BL08W High Energy Inelastic Scattering

This beamline is designed for Compton scattering spectroscopy with linearly or elliptically polarized X-rays in the energy ranges of 100 ~ 120 keV and 170 ~ 300 keV. The spectroscopy will be widely applied to the studies of Fermiology and magnetism of materials.

The beamline serves two experimental stations. Station A is designed for magnetic Compton scattering experiments using elliptically polarized 170 ~ 300 keV X-rays. A superconducting magnet with a maximum field of 3 T and a minimum polarity-switching time of 5 seconds and a 10-segmented Ge solid-state detector are installed. Station B is designed for high momentum-resolution experiments of 0.15 a.u. using 100 ~ 120 keV X-rays, which makes it possible to measure Compton profiles of virtually all materials. A Cauchois-type X-ray spectrometer is installed, which consists of a Cauchois-type crystal analyzer and a position sensitive detector (PSD).

The beamline is also available for the studies of high energy Bragg scatterings, high-energy X-ray fluorescence analysis, and nuclear excitations.

Area of research

Magnetic Compton scattering

High-resolution Compton scattering

High-energy Bragg scattering

High-energy fluorescent X-ray analysis

Keywords

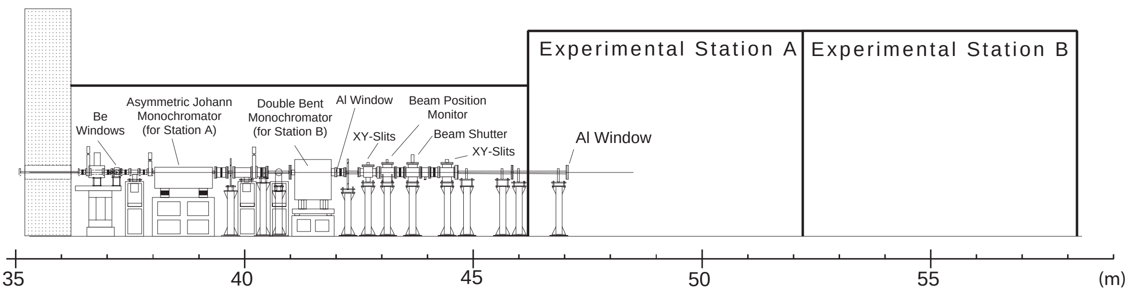
Scientific field

Fermiology, Magnetism, Electron momentum density, Elemental analysis

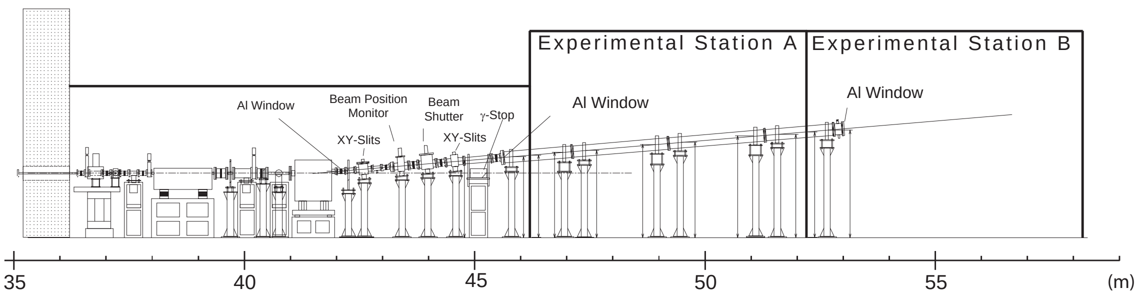
Equipment

3-T superconducting magnet, 7-T superconducting magnet, 10-K cryocooler, Magnetic Compton spectrometer, Cauchois-type X-ray spectrometer

Source and optics



(a) Experimental Station-A Branch



(b) Experimental Station-B Branch

Schematic view of beamline

X-rays at sample

Station-A

(Asymmetric Johann monochromator, Si 620/Si 771)

Energy range	174 ~ 270 / 270 ~ 300 keV
Energy resolution	$\Delta E/E \sim 2 \times 10^{-3}$
Photon flux	5×10^{9} ph/s at 300 keV
Beam size	3 mm (H) × 1 mm (W)

Station-B

(Doubly bent monochromator, Si 400)

Energy range	100 ~ 120 keV
Energy resolution	$\Delta E/E < 1 \times 10^{-3}$
Photon flux	1×10^{13} ph/s at 100 keV
Beam size	1 mm (H) × 2 mm (W)

Experimental stations

Station-A

Magnetic Compton scattering equipment

A magnetic Compton scattering experiments system is composed of a superconducting magnet and a 10-segmented Ge solid state detector with 10 DSP-based MCA systems. A maximum field of superconducting magnet is 3 T and its minimum polarity-switching time is 5 seconds. The 10-segmented Ge solid state detector can be also utilized for 300 keV experiments.

- 3-T Superconducting magnet (swiching time: within 5 seconds)
- Refrigerator for sample (10 K ~ 300 K)
- Ge solid-state detector (doughnut-type, ten segmented) and 10-MCAs

3-T superconducting magnet (swiching time: within 5 seconds) with Refrigerator for sample (10 K ~ 300 K)

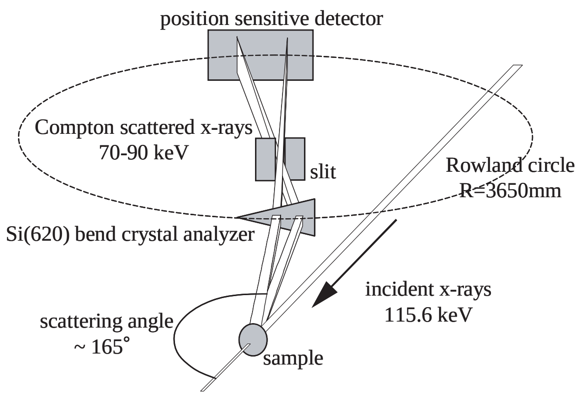
10-segmented Ge SSD

Station-B

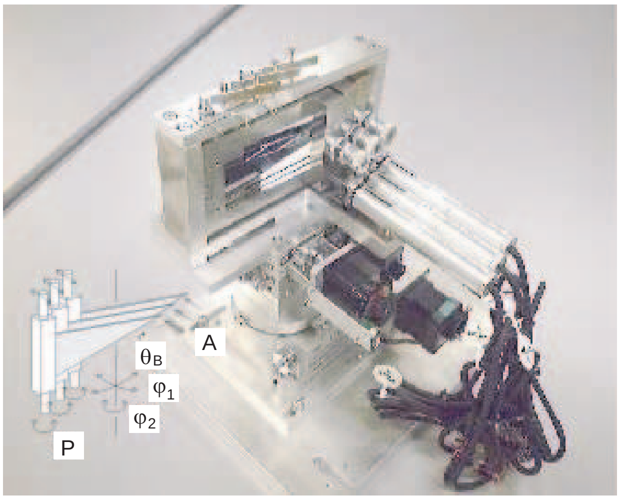
High resolution Compton scattering spectrometer

An X-ray spectrometer has been constructed for high-resolution Compton scattering experiments with an incident X-rays energy of 115 keV. The use of such high energy X-rays enables us to measure the Compton profiles of heavy element materials with good statistical accuracy. The spectrometer consists of a triply layered bent-crystal analyzer and a X-ray Image Intensifire (X-II) camera unit as a position sensitive detector. The camera unit consists of an X-II and a CCD camera. It covers the focal positions corresponding to the X-ray energies from 70 keV to 90 keV for the incident X-ray energy of 115 keV and the scattering angle of 165 degrees.

- 7-T Superconducting magnet (swiching time : within 5 seconds)
- 10-K Refrigerator for sample (10 K ~ 300 K)
- X-II camera
- Ge-SSD



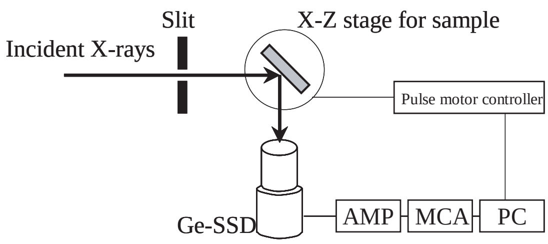
High resolution spectrometer



Tri-analizers

X-ray fluorescent spectrometer

High energy X-ray fluorescence analyses is suitable for nondestructive multielemental analyses of heavy elements such as rare-earth elements. The lowest MDL value evaluated for the bulk analysis of a JG-1 standard reference sample (granite rock) was 0.1 ppm for W for a 500 sec measurement. This energy-dispersive XRF analysis system is composed of an XY automatic stage, a Ge solid-state detector, a spectroscopy amplifier, and a multichannel analyzer.



XRF spectrometer

An example of results

The electron occupation numbers of x^2-y^2, $3z^2$-r^2, and t_{2g} orbital states in the double-layered manganite $La_{2-x}Sr_{1+2x}Mn_2O_7$(x=0.35, 0.42), have been experimentally determined using the magnetic Compton scattering (MCS) technique for the first time [1]. The result can explain the complicated magnetic phase diagram of this compound. This study demonstrates that MCS experiments provide unique and indispensable information on the magnetic properties of colossal magnetoresistance materials associated with the orbital degree of freedom.

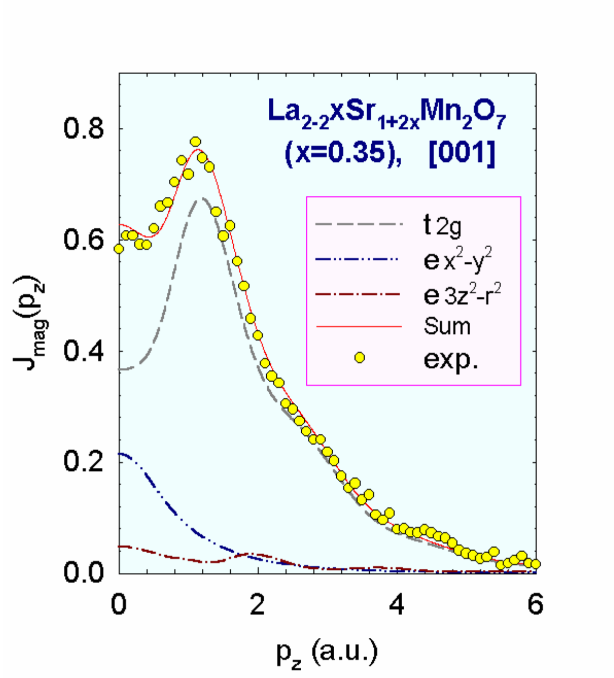


Fig.1. Magnetic Compton profile in $La_{2-x}Sr_{1+2x}Mn_2O_7$(x=0.35), together with fit using $(MnO_6)^{-8}$ cluster orbital.

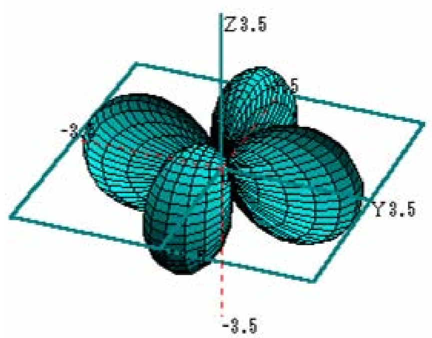


Fig.2. Charge distribution of x^2-y^2 orbital

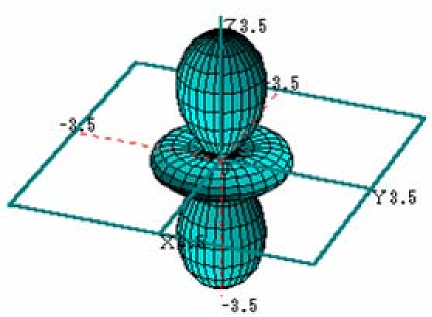


Fig.3. Charge distribution of $3z^2$-r^2 orbital

Reference

[1]A. Koizumi et al., Phys. Rev. Lett., 86(2001)5589-5592.

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