Experimental report

21/07/2022

Proposal: DIR-235 **Council:** 4/2021

Title: CHIRAL ORDER IN A MAGNETIC METAL-organic framework based on the trillium net

Research area:

This proposal is a continuation of 5-32-862

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Samples: NaMn(HCOO)3

Instrument	Requested days	Allocated days	From	To
D7	2	2	30/08/2021	01/09/2021

Abstract:

Final Report

July 21, 2022

This experiment, a continuation of 5-32-862, was useful in understanding the magnetic interactions in $NaMn(HCOO)_3$ and forms a central part of a recent publication and DPhil project [1].

As previously, we used the 10 point method to separate magnetic from nuclear and spin incoherent scattering. The magnetic scattering was normalised by fitting a scale factor to the nuclear diffuse scattering (an internal standard). The magnetic scattering at 1.5 K was remeasured with a higher wavelength of 4.873 Å, compared to the previous 3.1565 Å. This measurement is compared to the previous one in figure 1a, which shows that the results are consistent, including in normalisation.

At 100 mK [Figure 1(b)] we gathered evidence of the long–range magnetic order predicted in the form of sharp magnetic bragg-peaks. However, the position of the Bragg peaks is inconsistent with the theoretical predictions of the nearest neighbour antiferromagnet (nnHAF) model , which predicts the $\mathbf{k} = \left[\frac{1}{3}, 0, 0\right]$ groundstate [2]. The scattering function of this groundstate is shown in blue in figure 1(b) and is clearly inconsistent, even in peak positions. In our paper [1], we go on to show how including the theoretical value for the Dipolar interaction shifts the groundstate to one which well predicts the measured diffraction. Only this low temperature measurement was able to definitely distinguish between the two models, which show similar diffuse scattering at 1.5 K.

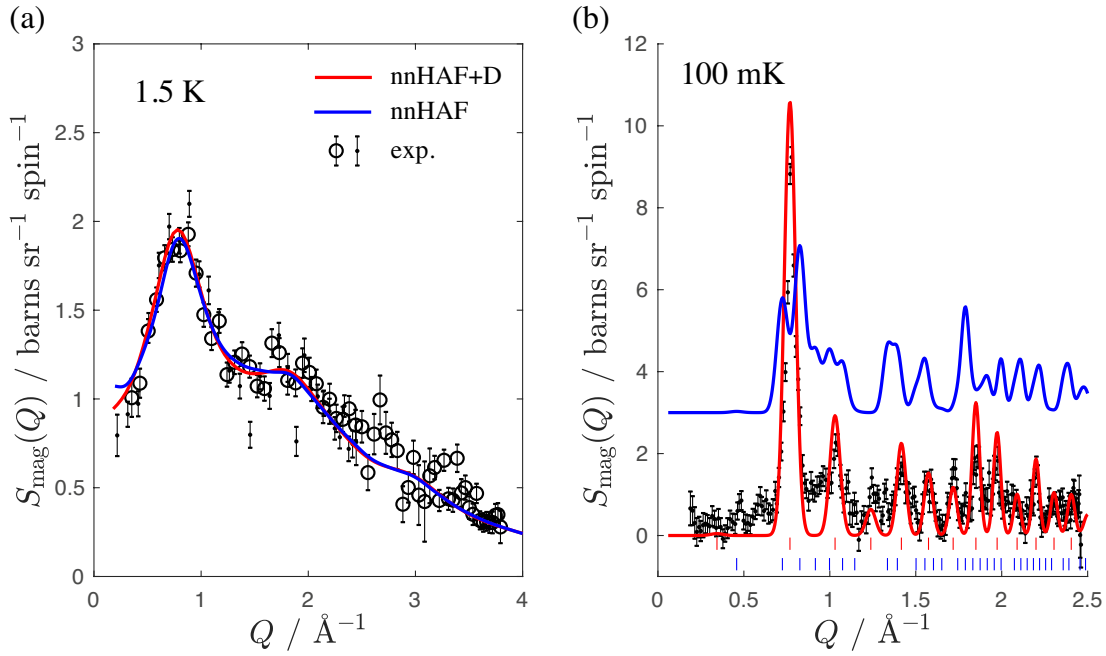

Figure 1: (a) The magnetic diffuse neutron scattering functions measured at 1.5 K; open and filled circles denote data collected at two different neutron wavelengths. (b) The experimental magnetic neutron scattering function at 100 mK. In both figures, blue and red lines and tick–marks correspond to the nnHAF and nnHAF+D models respectively. While the nnHAF model accounts similarly for scattering at 1.5 K, its incorrect prediction of the ordering vector means it does not correctly reproduce the ordered state. In 1(b), the nnHAF simulation is offset by 3 units for clarity.

References

[1] J. M. Bulled, J. A. M. Paddison, A. Wildes, E. Lhotel, S. J. Cassidy, B. Pato-Doldán, L. C. Gómez-Aguirre, P. J. Saines, and A. L. Goodwin *Phys. Rev. Lett.* **128**, 177201 (2022)

[2] S. V. Isakov, J. M. Hopkinson and H.-Y. Kee, *Phys. Rev. B* **78**, 014404 (2008).