ESRF	**Experiment title:** Static and dynamic magnetism of kagome-lattice Fe_3Sn_2	**Experiment number**: HC-3016
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Names and affiliations of applicants (* indicates experimentalists):

- Jonathan Pelliciari

- Roberto Fumagalli

Report:

Fe_3Sn_2 has the potential to be a magnetic topological insulator where the time reversal symmetry breaking associated with the emergence of ferromagnetism, can lead to new non-trivial topological states. At 300 K, the Fe spins of the kagome lattice are ferromagnetically aligned along the **c** axis and are gradually shifted into the **ab** plane when the temperature is decreased [1]. An anomaly in the susceptibility around 100 K had been detected, possibly indicating that frustration can play an important role.

We cleaved the sample at a pressure better than 10^{-10} mbar. The XAS measurements have been performed in both Total Electron Yield (TEY) and Total Fluorescence Yield (TFY), in order to ensure that the bulk and surface are consistent and that no surface effects are present in the XMCD signal. We probed 3 temperatures 300 K, 100 K (not shown), and 10 K. We measured at two different incident angles (20 and 70 degrees) in order to study the projection of the magnetic moment in both off-plane and in-plane directions. We acquired high statistics XAS and XMCD at 3 magnetic field values. We also reversed the sign of the field to check for possible inhomogeneity in the polarization of the incoming beam. The values of the magnetic field for high statistics scans had been selected on hysteresis curves collected at fixed energy (without acquiring the full XAS and XMCD) where the dichroic signal was maximized.

In Fig. 1(a) we show a typical X-ray absorption spectrum for Fe_3Sn_2. The XMCD signal has no difference between TEY and TFY. Moreover, we observe that the edge jump in the absorption is about 30-40 % that might indicate a moderate absorption cross section. This is not surprising since the sample is an intermetallic compound and from previous experience on Fe pnictides [2], we can extrapolate that the RIXS investigation is feasible and a conservative estimation of the time for a high resolution RIXS spectrum is around 4 hours.

In Fig. 1(b) we show the XMCD spectra at 300 K collected at 70 degrees of incidence angle (blue line) and at 20 degrees of incident angle (green line). The XMCD represents the projection of the magnetization along the out-of-plane (blue line) and in-plane components. The XMCD signal have been normalized by the total area of the XAS. The main contribution of the magnetic moment points along the **c** axis at 300 K, as demonstrated by XMCD signal at 70 degrees. At 20 degrees of incidence we observe an XMCD signal which is about one third of the one along the **c** axis. In this configuration the XMCD arises from both components in-plane and out-of-plane and if corrected for the geometrical factor we observe that ath out-of-plane projection coincides with signal observed, demonstrating the lack of XMCD signal in the in-plane components. This is in agreement with previous neutron diffraction measurements [1] and consistent with a spin glass phase.

When the system is cooled down to 10 K we observe an increase of the in-plane components of the XMCD signal compared to 300 K as displayed in Fig.1(c). This increase suggests the emergence of ferromagnetism in the **ab** plane at low temperature as was previously suggested by neutron diffraction [1]. At the same time the out-of plane component is quenched but not completely eliminated as depicted in Fig.1(d), indicating that there is a general reshape of the magnetism at low temperature. Additionally, the presence of a small magnetic moment along the out-of-plane direction indicates that the magnetic frustration can play a role especially at low temperature where thermal effect are minimized.

We plan to perform further analysis to quantify the magnetic moment applying sum rules elucidating how such parameter evolves as a function of temperature. The additional RIXS measurements proposed can provide important information in the elucidation of the magnetic Hamiltonian giving further insights on the effect of magnetic frustration in this material, which can only be partially detected by XMCD. Our XMCD experiments show that temperature study may unveil surprising effects due to rearrangements and fluctuations of the spins from the out-of-plane to in-plane directions and suggest that this should be taken under strong consideration in planning the future RIXS experiment.

[1] L. A. Fenner et al., *Journal of Physics: Condensed Matter*, 21, 452202 (2009)
[2] J. Pelliciari et al., *Phys. Rev. B*, 93, 134515 (2016)

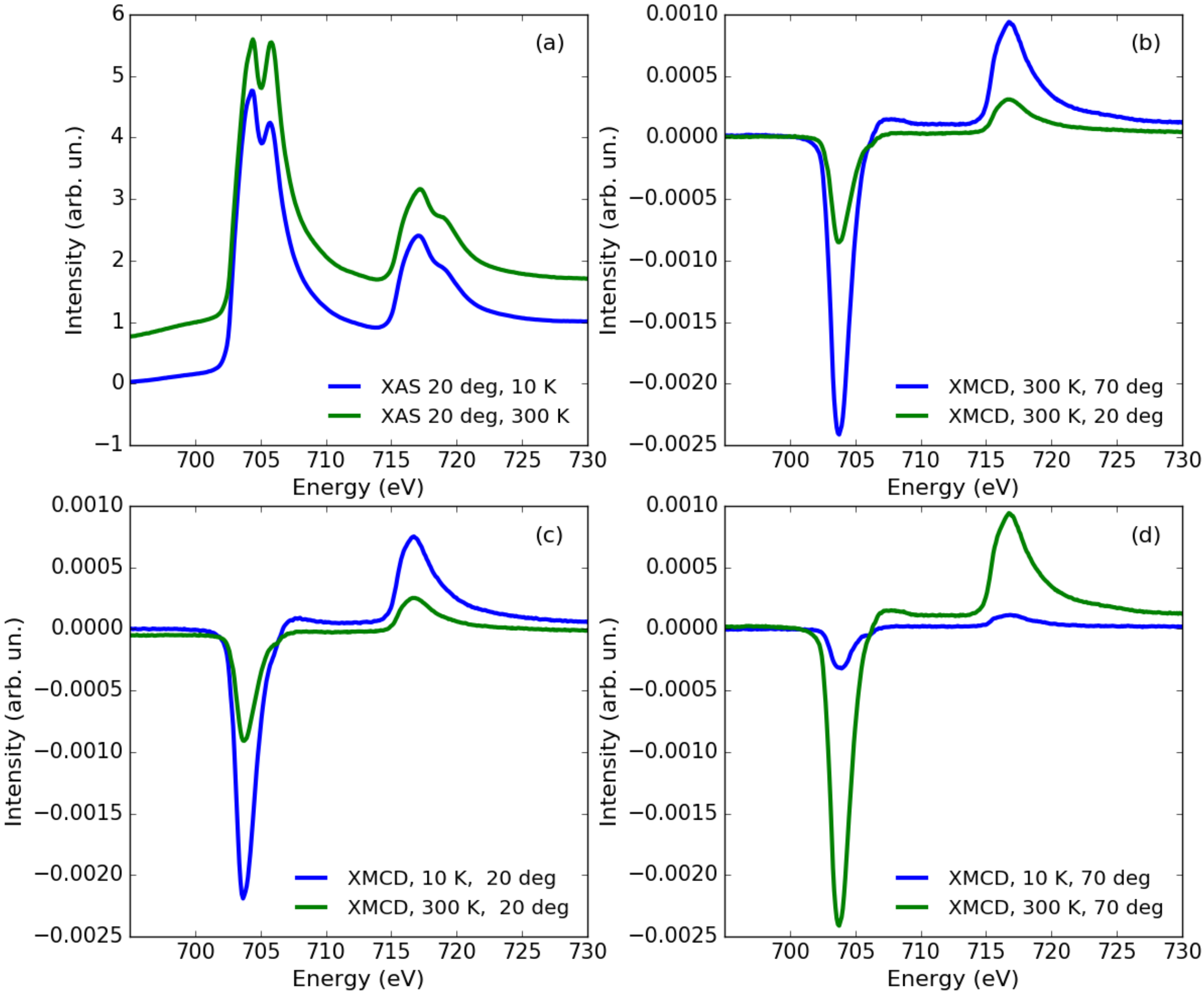

Figure 1. Summary of XAS and XMCD measurements. (a) XAS spectra at 10 (blue line) and 300 K of Fe_3Sn_2 at 70 (green line) degrees of incident angle. (b) XMCD at 300 K corrected at 20 (green line) and 70 (blue line) degrees of incidence angle. (c) XMCD at 20 degrees of incident angle at 10 (blue line) and 300 K (green line). (d) XMCD at 70 degrees of incident angle at 10 (blue line) and 300 K (green line).