Experimental report

15/09/2019

Proposal: 5-41-970 **Council:** 4/2018

Title: Study of the magnetic chirality inbeta-CaCr2O4

Research area: Physics

This proposal is a new proposal

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Samples: beta-CaCr2O4

Instrument	Requested days	Allocated days	From	To
D3	5	5	19/09/2018	24/09/2018
ORIENTEXPRESS	0	1		

Abstract:

beta-CaCr2O4 is a zigzag chain compound for which an incommensurate magnetic order sets in below 21K. The magnetic structure consists in a cycloidal arrangement with the spins confined in the (a,c) plane and the propagation vector is k=(0 0 0.47). A powder study shows that the magnetic ordering sets in following two steps which consist in the onset of a collinear spin-density wave parallel to the a-axis followed by the onset of a secondary component along c allowing the cycloidal modulation of the moments. Furthermore, a non-uniform chirality of the cycloids along the triangular chains was reported.
We would like to confirm these results in a single crystal study using spherical polarimetry. We hence request 5 days on D3 with the CRYOPAD option.

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β-$CaCr_2O_4$ exhibits a tunnel-like structure in which the magnetic Cr^{3+} ions (S=3/2) are located on two different crystallographic sites, and form triangular ladders running along the c axis. Previous neutron diffraction experiment on a powder combined with heat capacity and susceptibility measurements revealed the onset of an incommensurate magnetic ordering, which sets in following two steps. Below T_{N1} = 21 K and down to T_{N2} = 16 K the moments are collinear to the a-axis and form a spin density wave. In the low temperature phase, the magnetic structure consists in a cycloidal structure with the moments confined in the (a,c) plane (the propagation vector is k = (0 0 0.47)).

The aim of this experiment was therefore to confirm the existence of a spin density wave and refine the magnetic structure in a single crystal using neutron diffraction with spherical polarization provided by the CRYOPAD option on the D3 diffractometer. The crystal was aligned with the b-axis as the vertical axis and the full polarization matrix was measured for the (1 0 ±q) and (1 1 1±q) magnetic reflections at T = 18 K (between T_{N1} and T_{N2}) and T = 1.5 K.

The refinement was performed with the MAG2POL software and the data corroborates the presence of a spin density wave in the intermediate regime. At low temperature, however, the refined magnetic structure is not a cycloid with the moments confined in the (a,c) plane but a helix with the moments in the (a,b) plane instead (see figure below).

In order to refine the full structural model along with the ordered moment values in both intermediate and low temperature regimes, it will be necessary to perform further single crystal diffraction measurements with unpolarized neutrons.

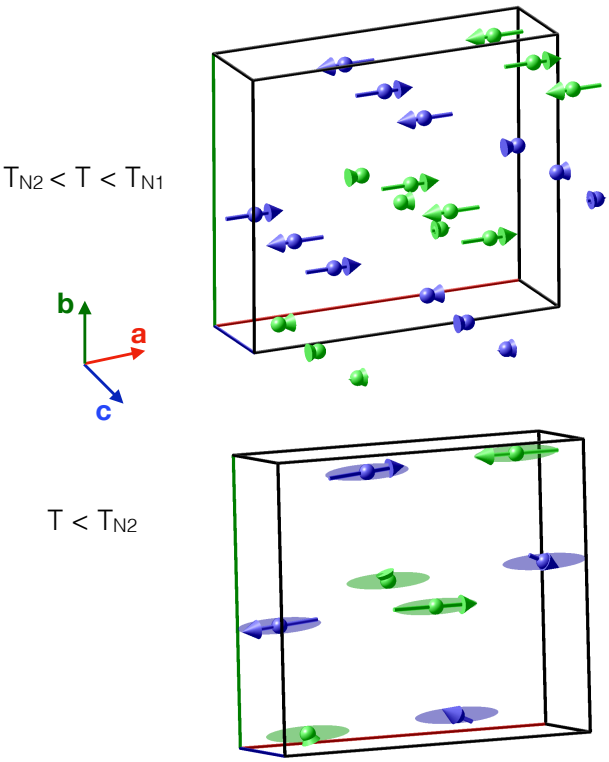

Fig. Magnetic structures refined using the MAG2POL software, from the data collected on D3 with CRYOPAD, in the intermediate regime (top) and the low temperature regime (bottom).