ESRF	**Experiment title:** Collective spin dynamics of bound states in the spin-ladder system $Sr_{14}Cu_{24}O_{41}$ studied by resonant inelastic x-ray scattering	**Experiment number**: HE-2886
Beamline: ID16	**Date of experiment**: from: 12.11.2008 to: 17.11.2008	**Date of report**: 01.08.2009
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Report:

Recently magnetic quantum fluctuations which manifest in, e.g., so-called two-triplon excitations have been predicted for the spin-ladder system $Sr_{14}Cu_{24}O_{41}$.[1] Such low-energy excitations can be probed using high-resolution indirect resonant inelastic x-ray scattering. This was shown for the first time for the compounds La_2CuO_4 and Nd_2CuO_4 by Hill and coworkers who found spectral features assigned to two-magnon excitations at energy losses of about 500 meV measured with an energy resolution of 120 meV.[2, 3] For a deeper understanding of this new kind of quantum fluctuations resonant inelastic x-ray scattering (RIXS) allows not only to observe such low-energy excitations but also to study their momentum transfer q dependence. Aim of this experiment was to find experimental evidence for the proposed two-triplon excitation in $Sr_{14}Cu_{24}O_{41}$ and to probe its q dependence using RIXS. The energy loss position of this excitation was predicted to be around 350 meV resulting in high demands on the energy resolution and surpression of elastic scattering in the current experiment.

The measurements were carried out at beamline ID16 employing the RIXS spectrometer using a Si 553 diced analyzer at a 1m Rowland circle together with a Maxipix area detector.[4] The intensity of the quasi-elastic scattering was minimized by cooling the $Sr_{14}Cu_{24}O_{41}$ single crystalline sample using a cryostat to a temperature of about 40 K and by choosing the scattering angle close to 90° where charge scattering is strongly reduced due to the

polarization factor. However, during the experiment it was not possible to obtain a better energy resolution than 210 meV without loosing to much intensity. Thus, we expected to find the two-triplon excitation as small feature in the high energy tail of the quasi-elastic line. Numerous RIXS spectra were taken in the vicinity of the quasi-elastic line for several excitation energies across the copper absorption edge. The momentum transfer was varied to probe different positions in the Brillouin zone to optimize the energy-loss position and intensity of this excitation according to theory. Despite a careful search for the two-triplon excitation we were not able to resolve this spectral feature during the experiment which most probably can be related to the fact, that an energy resolution of about 100 meV could not be reached with sufficient intensity.
Nevertheless, in combination with the search for the two-triplon feature we were able to measure very detailed the charge-transfer and d-d excitation spectrum of $Sr_{14}Cu_{24}O_{41}$ for two different directions of the polarization, within and perpendicular to the ladder planes. Here, we focused on a complete mapping of the RIXS spectra along the copper K-edge with particular attention on the pre-peak most prominent for a polarization within the ladder planes. The corresponding RIXS maps for both polarizations are presented in Fig. 1 showing several spectral features which have been discussed so far only for excitation energies above 8.985 keV (see e.g. [5-6]). In a next step the experimental spectra will be compared with calculations and spectra of reference samples to assign the different features to corresponding excitation channels.

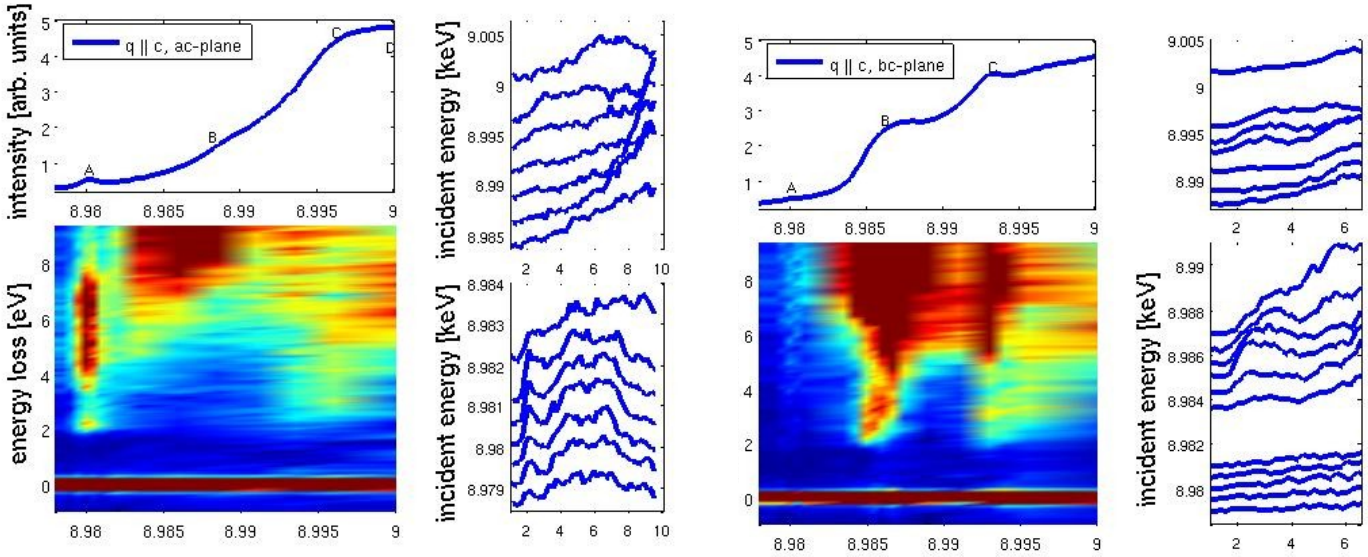

Fig. 1: RIXS energy-loss/excitation-energy maps of d-d and charge transfer excitations for polarization parallel and perpendicular to the ladder planes. The corresponding copper absorption edge (A marks the pre-peak) and a selection of RIXS spectra are also shown.

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