Experiment title: Hard X-ray RIXS Study of Strain Effects in Sr2IrO4 and Sr3Ir2O7 Thin Films.	**Experiment number**: HC3772
Beamline: ID20	**Date of report**:
Shifts: 18	*Received at ESRF:*

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Report:

Aims: The aim of the experiment was to investigate the strain effects on the magnon dispersion of the exotic magnetic properties of the large spin orbit driven Mott Insulators Sr_2IrO_4 and $Sr_3Ir_2O_7$, with J_{eff}=1/2 ground state. The experiments were undertaken at the ID20 beamline, RIXS with photon tuned to the Ir L_3 absorption edge. The experiment focussed measuring the magnon dispersions for the two compounds at low temperature and comparing the magnon dispersions with the bulk compounds. Below we report on the results from. the two compounds separately - **Part I: Sr_2IrO_4 Results** and **Part II: $Sr_3Ir_2O_7$ Results.**

Part I: RIXS on Sr_2IrO_4 Thin films.

The thin film investigated was 108nm thick and previous results from the XMaS beamline indicate that the film was completely strained. During the experiment we found that the RIXS at the Ir L_3 edge was strong enough to measure the magnon dispersion across the entile Brilloun zone, as shown in **Fig.1** below.

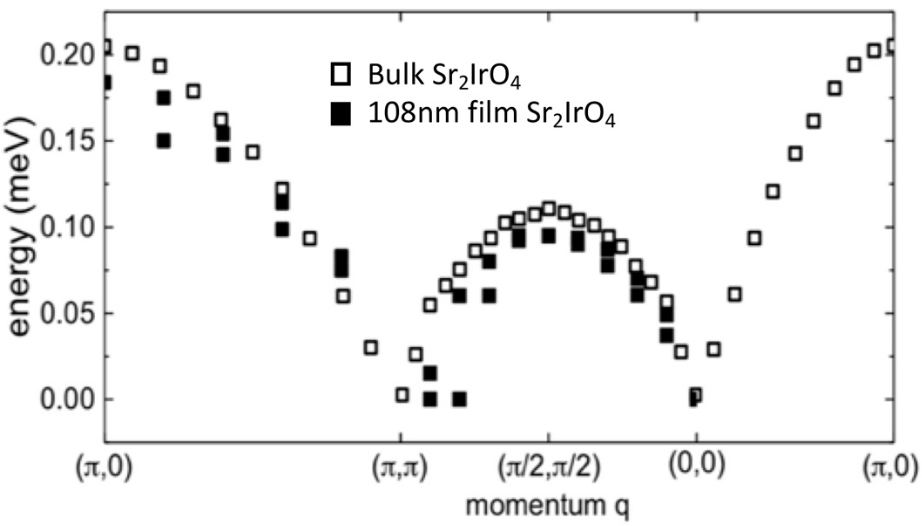

Fig. 1. The magnon dispersion for a 108nm thin film of Sr_2IrO_4 measure with RIXS at ID20 (solid squares), compared to the bulk compound (open squares).

Interestingly, we find that the magnon energies are reduced for the thin film compared to the bulk, consistent with strain tuning of the magnon properties. Modelling the magnon dispersion is currently in progress using the Spin-W package.

Part II: RIXS on $Sr_3Ir_2O_7$ Thin Films.

Thin epitaxial films of $Sr_3Ir_2O_7$ are notoriusly difficult to fabricate compared to the Sr_2IrO_4 system. This is because they have a minute parameter space for growth in terms of temperature and pressure to stabilize the corrrect stoichiometry. Thanks to stringent effors by our growers at the Walther Meissner institute, we have managed to fabricate stoichiometric and strained thin films of $Sr_3Ir_2O_7$, which to our knowlege are almost unique globally. We have measured the magnon dispersion on a 61nm thick film at 20K using RIXS and we succeeded to determine the magnon dispersion across the entire Brillouin zone and compare the results to those taken on the bulk compound [1]. In fig.2. we compare the energy scans from film and bulk single crystal at the wave-vector Q=(5 0 2). The observed peaks are labelled A,B,C&D, with A the elastic line and B-D magnon branches.

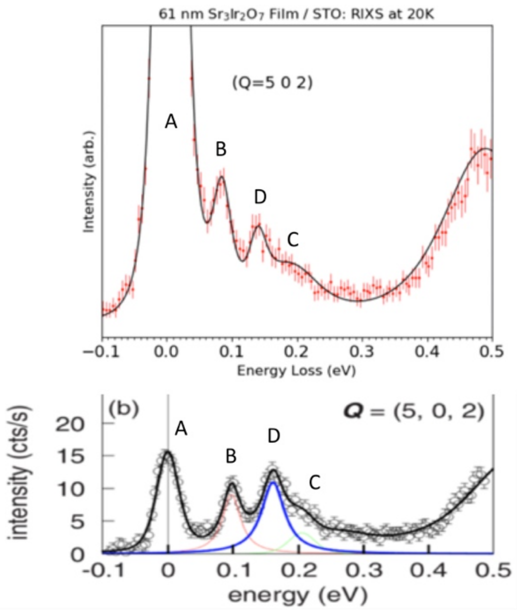

Fig.2. (left) The RIXS magnon spectra taken at the (5 0 2) reglflection for a 61nm thin film and bulk crystal of $Sr_3Ir_2O_7$. Several peaks are observed in the spectra, A is the elastic line and B,D & C the magnon branches. Note the dramatic shift of the B&D peaks compared to the bulk compound, suggesting strain tuning of the possible quantum dimer state in thin films of $Sr_3Ir_2O_7$.

Note the dramatic shift of the peaks B&D of the film compared to the bulk. This result suggests a dramatic strain tuning of the possible quantum dimer state in our thin films of $Sr_3Ir_2O_7$. The work is currently undergoing theoretical calculations in collaboration with Tim Ziman of the ESRF theory group.

Further work and publications:

Sr_2IrO_4: We have observed some even more dramatic effects in the magnetic structure of Sr_2IrO_4 films in applied magnetic fields using elastic XRS. We have submitted a continuation proposal to investigate the magnon properties of these fils in applied magnetic field to complete these RIXS measurements.

$Sr_3Ir_2O_7$: We have not determined the magnetic structure of the $Sr_3Ir_2O_7$ thin film using XRS elastic methods. We have submitted a continuation proposal to the XMaS beamline aimed at completing the studies of the magnetic structure, which will for part of a publication on this materials along with the RIXS work. Here it is vital to determine if the magnetic structure is long or. short ranged ordered, in comparison to out results on the Sr_2IrO_4.