BL12XU
NSRRC ID

BL12XU is one of the two contact beamlines between National Synchrotron Radiation Research Center (NSRRC, Taiwan) and Japan Synchrotron Radiation Research Institute (JASRI). BL12XU has an undulator source and two branches of the mainline and a sideline (see Fig.1). The mainline has been fully operational since 2001 and used by many domestic / foreigner scientists. Inelastic X-ray Scattering (IXS) experiments were mainly performed in BL12XU, and several other experiments, such as high resolution X-ray optics experiment and micro-imaging, were also carried out. In the side line, hard X-ray photoemission spectroscopy (HAXPES) was intensively performed.

1. Instrumentation

We made the following upgrades in 2015.

・High-resolution RIXS set-up

We tried further higher-resolution RIXS than we ever made. With a 4-bounce Si553 channel-cut high-resolution monochromator and a quartz 244 diced spherical analyzer fabricated in DESY (Fig.2), we achieved a 23.5 meV resolution at Cu K-edge 8.978 keV. A MYTHEN Si 2D sensor was used (50 microns pitch) as the detector. Some features possibly due to phonons resonating with a core electron absorption were observed on a tail of the elastic line. This projected was performed under collaboration with H. Yavas (DESY) and K. Ishii (QST).

・CdTe sensor array for a 20-keV NIXS spectrometer

A CdTe array sensor was tested for the 20 keV spectrometer. A CdTe is a promising material for high energy X-rays above 10 keV because it has a higher absorption coefficient than Si or Ge while it has a sharp pulse-width, allowing us to set a narrower energy window for signals, so as to reduce the background. We tested a vertical array of four crystals having a 10 × 10 mm^2 surface area each (Fig.3). A high potential was indeed observed although further tuning would be necessary. This project was conducted with collaboration with K. Matsuda at Kyoto University.

Fig.2 Photo of spherical quartz analyzer. Quartz itself is transparent but it looks black after bonded onto a substrate

2. Experiments

In 2015, we had ten experiments of non-resonant IXS, 16 of resonant inelastic experiment (including X-ray emission), three of high-resolution X-ray optics, one of micro-imaging. Interesting examples are introduced below.

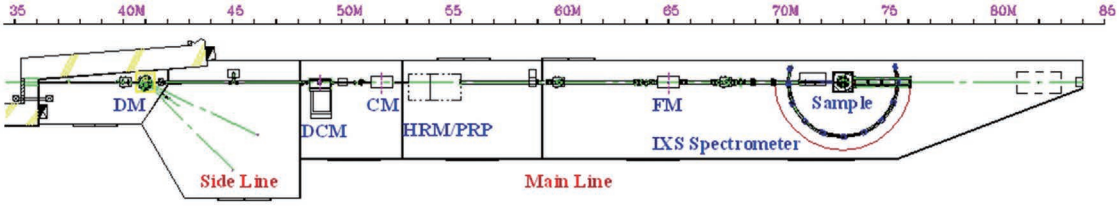

Fig.1 Schematic diagram (top view) of the BL12XU: DM represents a diamond monochromator for the sideline, DCM a double crystal monochromator for the mainline, CM a collimating mirror, HRM a high resolution (channel cut) monochromator, PRP a phase retarding plate, FM a focusing mirror, and IXS an inelastic X-ray scattering spectrometer.

Fig.3 CdTe array detector (presently 4 elements, having 10 × 10 mm^2 each surface)

・Oscillator strengths in carbon oxide

The oscillator strengths of gaseous CO have significant applications in the studies of interstellar gases. However, not all previous experiments and calculations agree with each other, posting a necessity of higher accuracy measurements. Precise determination of the dipole transitions in CO was performed by high resolution nonresonant IXS that was introduced to this field recently. With a 70 meV resolution series of vibronic features were observed in 8 – 9 eV and near 11.5 eV (Fig.4). The obtained oscillator strengths support some previous results while reject others, setting new reference values. IXS has no saturation effect and thus no need of careful correction for the self-absorption. This is a great advantage. It was demonstrated that IXS could be a useful method for this type of studies. [Kang, *et al*., the Astrophysical Journal **807**, 96 (2015)]

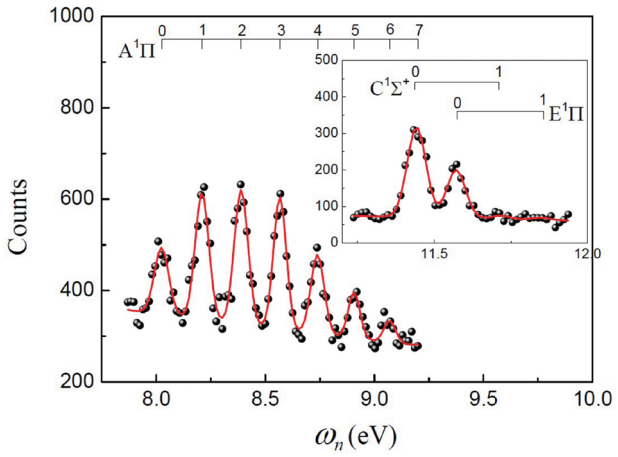

Fig.4 IXS spectrum on gaseous CO measured with a 70 meV resolution.

・Crossover from a heavy fermion to intermediate valence state in noncentrosymmetric Yb compounds

Yb compounds exhibit a wide variety of electronic and magnetic properties, e.g., valence fluctuation, heavy fermion behaviors, superconductivity, and/or unusual magnetic transitions. Their properties significantly vary as a function of pressure and temperature. We investigated a noncentrosymmetric system, $Yb_2Ni_{12}(P,As)_7$ by partial fluorescence yield X-ray absorption spectroscopy PFY-XAS across the L_3 edge of Yb. Corroborated the PFY data with those of X-ray diffraction, electrical resistivity, and magnetization the crossover from heavy fermion behavior to intermediate valence state in these two compounds was identified. [W. B. Jiang *et al*, Sci. Reports **5**, 17608 (2015)]

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