitted vanadium sample and GAG sample at 500 mK.

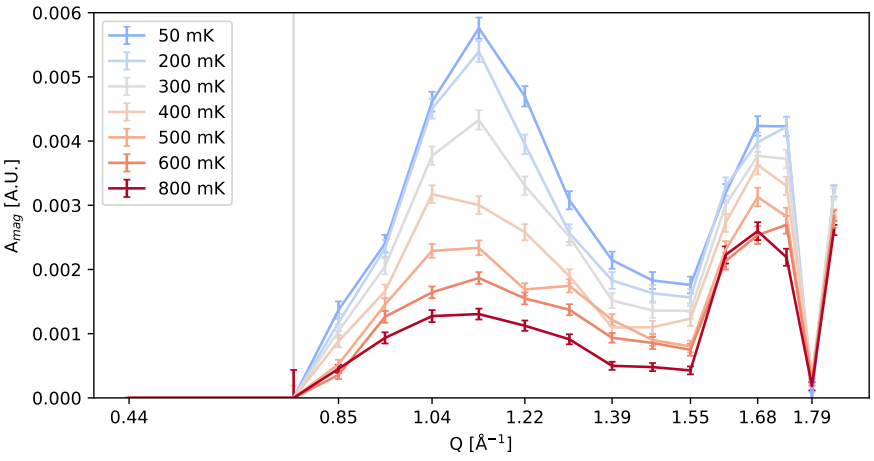


Figure 2: Q-dependence on the quasielastic magnetic scattering intensity.