Experimental report

08/05/2017

Proposal:	**5-31-2470**	**Council:**	4/2016
Title:	Magnetic correlations in a geometrically frustrated magnet		
Research area:	Physics		

This proposal is a new proposal

Main proposer:	**Peter BABKEVICH**
Experimental team:	Peter BABKEVICH
Local contacts:	Emmanuelle SUARD Vivian NASSIF

Samples: Ba_2CaReO_6

Instrument	Requested days	Allocated days	From	To
D2B	3	0		
D1B	3	2	02/07/2016	04/07/2016

Abstract:

In this proposal we wish to investigate a potentially novel perovskite system in order to determine its groundstate magnetic structure and characterise the nature of magnetic transitions observed in the heat capacity measurements. D1B and D2B diffractometers are ideally suited for this study.

Proposal 5-31-2470: Magnetic correlations in a geometrically frustrated magnet

P. Babkevich[1], V. Nassif[2], D. Hirai[3] and H.M. Ronnow[1]

[1] *Laboratory for Quantum Magnetism, Ecole Polytechnique Fédérale de Lausanne, CH-1015 Lausanne, Switzerland*

[2] *Institut Laue-Langevin, Boite Postale 156, 38042 Grenoble Cedex, France*

3 Institute for Solid State Physics (ISSP), The University of Tokyo, Kashiwa, Chiba 277-8581, Japan

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We have performed magnetic powder diffraction measurements on a novel Ba_2CaReO_6 compound using the D1B beam line.

Geometrically frustrated magnets are the centre of materials displaying rich variety of physical states. Due to the arrangement of ions on a lattice and despite strong coupling, the system is unable to achieve long-range order [1]. If long-range order does occur, it is typically on a temperature scale of $T < T_N << |\theta_{CW}|$, where θ_{CW} is the Curie-Weiss temperature. Meanwhile exotic correlations can exist in the intermediate temperature interval of $T_N < T < |\theta_{CW}|$ [2]. Moreover, the perovskite compounds with the composition of $A_2B'B''O_6$ are an excellent testing ground of structural distortions, superconductivity, order-disorder phenomena, magnetic ordering, etc. [3]. The corner-sharing $B'O_6$ and $B''O_6$ octahedra allow for the possibility of two magnetic sublattices and frustrated ordering within B' and B'' sublattices can be further modulated by the coupling between the sublattices [4]. Very recently, perovskites containing Ru, Os and Ir have emerged as a fertile ground for novel phenomena originating from strong spin-orbit coupling. However, the exploration of Ir compounds has been hindered by the large neutron absorption cross-section of the ion making neutron scattering experiments difficult.

Neutron scattering measurements on Sr_2YRuO_6 showed that the quasi-fcc lattice of Ru moments condense into a partially long-range ordered state below T_{N1} = 32 K with a second transition observed into a fully ordered antiferromagnetic state below T_{N2} = 24 K [2]. It was suggested that a cancelling of magnetic couplings exists between successive fcc layers, similar to the dimensional reduction predicted in dipolar-coupled systems and observed in $LiErF_4$ [5,6].

To this end, we have chosen to examine Ba_2CaReO_6 which has been found to have successive transitions around 14 K in the heat capacity and magnetisation measurements.

To determine the low-temperature magnetic spin structure, we have employed the D1B diffractometer. A powder sample of 4.4 g was sealed in an Ar atmosphere inside a 9 mm diameter V can. Figure 2 shows the powder patterns collected at 1.5 and 30 K after 8 hours of counting at each temperature. No clear indication of long-range magnetic order could be found. Some weak signals were observed that correlate with the magnetisation measurements, however, their origin is currently unclear and require further investigation.

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[4] Ranjbar, B. et al., Inorg. Chem. 54(21) 10468, (2015)
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[6] Kraemer, C., Science 336, 1416 (2012)

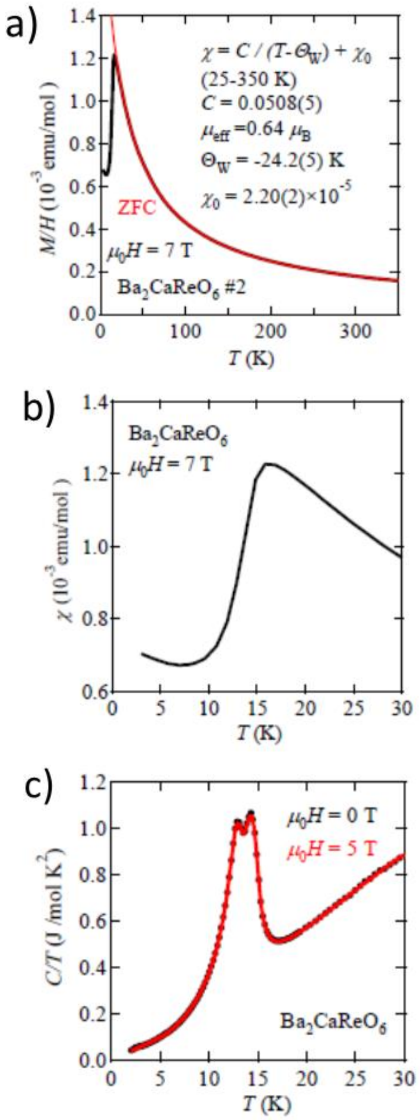

Figure 1. a) Magnetisation measurements of Ba_2CaReO_6 to show Curie-Weiss dependence at high temperatures. b) A broad transition indicative of low-dimensionality found in the magnetisation measurements. c) Double transition found in the heat capacity.

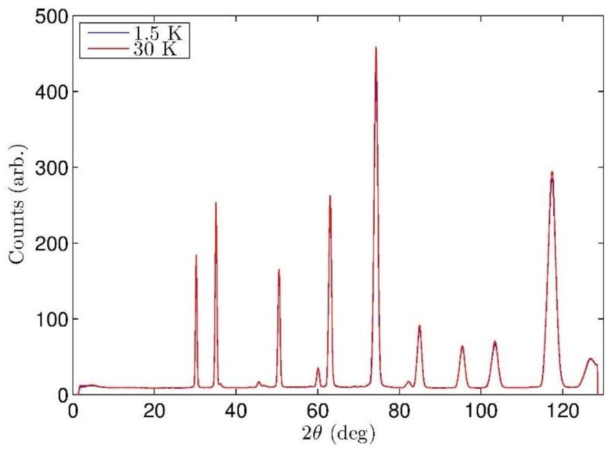

Figure 2. Powder diffraction pattern collected on Ba_2CaReO_6 at 1.5 and 30 K.