ESRF	**Experiment title:** Magnetic X-ray Scattering from 3d Metal Oxides	**Experiment number:** HE201
Beamline: ID20	**Date of Experiment:** from: 15/10/97 to: 20/10/97	**Date of Report:** 28/01/1998
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Report:

This first experiment on 3d Metal Oxides was devoted to the L/S determination in NiO. Essentially the non resonant magnetic X-ray scattering techniques were used. However a quick survey through the k-edge of Ni has revealed a strong magnetic resonance.

The outstanding result of this work is the proof of existence of an orbital moment on the Ni ion. The orbital moment contributes 17±3% to the magnetization density. This determination of the orbital moment contribution to the total magnetizationin the antiferromagnetically ordered state of NiO is a valuable piece of information for a better understanding of the electronic and magnetic properties of the 3d metal oxides [l].

The experiment was performed at two different energies (7.84keV and 17.41 keV) in the non-resonant regime, far off the k-edge of Ni (8.33keV). All measurements were done at room temperature. At this temperature NiO (T_N=523K) is ordered in a type II antiferromagnetic structure, with the magnetic moments ferromagnetically aligned in the (111) planes that are stuck antiferromagnetically. The crystal was mounted on the four-circle diffractometer with the (111) axis in the scattering plane and parallel to the ϕ axis. This geometrie gave us access to the different S-domains corresponding to the threefold symmetry of the (111) planes.
We were looking for three different magnetic reflections $(\frac{1}{2}\frac{1}{2}\frac{1}{2})$,$(\frac{3}{2}\frac{3}{2}\frac{3}{2})$ and $(\frac{5}{2}\frac{5}{2}\frac{5}{2})$ and made polarization analysis on each of them. We also looked at non-specular reflections but their intensities were extremely weak compared to the specular ones. The sample seemed to be single T-domain.

All of the reflections showed a rotated intensity I,, which evidenced the magnetic nature of the signal. Spin and orbital moment contribute to the rotated part, whereas only the spin contributes to the non-rotated part of the intensity. This difference allowed us to measure the orbital moment.
By rotating the sample around the surface normal, we could study the S domain distribution within the [111] T-domain. Figure 1 shows the modulation of the three domains in $\sigma\pi$ and $\sigma\sigma$ of a $(\frac{3}{2}\frac{3}{2}\frac{3}{2})$ reflection. We found out that all three S domains where populated and that the size of these domains are of order of the footprint size. The $\pi/2$ shift between the two polarized components show that spin and orbital moment are collinear.
By averaging the intensities of the three different reflections, L/S can be calculated. Figure 2 shows the result obtained. The continuous line is the Q-dependence estimated by Blume (ref 1.). By extrapolating to $Q=0$ the orbital contribution of the magnetization density can be estimated to be 17%.

This experiment was made possible because of the high flux of high-polarized x-rays on ID20. The future project will be on resonant magnetic scattering from transition metal oxides.

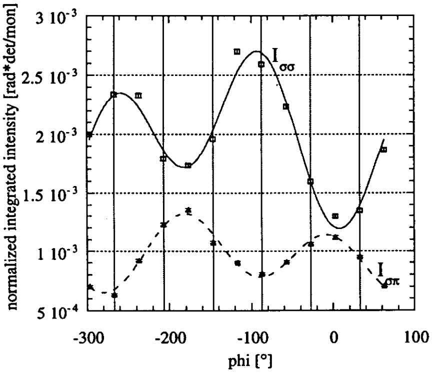

Fig.1: Normalized integrated intensities of the $(\frac{3}{2}\frac{3}{2}\frac{3}{2})$ reflection as a function of Renninger angle ϕ at 7.84keV.

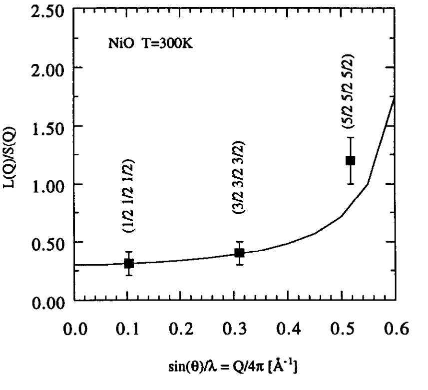

Fig.2: Measured variation of L(Q)/S(Q) as a function of $Q/4\pi$.

These results will be published in Phys. rev. B 57 April 1998.

Reference: [l] M. Blume, Phys Rev. 124, 96 (1961)