



	<b>Experiment title:</b> Spin-state, charge-order and orbital-order transitions in RBaCo <sub>2</sub> O <sub>5+d</sub>	<b>Experiment number:</b> HE-2775
<b>Beamline:</b> ID 20	<b>Date of experiment:</b> from: 30/04/2008 to: 06/05/2008	<b>Date of report:</b> 28/08/2008
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The perovskites oxides ABO<sub>3</sub> and their derived compounds may exhibit spectacular electronic properties, such as high-T<sub>c</sub> superconductivity or colossal magneto-resistance (CMR). A large number of activities focused on the Mn oxides of general type A<sub>1-x</sub>A<sub>x</sub>MnO<sub>3</sub> in order to explain the mechanism leading to the CMR effect observed in these materials. In the parent cobaltites La<sub>1-x</sub>Sr<sub>x</sub>CoO<sub>3</sub>, magneto resistance properties were also reported, but to a far much smaller magnitude. The highest values are found in the layered perovskite based compounds LnBaCo<sub>2</sub>O<sub>5+δ</sub> (Ln: Lanthanide or Y) [1]. These systems are particularly interesting since they also display a large variety of magnetic and transport properties, which depend on the tunable oxygen concentration. It is believed that the magnetic and transport behaviors are driven by the mixed valence state of the cobalt ions and possible orbital ordering and therefore by the Co<sup>2+</sup>/Co<sup>3+</sup> (Co<sup>4+</sup>/Co<sup>3+</sup>) ratio determined by the oxygen content of the material.

Particularly interesting is the δ=0.0 oxygen concentration, at high temperature the sample is paramagnetic and has a tetragonal crystallographic structure. The crystal structure in this phase corresponds to a layered structure with oxygen atoms fully occupying the Ba layer while the Gd layer is free of oxygen. Below 340K, GdBaCo<sub>2</sub>O<sub>5.0</sub> undergoes a magnetic transition to an antiferromagnetic phase, which induces an orthorhombic distortion. Below TCO = 210K, neutron measurements suggest the presence of charge ordering [2].

We have performed resonant diffraction experiments to study the presence of charge ordering below 210K. The superstructures peaks present a strong resonance at the Co K-edge (Fig. 1), a strong indication of the presence of charge ordering. The presence of the anisotropy of the tensor of susceptibility (ATS) may also explain the observed resonances.

Fig. 2 shows the azimuthal dependence of the reflection (071). Fits based on the crystal symmetry of the sample (Pmmb) are consistent with a main charge ordering contribution, together with a small ATS component.

More quantitative results will be extracted with a comparison of the spectra with *ab initio* calculations.

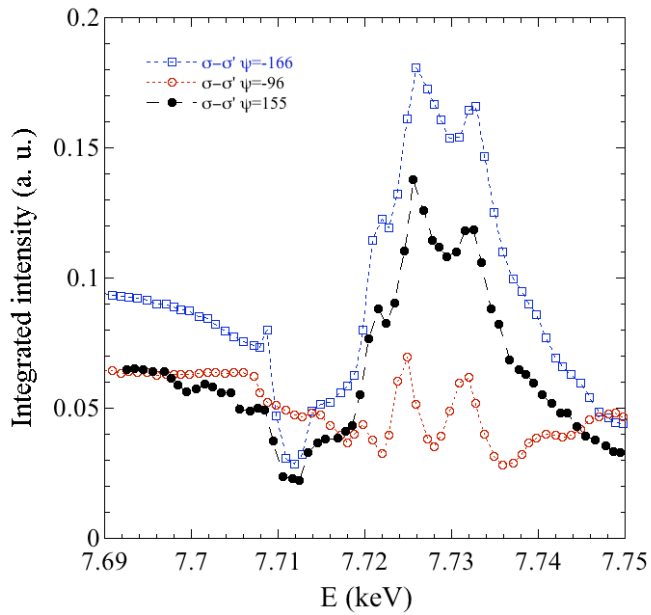


Fig.1 Energy dependence for the (071) reflection in the charge ordered phase.

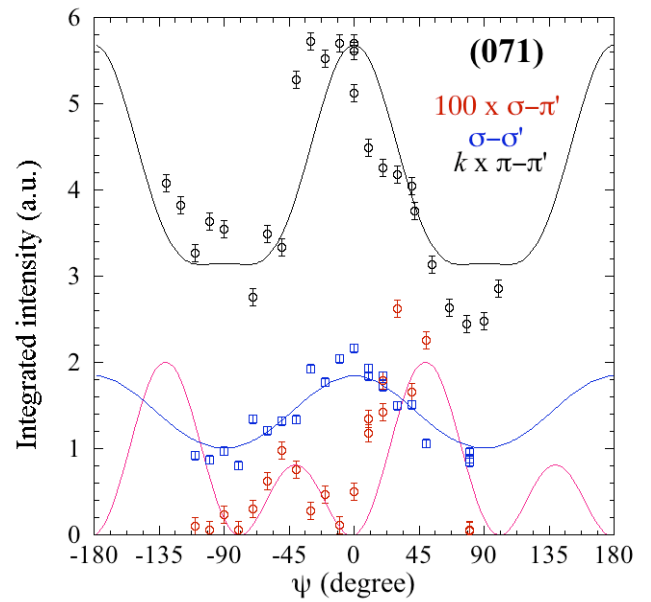


Fig.2 Experimental azimuthal angle dependence in the different polarization channels. Lines are fit based on the crystallographic structure of the sample.

## Reference

- [1] C. Martin, *et al*, Appl. Phys. Lett. 71, 1421 (1997).
- [2] F. Fauth *et al.*, Eur. Phys. J. B **21**, 163-174 (2001)