Experimental report

04/04/2016

Proposal: **4-01-1471** **Council:** 4/2015

Title: Inelastic scattering study of $CaFe_2O_4$

Research area: Physics

This proposal is a new proposal

Main proposer: **Manila SONGVILAY**

Experimental team: Françoise DAMAY
Manila SONGVILAY

Local contacts: Martin BOEHM

Samples: $CaFe_2O_4$

Instrument	Requested days	Allocated days	From	To
IN8	7	6	24/11/2015	01/12/2015

Abstract:

The 1D zigzag antiferromagnet $CaFe_2O_4$ exhibits a magnetic phase transition in which the interchain couplings, which are ferromagnetic in the A phase below 160 K, become antiferromagnetic in the B phase (above 160 K). We would like to investigate this intriguing behavior by studying the excitation spectrum of $CaFe_2O_4$.

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$CaFe_2O_4$ crystallizes in an orthorhombic *Pnma* structure, in which units of two FeO_6 octahedra sharing an edge are connected by corners. This results in a tunnel-like structure, which contains large prismatic cavities occupied by Ca^{2+}. $CaFe_2O_4$ becomes antiferromagnetic around T_N~180 K and goes through two magnetic transitions: the first transition occurs at 180 K towards a so-called « B phase » which is observed in the 180-160 K temperature range. Below 160 K, another transition towards an « A phase » takes place. The two corresponding magnetic orderings are both **k** = 0 magnetic structures, which can be described using antiferromagnetic Fe-O-Fe-O… chains running along b (dashed red lines on figure 1b)). The only difference between the A and B orderings is the coupling between these chains, which is antiferromagnetic in the B phase, but ferromagnetic in the A phase (J_{int}). In both cases, the moments are aligned along c.

The aim of the experiment was to study the excitation spectrum of $CaFe_2O_4$ using a single crystal sample, in order to investigate this intriguing behaviour.
Several constant-Q scans were hence performed to map out the dispersion along the (H 1 0) and (H 2 0) directions. Because the single crystal was very small, the experimental conditions were limited by the large mosaicity of the graphite and silicon monochromators, compared to the sample size. Hence, measurements were only attempted in the A phase, at T = 50 K.
Although the magnetic signal was very weak, the constant-Q scans were compared to spinwave calculations, in order to attempt to determine the exchange coupling values.
However, it would be necessary to complete this experiment with powder inelastic scattering measurements in order to extract the dominant value of the exchange interactions involved in the two phases.

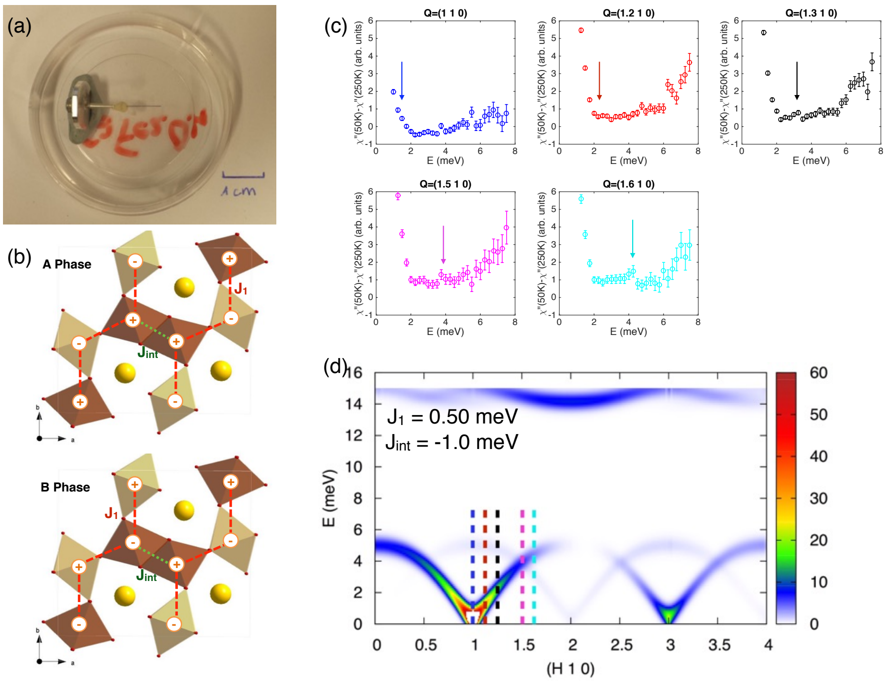

fig.1: (a) CaFe2O4 single crystal. (b) Magnetic structure in the A and B phase viewed in the (a,b) plane. The Fe1 and Fe2 sites are represented in brown and beige octahedra respectively. (c) Constant-Q scans in the (H 1 0) direction. Data have been corrected for background intensity, resolution and Bose factor. The arrows point to the inelastic magnetic signal. (d) Calculated magnon dispersion [1] in the A phase. The dashed lines represent the constant-Q measurements.

[1] S. Petit, Collection SFN 12, 105-121 (2011)