Experimental report

14/09/2023

Proposal: 5-31-2963 **Council:** 4/2023

Title: Possible universal magnetic order,precursor of the superconducting phase in pressurized Fe-spin laddersBaFe2X3 (X=S, Se)

Research area: Physics

This proposal is a new proposal

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Samples: BaFe2S3

Instrument	Requested days	Allocated days	From	To
D1B	5	5	31/08/2023	05/09/2023

Abstract:

The discovery of iron-based superconductors had a significant impact on condensed-matter and led to an intensive study of the crystal structure as well as the magnetic and superconducting behaviours. Recently, Fe-based ladders BaFe2X3 (X=S, Se) superconducting under pressure have attracted strong attention due to their quasi-1D character, easy to theoretically model. BaFe2S3 crystallizes in an orthorhombic non polar structure while the parent compound BaFe2Se3 has been recently shown to crystallize in a polar structure and present a multifferroic character. The study and understanding of the various competing phases in these Fe ladders requires the detailed magnetic structure as a function of pressure and temperature. It is the aim of the proposed experiment to perform an accurate data collection as a function of P and T for BaFe2S3 as has been done by the PI for BaFe2Se3

Possible universal magnetic order, precursor of the superconducting phase in pressurized Fe-spin ladders $BaFe_2X_3$ (X=S, Se)

- Objective & expected results : **-**

In this spin ladder system, BaFe2S3, the aim was to perform an extensive powder neutron diffraction experiment of $BaFe_2S_3$ under pressure up to 10 GPa in order to determine the evolution under pressure of the magnetic structure close to the superconducting dome.

- Results and the conclusions of the study (main part): **-**

The measurements were performed in August 2023 on the D1b spectrometer (experiment 5-31-2963). We had high quality single crystals that we have grind and introduced in the Paris-Edimbourg pressure cell placed inside a closed-circle cryostat. We **have** tune**d** the pressure from 0 to **9** GPa by steps of 3 GPa. The measurement **have been** performed at **10 K**. For each pressure step, it was necessary to heat up the cryostat and change manually the pressure and then cool down. This procedure is very time consuming. During the beginning of the experiment, we encountered technical difficulties due to the crystallization of the pressure transmission liquid in the DAC. It contained water which crystallized under pressure and low temperature inducing noise. This required to load a second sample. We then succeeded in evidencing the presence of the magnetic order at q=(½ ½ 0) until 5.5 GPa (see fig). The amplitude of the ordered moment refined was found consistent with the ambient pressure and constant in the 2 GPa and 5.5 GPa region. This is a strong indication that the stripe phase does not change with pressure in the 0-5.5 GPa range contrary to the proposition of Takahashi et al 2015. However, due to the waste of time at the beginning of the experiment, we were not able to study accurately the high temperature region. In particular, the exposure time of the 9 GPa experiment was not enough to observe the magnetic reflection or really exclude its presence. In addition, no intermediate pressure was recorded. Furthermore the last point at 12 GPa was not reached. When increasing the temperature after the last measurement the cell exploded. This study is a part of the PHD thesis of Y. Oubaid.

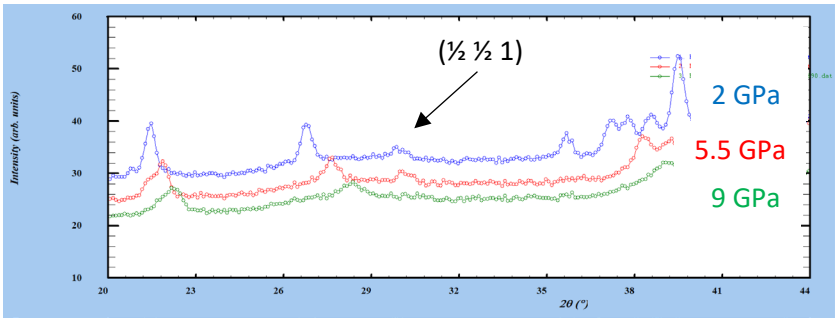

Figure : Evolution of the powder neutron diffractogram at 10K under pressure (experiment 5-31-2963)