ESRF	**Experiment title:** *Element-specific magnetometry on negative magnetization systems*	**Experiment number:** HE-3282
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Experiment HE-3282 was performed with the aim of unraveling the origin of the phenomenon of negative magnetisation in oxides, molecular magnets and other systems [1-9] under low-field FC magnetization measurements, as shown in Fig. 1 (data obtained in $NdFe_{0.8}Ga_{0.2}O_3$): when cooling under a magnetic applied field H_a smaller than a threshold value the magnetization is parallel to H_a just below T_N. However, upon cooling the net magnetization increases, reaches a maximum and then diminishes to zero. Instead of the normal behaviour of ferrimagnets presenting a compensation point (T_{COMP}), a **negative net magnetization** is developed below an inversion temperature. Two models are able to explain the observed phenomena: **A**) a compensation point, in which the magnetisation of two antiferromagnetically coupled sublattices should reverse, is attained, but a freezing phenomenon avoids the reversal of the momenta, or **B**) a phase-separated scenario with different temperature evolution of each magnetization generates a flipping temperature due to antiferromagnetic coupling between the moments in both phases.

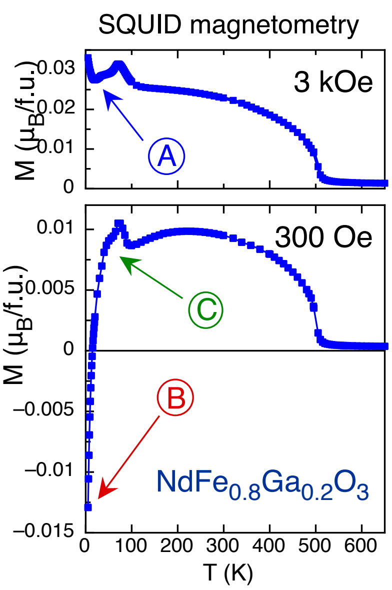
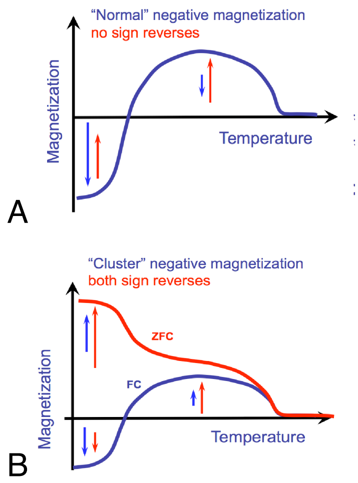


Fig 1. Left: FC magnetization in NFGO under 300 Oe and 3kOe.

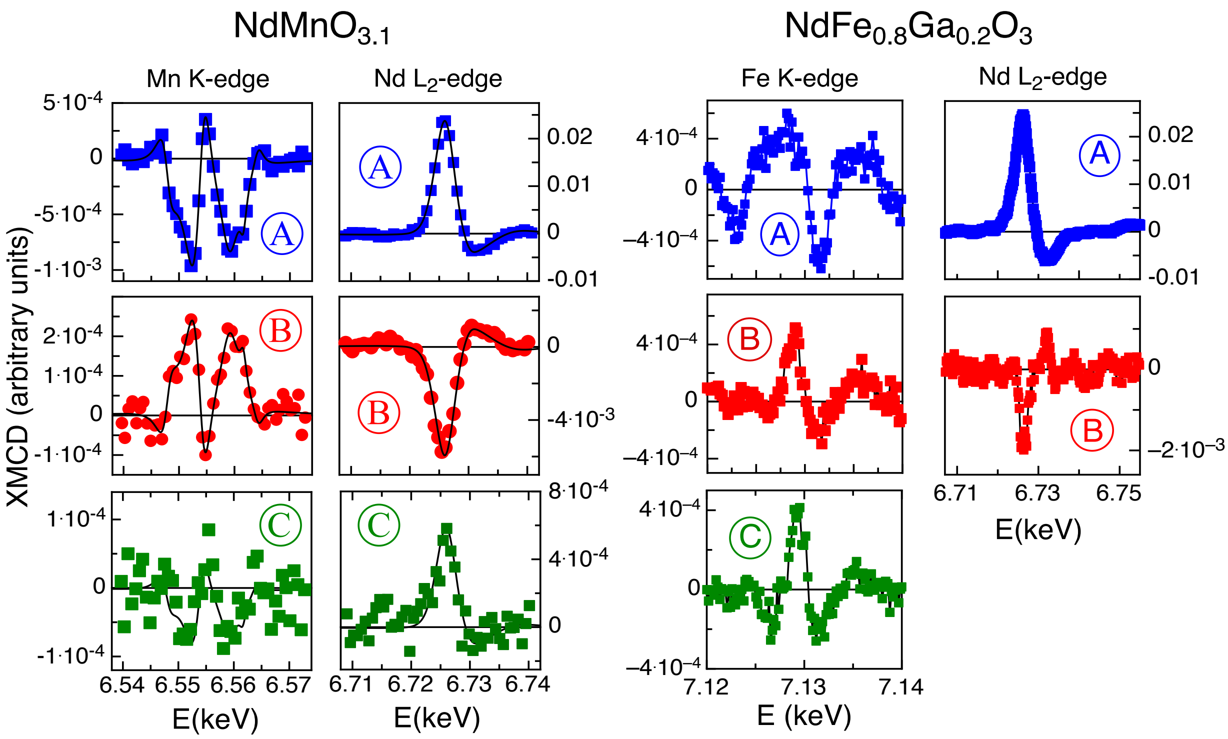


Right: The two schemes for negative magnetization are distinguishable by XMCD.

These different models are schematized in Fig. 1 (right column). Both are distinguishable by XMCD, as **none (A)** or **both (B)** sublattices inverse its magnetisation at the inversion temperature.

As proposed, we measured XMCD at two temperatures in FC and ZFC conditions at the Nd $L_{2,3}$ and Fe K edges in $NdFe_{0.8}Ga_{0.2}O_3$. We also completed previous XMCD measurements on $NdMnO_{3.1}$

The main experimental results are shown in Figure 2.



The **A, B,** and **C** labelling (as well as the coulours) in the experimental results refer to the A, B, and C points in Figure 1(left). A indicates a low temperature state after a FC process under high field applied, such that negative magnetization does not appear. B indicates a low temperature, negative magnetization state reached after a FC process under a low field. C indicates a higher temperature state of magnetization reached after a FC process under a low field, thus once negative magnetization has been first stablished and lately thermally overcome. We also measured XMCD other points of the diagram (ZFC states, FC intermediate points between B and C, etc, not shown here for clarity)

The main result can be extradcted from the comparison between the relative orientation of Fe and Mn sublattices between B and C points. A publication which will include magnetization, susceptibility, specific heat and neutron diffraction data is in preparation.

This are particularly difficult XMCD measurements. Because of the central role played by magnetic history in this measurements, one has to measure XMCD by flipping only the polarisation of the incoming beam. Hoewever, to avoid any experimental artifact we performed each FC or ZFC process twice, with oposite fields. Due to the lack of time we did not measured the Nd signal at 60 K (point C) in $NdFe_{0.8}Ga_{0.2}O_3$ (which is expected to be zero, as Nd is paramagnetic in the whole range of temperatures in these perovskites, and it is only visible below 20 K by neutron diffraction or XMCD, as in $NdMnO_{3.1}$. For the same reason, we did neither measured Ni-Mn-Fe Prussian blue analogs, which also present negative magnetization and were mentioned in the proposal. However, we are rather satisfied with the results obtained as the main goal of the proposal has been accomplished.

References

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