Experimental report

23/09/2022

Proposal: **5-42-562**

Council: 4/2021

Title: Inhomogeneous magnetic order in the archetypical 2D van der Waals magnet CrI3

Research area: Physics

This proposal is a new proposal

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Experimental team:

Local contacts: Nina-Juliane STEINKE

Samples: CrI3

Instrument	Requested days	Allocated days	From	To
D33	2	2	04/10/2021	06/10/2021

Abstract:

Layered van der Waals (vdW) materials have become the subject of intense interest in the condensed matter physics and especially the spintronics community. The reason is the rich diversity of optical, electronic and topological states which can arise in monolayer limits and which may be strongly dependent on layer thickness, doping and other tuning parameters. In a very recent study it was revealed that even the bulk of the archetypical vdW magnet CrI3 shows several magnetic phases with distinct transitions below the established and magnetic phase separation down to very low temperatures. Here we propose to map out the spatial correlation of the magnetically coexisting phases and look for signs of more complex magnetic ordering using SANS.

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For this experiment a set of unoriented single crystals was prepared for beamtime at the university of Oxford. The samples are very air sensitive and react readily with a variety of solvents and for this reason it was decided to coat them in low temperature grease prior to shipment to protect them from oxidation. This is obviously a last resort choice for neutron measurements but no other suitable coating materials where admissible in the high purity glove box system. Despite the large background caused by the hydrogen, it was hoped that the background would be flat and unchanging with temperature and field. From previous muSR experiments and magnetometry the relevant temperature regimes were identified as < 20K, 20-45K, 45-60K, >62K. Measurements were carried out at 4.6Å and 10Å and 12.8m. The sample was zero field cooled and measurements were taken in zero field as a function of temperature and additional field scans were carried out at selected temperatures. Great care was taken to take long background measurements at several temperatures (300K, 220K and 80K) to check for temperature variations induced by the coating. A magnetic signal was found at low Q, which shows field and temperature dependence (see Figure) but the relatively weak magnetic scattering was swamped by the very large background signal despite long acquisition times and careful background subtraction.

Data was taken at zero field at temperatures of 5, 20, 30, 40, 50, 55, 62 and 70K as well as background measurements at three temperatures. In addition fieldscans were carried out at 40K and 55K. Analysis is ongoing to try and optimise the background subtraction and for future measurements discussions are ongoing to design a special holder that can be sealed airtight directly at the university, given the constraints of working in a glove box and the very limited solvents that can be introduced into a high purity glove box environment. Despite these challenges we were able to identifiy a clear magnetic signal and our results will be complemented by futher neutron experiments, ideally on oriented crystals.

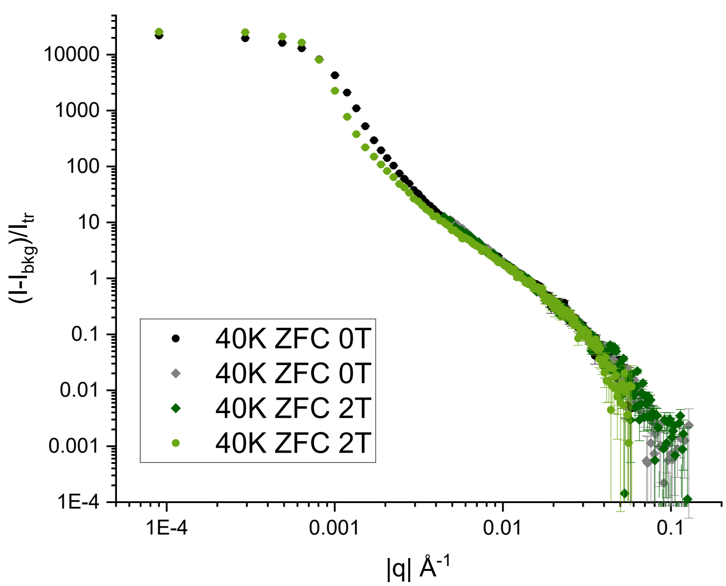

Figure 1 Preliminary data at 40K as a function of field.