Experimental report

13/09/2024

Proposal: **CRG-3018** **Council:** 4/2023

Title: Field induced magnetic state of the ¿Faraday-rotator¿ KTb3F10

Research area: Physics

This proposal is a new proposal

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Samples: KTb3F10

Instrument	Requested days	Allocated days	From	To
D23	3	3	22/11/2023	27/11/2023

Abstract:

The abstract is in the scientific case pdf file.

Experimental report on
Magneto-elastic coupling in the "Faraday-rotator" KTb_3F_{10}
@D23

<u>Scientific context:</u> As is well known for non-Kramers ions, the crystal-electric field (CEF) splits the (2J+1)-fold degenerate J-multiplet into a series of doublets but also singlets. The class of magnetic materials whose CEF ground state is *such a singlet*, like in KTb_3F_{10} is quite remarkable. Depending on the precise value of the gap to the excited states, the singlet state could be either well protected, or much more subtle, (so called "induced magnetism") [1 -8].

In KTb_3F_{10}, the Tb ions occupy the vertices of a network of corner-sharing octahedra (cubic *Fm*-3*m* space group, see Ref [7]). Its CEF scheme encompasses a singlet ground state |O> = |J=6, J_z=0 > and an excited doublet |±> = |J=6, J_z=±1> at about 2.7 meV. Importantly, the z quantification axis changes from site to site, being one of the cubic axes [2]. Our modelling of the CEF levels leads to the fact that any field induced magnetic moment appears within the plane perpendicular to this local z quantification axis. Depending on the site, this plane is perpendicular to the local *a*, *b* or *c* axis of the cell. This experiment was dedicated to carry out diffraction measurements on KTb_3F_{10} to study the induced magnetism. The magnetic field was applied along the [111] direction.

The D23 diffractometer was operated at the wavelength of λ = 1.28 Å. It was equipped with a 6T cryomagnet. A high-quality single crystal (5x5x5 mm^3, commercial, Northrop-Grumman) was oriented with [111] vertical, along the magnetic field direction.

We spent 5 days to record data collections at various magnetic fields and temperature, ranging from 0 to 4.5 T at 1.5 K. We also ramped the field on a series of reflections to obtain a continuous evolution of the induced magnetic structure.

Representative results are shown in Figure 1. On that figure, M_0 represents the magnetic moment component parallel to the 4 fold axis of a given terbium site. M_1 is a magnetic moments component parallel to the magnetic field and orthogonal to the 4-fold axis of any terbium site.

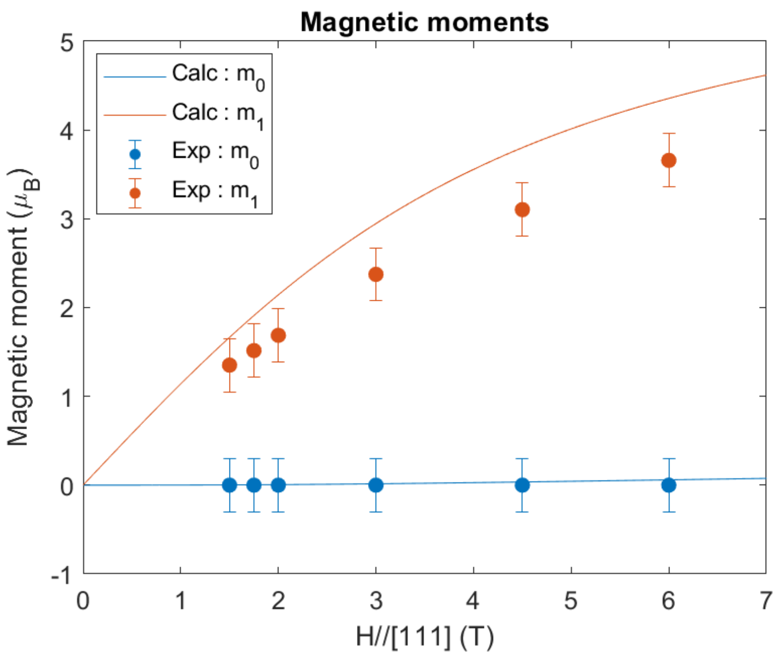

Figure 1 : Evolution of magnetic moments carried by magnetic ions.

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