EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

	Experiment title: RIXS study of a new Cu-based spin-order in cuprate/ manganite multilayers	**Experiment number:** 88449 HC-4634
Beamline: ID32	**Date of experiment:** from: 07.10.2021 to: 13.10.2021	**Date of report:** 19.04.2022
Shifts: 18	**Local contact(s):** Dr. Kurt Kummer	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Prof. Dr. Claude Monney, University of Fribourg, Switzerland

Prof. Dr. Christian Bernhard, University of Fribourg, Switzerland

Dr. Subhrangsu Sarkar, University of Fribourg, Switzerland

Dr. Christopher Nicholson, University of Fribourg, Switzerland

Dr. Roxana Capu(Gaina), University of Fribourg, Switzerland

We performed RIXS measurements on $YBa_2Cu_3O_7/Nd_x(Ca_{1-y}Sr_y)_{1-x}MnO_3$ (YBCO/NCSMO) multilayers for which different kinds of Cu-based density wave orders can be induced via the hole doping, x, and the Sr:Ca ratio, y, (or the tolerance factor, t) of the manganite layer. We measured high resolution RIXS at the Cu L_3-edge at grazing incidence geometry to maximize the signal of the charge order and minimize the influence of the magnons. Oppositely, by measuring at grazing exit geometry, we could also investigate the presence and nature of the magnons present in the multilayers. In these samples, the YBCO thickness being 7 nm, the measurement with polarimeter took aprox 20 hours per spectrum, with a resolution of 35 meV.

We measured one heterostructures with x=0.5, y=0.25 at different incidence energies at different points at the Brillouin zone.

1.XAS spectra on YBCO/NCSMO (x=0.35, y=0.3, θ=90°):

From Fig. 1, we identify that the resonance of the TEY signal happens at 931.6eV and we can identify a small shoulder at lower energy as expected from [1,2].

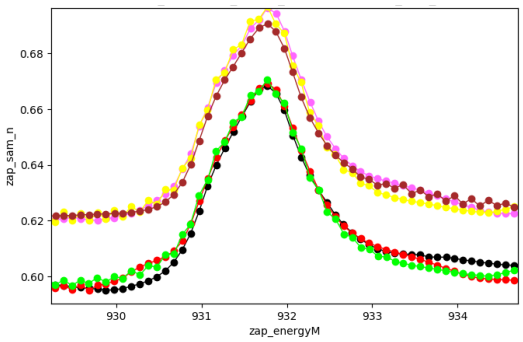


Figure 1: XAS of NYN with x=0.35,y=0.3

2. Determination of the Energy range for which anomalously low energy *dd*-excitations and magnons related to the interface resonance occurs:

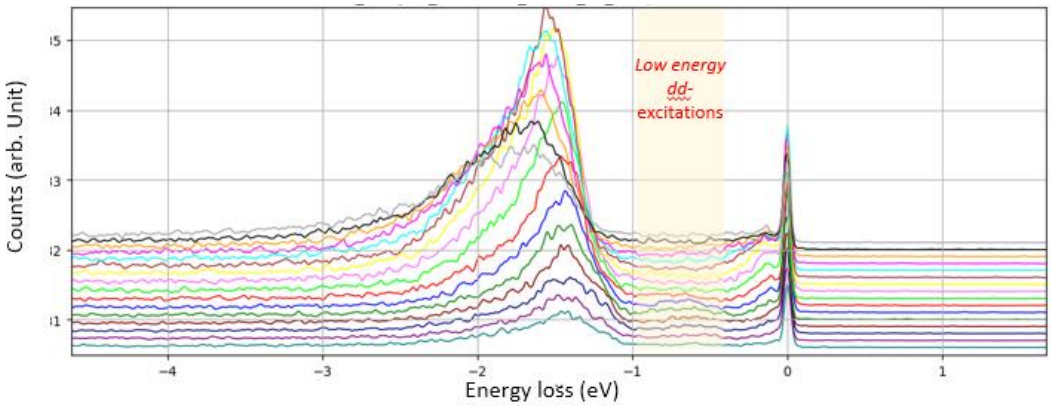
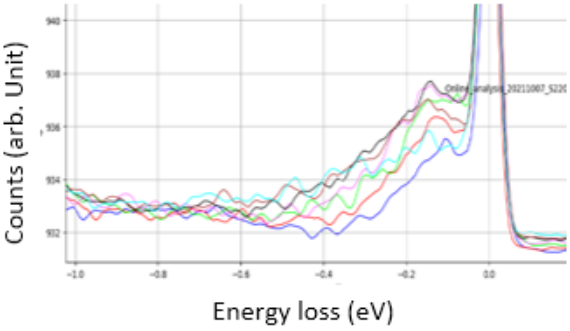


Figure 2: Waterfall plot of RIXS spectra of NYN superlattice with x=0.35,=0.3 at q=0.13 rlu. The energy is varied between 932.1 eV (top, grey) and 930.6 eV (bottom,cyan) in steps of 0.1 eV.



The Low energy-dd excitations appear onley between 931.3 eV and 930.7eV. This energy range is most sensitive for exciting interface properties.

The magnons exhibit similar energy dependence and are strongest for E=930.6 eV, which is same as the resonance energy observed from XAS (Fig.1).

3. Spin-polarimetry for NYN superlattice with x=0.35, y=0.3 along $(\pi, 0)$ and (π, π) directions:

$(\pi, 0)$ (π, π)

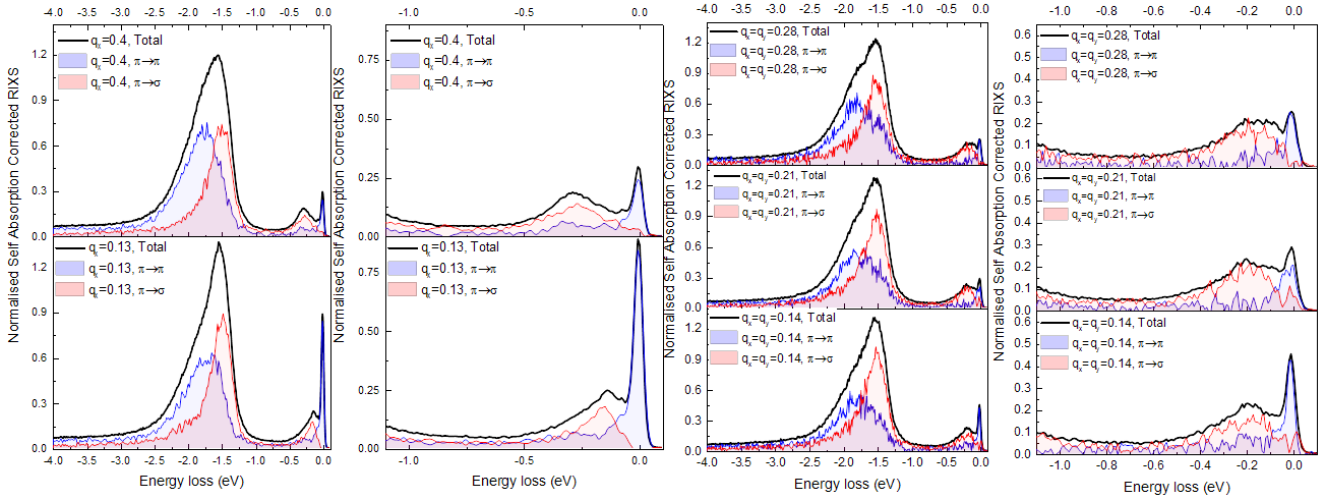


Figure 3: Self- absorption corrected RIXS polarimetry spectra along $(\pi, 0)$ (left) and (π, π) (right) directions

The spin-polarimetry measuremements re-confirm that the region in the inelastic part between -0.1 – 1.1eV is dominated by spin-flip scattering events- presumabily magnon scatterings. The scan at $q_x = q_y = 0.21\ eV$ shows a spin-flip contribution at the elastic part of the spectra accompanied by loss of intensity fromnon-spin flip scattering events.

We are presently composing a manuscript on anomalous 2-component magnon dispersions combining our RIXS data from this beamtime, HC-4714, HC-4618 and previously performed RIXS beamtime on this sample at DLS, Oxford.

References: [1] R.Gaina *et al.*, npj QM, **6**, 12 (2021) ; **[2]** E.Perret *et al.*, Comm.Phys **1**, 45 (2018)