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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

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The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

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Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

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Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title: High Energy X-ray scattering studies of the half-doped nickelates and cobaltates $La_{1.5}Sr_{0.5}NiO_4$ and $La_{1.5}Sr_{0.5}CoO_4$**	**Experiment number**: HE-1472
Beamline: ID15A	**Date of experiment**: from: 09/04/2003 to: 15/04/2003	**Date of report**: 28/08/2003
Shifts: 18	**Local contact(s)**: T d'Almedia, T. Buslapps	*Received at ESRF:*

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Report:

In recent years the nickelate system $La_{2-x}Sr_xNiO_4$ has been studied greatly due to it being isostructural with the high temperature superconducting cuprates. Our previous results have shown that the charge stripes are most intense, correlated and stable at the commensurate doping level of $x = 1/3$ [1][2] where the spin stripes occur at the same position as the charge stripes and stabilise the charge ordering pattern. In this experiment the $x = 0.5$ doped nickelate was studied in order to investigate the behaviour of the charge stripes for doping levels of greater than 1/3 and to observe if the doping level of $x = 0.5$ corresponded to another stable charge ordering regime. Recent neutron scattering measurements have demonstrated a rearrangement of the charge order from an incommensurate stripe pattern at low temperatures to a checkerboard charge order pattern similar to that in the half doped cobaltates [3] and manganites [4] which is stable to high temperatures ~ 480 K.[5]. We also intended to investigate the behaviour of the charge order in the bulk of the half doped cobaltate which is isostructural with the nickelate. We had previously carried out measurements at normal x-ray energies (12 keV) on both systems. Using high energy X-rays we intended to investigate the bulk charge order properties and compare with those at the surface and compare the charge ordered state in the cobaltates with that in the nickelates. In addition we attempted a search for any stripe type charge order reflections because if they do exist the chances of observing scattering from them will be maximized by probing a large scattering volume. This study would confirm if charge stripes are present in the cobaltate system or whether they are a characteristic of only the nickelates and cuprates.

Measurements were made on beamline ID15A using an incident energy of 100 keV which is close to the peak flux of the beamline. Silicon (1,1,3) crystals were used as the monochromator and analyser to provide high resolution triple axis measurements. The $La_{1.5}Sr_{0.5}NiO_4$ and $La_{1.5}Sr_{0.5}CoO_4$ samples were mounted in a displex cryofurnace that allowed a temperature range of 10 K – 800 K to be accessed. The nickelate crystal was mounted with the <101> axis surface normal and the cobaltate crystal with the <110> axis surface normal. Both crystals were of a high quality with rocking curve

widths of ~ 0.03°. The nickelate sample was cooled to low temperature and a carried out around the (4, 0, 4) Bragg reflection which our previous studies had shown to have the strongest charge order satellites. No evidence of the stripe order at low temperatures or the checkerboard charge order at 200 K was found in the nickelate. Our experiments at normal x-ray energies (~12 keV) had determined that this sample exhibited charge order. We therefore, postulate that the charge order could not be observed because it was too weak to be observed above background. However, in the cobaltate system we were able to observe the charge order at a modulation of (1.5, 1.5, 0) and this was measured as a function of temperature in the temperature range 10 – 800 K and this is shown in Figure 1.

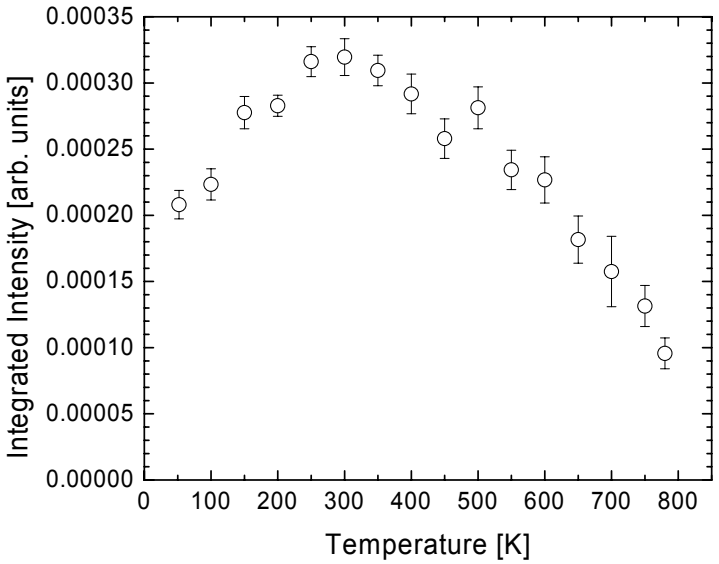

Figure 1 Temperature dependence of the (1.5, 1.5, 0) charge order reflection in the half-doped cobaltate

The charge order was still present at 800 K which was the limit of the cryofurnace but we extrapolated the data and obtained a charge ordering temperature of 825 K. The charge order was weak and diffuse and existed in a charge glass phase. It was found to be two dimensional in nature with it being very poorly correlated between the planes. When comparing these results with the those obtained at the surface using 12 keV x-rays a comparison showed that there was no difference in the correlation of the charge order between the bulk and the surface and we can conclude that the charge order state in the cobaltate is the same at the bulk and at the surface. No evidence of any charge stripe order was observed in the cobaltate and this suggests that stripe order does not occur in the cobaltate system.

To summarise the charge order in the cobaltate was observed to behave in the same way in the bulk as it does at the surface. The charge order state was thermally very stable with a transition temperature of ~ 825 K. No evidence of stripe order was seen in the system which suggests that the cobaltate only shows the checkerboard charge order. The nickelate charge order could not be observed above the background and we conclude from this that the charge order state in the cobaltate is stronger and more stable than that in the nickelate.

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