ESRF	**Experiment title:** Spin dynamics of La2-xSrxCuO4 system by resonant inelastic x-ray sctering	**Experiment number**: HE3031
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Report:

The aim of the experiment was to study the spin dynamics in the 2D antiferromgnetic cuprate La_2CuO_4 using resonant inelastic scattering at the Cu-K edge. Our purpose was primarily to validate the magnetic origin of the mid-infrared mode found in this compound by other authors [1] by measuring its dispersion in the k space, and by comparing it with the results obtained in the soft x-ray regime with the Cu-L_3 and the O-K edge RIXS [2,3] and with advanced theoretical calculations [4-6].

The experiment is inherently very difficult because high resolving power is necessary to separate the low energy loss (~400 meV) from the very strong elastic peak and the scattering cross section is very small. The optimization of the instrumentation and the alignment of the sample required a long setting up time, in order to reach the best compromise between the counting rate and the resolving power. The chosen energy resolution was ΔE=160 meV, while the momentum resolution was Δq=0.2[1].

We used a La_2CuO_4 single crystal, oriented with the c-axis perpendicular to the surface. It was mounted on a liquid He cold finger to reach a temperature of 15K and measured with the high-resolution RIXS spectrometer available at the ID16 beamline. The experimental geometry is presented in Fig. 1. Since we were interested on a short energy range for our RIXS spectra, in order to optimize the acquisition time a new scanning method has been applied instead of the traditonal one (simultaneous motion of the analyzer and detector along the Rowland circle): a simple vertical translation of the detector has been done to scan 2 eV of range around the elastic peak, by keeping the analyser fixed. To accumulate a good statistics, each spectrum requires 10-12 hours of acquisition .

[1] The momentum q is expressed in units of π/a ($Å^{-1}$)

Figure 2 shows the spectrum measured at the $(\pi,0)$[2] point of the reciprocal space (red dotted line) together with its background, i. e. the elastic spectrum (black dotted line) measured off-resonance. The magnetic feature (blue circles) comes out after subtracting the second spectrum from the first: the result is a weak feature centred around 0.42 eV.

In order to measure the momentum dispersion of the magnetic peak, in addition to the spectrum at $(\pi,0)$, we acquired four spectra corresponding to different momenta along the (π,π) direction of the reciprocal space (Figure 3): the measured dispersion is quite small and the peak position changes very little from $(0.4\pi, 0.4\pi)$ to $(0.8\pi, 0.8\pi)$.

We have compared these results to those obtained by us at ID08 using the Cu-L_3 RIXS and to the theoretical predictions for bi-magnon excitations at the Cu-K and the Cu-L_3 RIXS (theory includes magnon-magnon interaction as seen in Fig. 4). The agreement is very good thus demostrating that the mid-IR feature characterizing Cu-K RIXS is due to bi-magnon excitations [2-5].

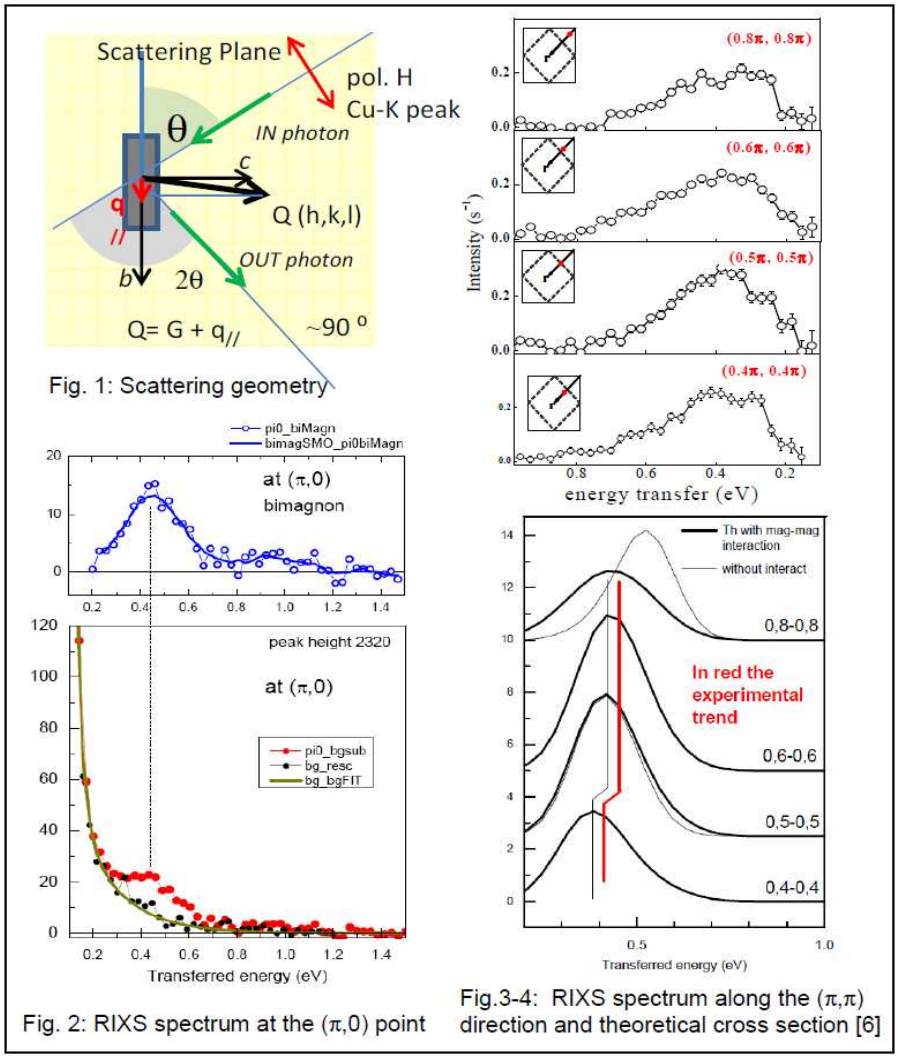

Fig. 1: Scattering geometry

Fig. 2: RIXS spectrum at the $(\pi,0)$ point

Fig.3-4: RIXS spectrum along the (π,π) direction and theoretical cross section [6]

References:

[1] J. Hill et al., Phys. Rev. Lett. 100, 097001 (2008)
[2] L. Braicovich et al., Phys. Rev. Lett. 102, 167401 (2009)
[3] L. Braicovich et al., *Unpublished*
[4] J. van den Brink, Europhys. Lett. 80, 47003 (2007)
[5] F. Forte et al., Phys. Rev. B 77, 134428 (2008)
[6] T. Nagao and J. I. Higarashi, Phys. Rev. B 75, 214414 (2007)

[2] We use the tetragonal notation of the system, with a=b=3.79 Å