EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal:
https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Deadlines for submission of Experimental Reports

Experimental reports must be submitted within the period of 3 months after the end of the experiment.

Experiment Report supporting a new proposal ("relevant report")

If you are submitting a proposal for a new project, or to continue a project for which you have previously been allocated beam time, you must submit a report on each of your previous measurement(s):

- even on those carried out close to the proposal submission deadline (it can be a *"preliminary report"),*
- even for experiments whose scientific area is different form the scientific area of the new proposal,
- carried out on CRG beamlines.

You must then register the report(s) as "relevant report(s)" in the new application form for beam time.

Deadlines for submitting a report supporting a new proposal

- 1st March Proposal Round - **5th March**
- 10th September Proposal Round - **13th September**

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report in English.
- include the experiment number to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Magnetic and electronic excitations probed by resonant inelastic X-ray scattering in Sr2IrO4/SrTiO3 superlattices	**Experiment number**: **HC-5312**
Beamline: ID 20	**Date of experiment**: from: 27/06/2023 to: 03/07/2023	**Date of report**: 18/09/2023
Shifts: 18	**Local contact(s)**: Christoph Sahle	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Xin Liu, Paul Scherrer Institut SwissFEL Bernina group

Roman Mankowsky, Paul Scherrer Institut SwissFEL Bernina group

Henrik Till Lemke, Paul Scherrer Institut SwissFEL Bernina group

Report:

With the assistance of laser-molecular beam epitaxy (L-MBE), we have fabricated series of high quality Sr_2IrO_4 thin film and $[(Sr_2IrO_4)_m/(SrTiO_3)_n]$ (I_m/T_n) (m,n) = (1,2), (2,4), (3,6), (6,12) superlattices. In the superlattices with inversion symmetry broken, an interesting magnetoelectric phase transition was observed. Both electronic and magnetic properties can be tuned (reduced band gap and magnetic transition temperature) by controlling the thickness of each layer, but the microscopic origin is not well understood.

Our purpose of the proposal with the experimental number of HC-5312 is to carry out the hard-RXIS on Ir-edge at ID 20 beamline to obtain the spin-orbit, magnetic and electron-hole pairs excitations, which can help to reveal the microscopic physics of the observed phenomena of tuneable magnetism and band gap, and further understand what kind of the role of the symmetry broken and charge transfer effect play in this system.

We have used the standard setup at ID 20 beamline for hard-RXIS measurement to detect the q dependent spectra at 10 K by using the cryostat at the beamline of ESRF. The energy is at the Ir L_3-edge of 11.215 keV with the energy resolution of ~28 meV. Four samples of $(Sr_2IrO_4)_1/(SrTiO_3)_2$, $(Sr_2IrO_4)_{1.5}/(SrTiO_3)_3$, $(Sr_2IrO_4)_3/(SrTiO_3)_6$ and $(Sr_2IrO_4)_3/(BaTiO_3)_6$were measured in total. In order to obtain the dispersion, we measured different 18 q-points for each sample.

As shown in Fig.1a, we plot one of the samples' q dependent measurements. Based on the results, magnetic and spin-orbit excitations were obtained for all the samples. As seen in Fig. 1b, the magnon dispersion demonstrates the controllable magnon by controlling the polarization in the sample (the thicker of $SrTiO_3$ layer, the larger of the polarization), revealing the microscopic mechanism of tuneable magnetism.

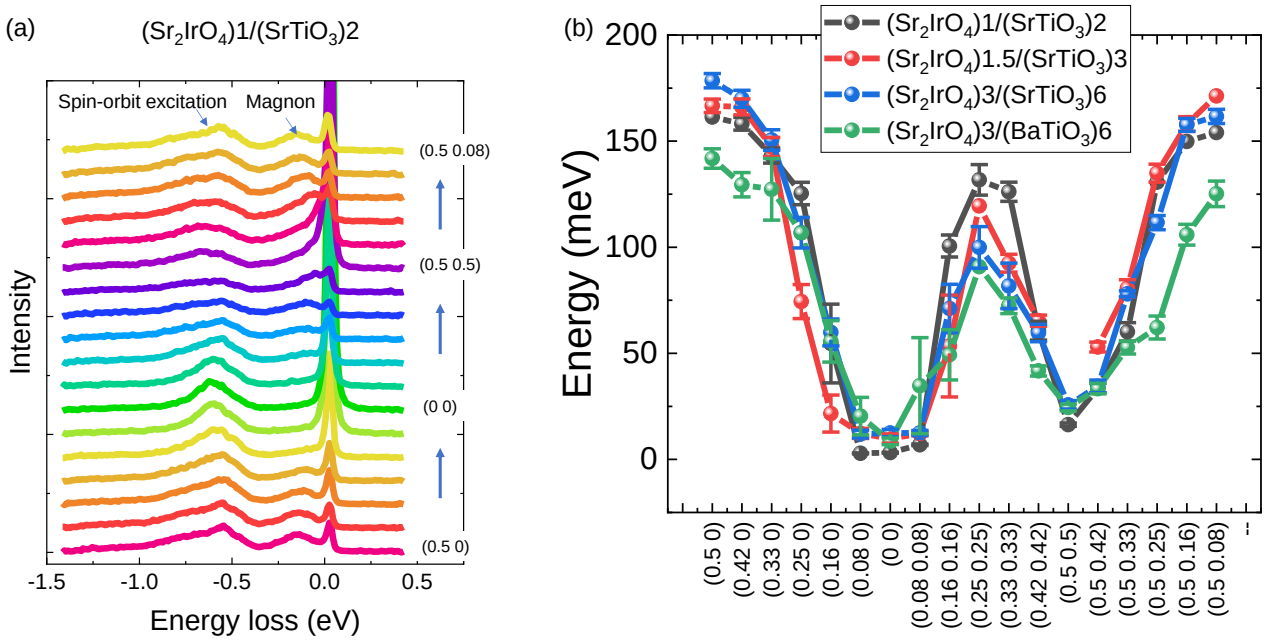

Fig.1 (a) q dependent measurement of $(Sr_2IrO_4)1/(SrTiO_3)2$. (b) Magnon dispersion for all the samples

The electron-hole pairs excitation can only be observed by soft-RIXS at the O K-edge, therefore, in order to further understand the reduced band gap in the superlattices, we are going to submit a proposal to apply the beamtime in ID 32 with the experimental number of HC-5639.