XMaS the UK-CRG	**Observation of an energy resonance in the π-channel at the Ni K-edgein $La_{5/3}Sr_{1/3}NiO_4$**	**Experiment number:** 28-01-48
Beamline: **BM 28**	**Date of experiment:** from: 01/09/99 to: 07/09/99	**Date of report:** 11/11/01
Shifts: 18	**Local contact(s)**: Dr. Anne Stunault	*Received at XMaS:*

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Report:

The single crystal of $La_{2-x}Sr_xNiO_4$ with $x = 0.33$ used in this experiment was grown at the Bell Laboratories using the floating zone method, and had been previously characterized by neutron scattering. The crystal was mounted on a Displex closed-circle cryostat, with the [1,0,1] axis surface normal and the sample mosaic width was measured to be ~0.05° (FWHM). The wavelength of incident x-ray was selected to be 1.2715(1) Å using a Si (1,1,1) monochromator and most of the higher order contamination was rejected by use of the focusing mirror. Polarization analysis of the scattered x-ray beam was performed using Bragg scattering from a Cu (2,2,0) analyser crystal at 90°. In this geometry the incident beam polarization was σ-polarized and the degree of linear polarization was found to be 96.7%.

First, by cooling the sample below the charge ordering temperature T_{CO}, we found a number of charge ordering satellites at the expected positions in reciprocal space. The intensity of these peaks was measured in both polarization channels, σ-σ and σ-π, as a function of energy (8.32-8.38 keV, Ni K-edge at 8.3475 keV) and normalized to the intensity of a monitor in the path of the incident beam. By tuning the energy to the Ni K-edge, we have performed the energy dependence of the charge (3.33, 0, 3), (2.67, 0, 5) and spin (3.33, 0, 4) satellites for both L = even and odd integers. A schematic view of the scattering geometry is displayed in Figure 1. The incident photons with wave vector K and polarization components of ε_σ and ε_π hit the sample and the scattered photons emerge with wave vector K' and polarization components of ε'_σ and ε'_π. By combined rotation of the detector and polarization analyzer crystal, it is possible to exclusively detect either scattering into the sigma or pi channel.

By tuning the beam energy to the Ni *K*-edge energy, energy scans were performed through selected charge/spin satellites. The main results are shown in Figure 2. The intensity of the charge ordering peaks (2.66, 0, 5) and (3.33, 0, 3), shown in Figure 2(a) and 2(b) respectively, are plotted as a function of incident photon energy at 200 K in both polarization channels. The data from fluorescence measurements is also shown for comparison. As the graphs show, there is a clear, large enhancement of the peak intensities in the σ - π channel at the Ni *K* absorption edge, without any resonance effect in the σ - σ channel. A resonant enhancement by a factor of approximately 4 is observed at the Ni main absorption edge. The σ - σ scattering shows only a dip at the absorption edge, a characteristic of normal charge scattering. The resonant effect can arise due to the transition metal ion being situated in an anisotropic crystalline environment. Because the edge energy of the Ni^{2+} and Ni^{3+} ions are slightly different, the peak intensity enhances near to the edge [2]. Hill *et al.* have observed a resonance at the Ni *K*-edge at superlattice peaks corresponding to the antiferromagnetism [1]. The energy scan at the Ni *K*-edge was also performed on the (3.33, 0, 4) peak, which was thought to be spin satellite, but the intensity did not show any resonance behavior.

In conclusion, by tuning the beam energy to Ni *K*-edge energy, an enhancement in the charge ordering peak intensity was observed in σ - π channel with a dip at absorption edge in the σ - σ channel.

References

1 J. P. Hill, C.-C. Kao, and D. F. McMorrow, Phys. Rev. B 55, 8662, 1997

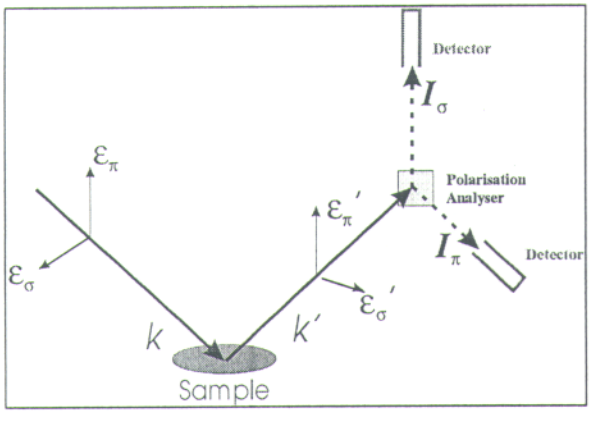

Figure 1

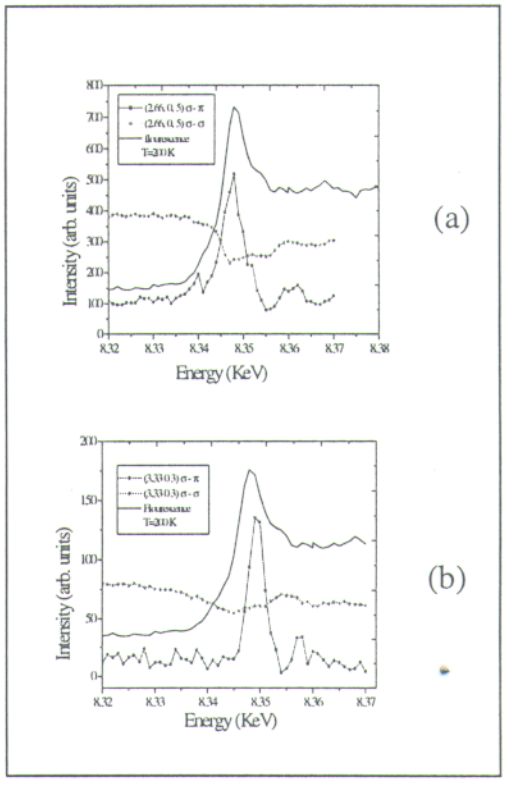

Figure 2