ESRF	**Experiment title:** **XMCD study of spin state transitionin $Pr_{0.5}A_{0.5}CoO_3$ (A - Sr, Ba) single crystals**	**Experiment number:** **HE-2715**
Beamline: **BM29**	**Date of experiment:** from: **07.05.2008** to: **13.05.2008**	**Date of report:** 01.09.2008
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The cobalt-based solid solutions with perovskite structure have attracted much research attention in recent years [1] due to a variety of magnetic and transport properties. Thus the most exciting cobaltites properties are the "colossal" magnetoresistance, possibility of the spin state transition and a high catalytic activity [2]. More interesting cobaltites properties were observed in the compound with chemical composition $R_{0.5}Sr_{0.5}CoO_3$ (*R* notes Pr, Nd, Tb, Sm). The Sr-doped cobaltites have entirely different properties, probably connected with oxygen content and *R* ionic radius [3]. Thus the metallic behaviour was observed in resistivity-temperature curves below 300 K. The ferromagnet-paramagnet transition occurs between T_1 ~230 and T_2 ~155 K and depends on lanthanide ionic radius. Among the mentioned Sr-doped cobaltites the $Pr_{0.5}Sr_{0.5}CoO_{3-d}$ compound has drawn a great attention. Our recent combination SQUID magnetization and neutron powder diffraction data (see **Fig. 1**) hysteresis loops curves revealed two unusual features observed on the M(T) dependence, which were not found in the similar cobaltites. First, there was a clear hysteresis between FC (field cooling) and ZFC (zero field cooling) magnetization curves. Second, there was a downward step around T ~100 K. It is note that the second feature causes a particular interest. This anomaly cannot be attributed to a transition into an anti-ferromagnetic state because the M(H) curve at 5 K clearly indicates ferromagnetism (see **Fig. 3**).

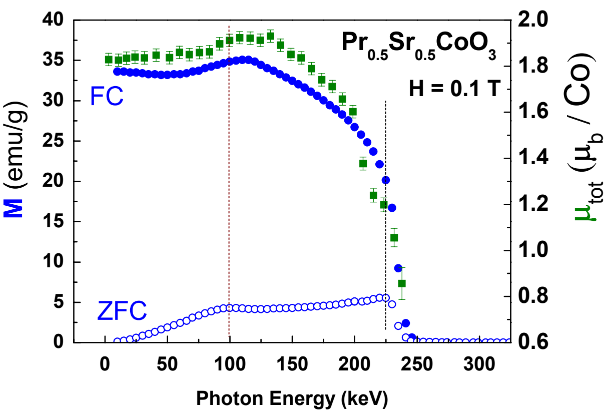

Fig. 1: The combination of the temperature dependence of the macroscopic SQUID magnetization (field cooling and zero field cooling) and the total magnetic moment determined from neutron powder diffraction data for the $Pr_{0.5}Sr_{0.5}CoO_3$.

In this work we have performed a combination of XMCD and neutron powder diffraction (NPD) measurements in order to study the correlations between contribution of the orbital magnetic moment of Co and spin and orbital moment of Pr to the total magnetic moment (deduced from the result of our neutron powder diffraction analysis) and local atomic and electronic distortion of the CoO_6 octahedron (our XAFS study at the ESRF BM29 beamline) in order to explain the origin of the unusual second ferromagnetic phase transition in the $Pr_{0.5}Sr_{0.5}CoO_3$ ceramic polycrystal.

The experiments have been carried out at beamlines **ID12** and diffractometer **D2B** (ILL).

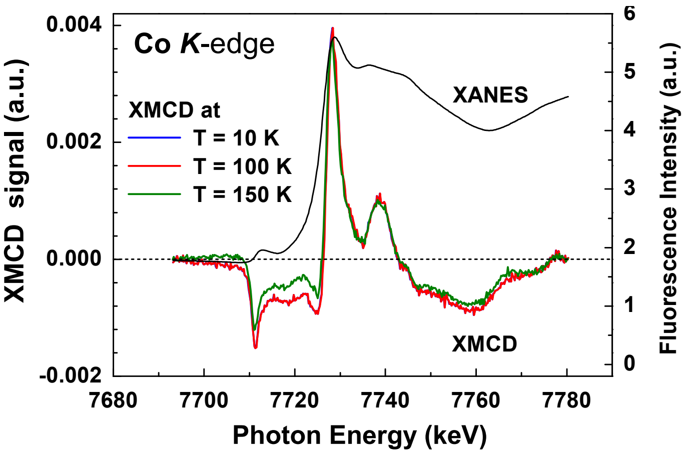

Fig. 2: Normalised XANES and XMCD spectra for $Pr_{0.5}Sr_{0.5}CoO_3$ at the Co *K*-edge under applied magnetic field of 6 T.

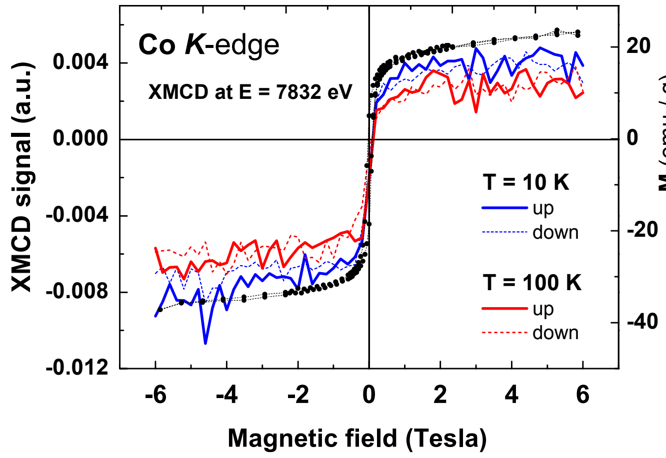

Fig. 3: Macroscopic magnetisation (black circules) at 100 K supperimposed on the temperature variation of the hysteresis loops mesured with XMCD at Co *K*-edge for $Pr_{0.5}Sr_{0.5}CoO_3$.

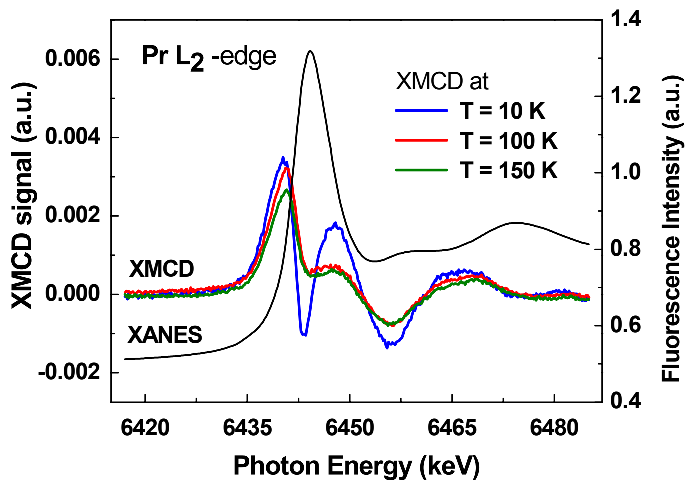

Fig. 4: Normalised XANES and XMCD spectra for $Pr_{0.5}Sr_{0.5}CoO_3$ at the Pr L_2-edge under applied magnetic field of 6 T.

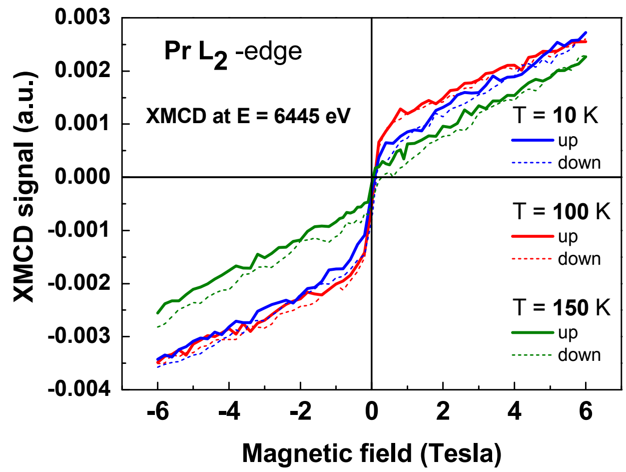

Fig. 5: Temperature variation of the hysteresis loops mesured with XMCD signal at Pr L_2-edge for $Pr_{0.5}Sr_{0.5}CoO_3$.

Figure 2 shows the temperature dependence of the normalized XANES spectra at the Co *K*-edge in $Pr_{0.5}Sr_{0.5}CoO_3$ and the corresponding XMCD signal. The latter directly reflects the variation of the orbital magnetic moment only for cobalt ions. The hysteresis loops measured with XMCD at the Co *K*-edge for $Pr_{0.5}Sr_{0.5}CoO_3$ at 10 K and 100 K (see **Fig. 3**) clearly indicate the saturation of magnetization at applied magnetic field about 2 T. Such behaviour correlates well with the macroscopic hysteresis loops curve (see **Fig. 3**). Moreover, the decrease of XMCD magnetization value with growth of temperature was found. It should be noted, that in the case Pr L_2-edge XMCD spectra of the $Pr_{0.5}Sr_{0.5}CoO_3$ the temperature dependence of shape XMCD signal (see **Fig. 4**) is essentially transformed, and as result leads to the absence of the saturation of XMCD signal up to applied magnetic field above 6 T (see **Fig. 5**). In addition, at temperature near 100 K, the growth of XMCD signal with respect to the 10 K and 150 K is observed. This result has been confirmed well by the temperature dependence of the macroscopic SQUID magnetization and the total magnetic moment behaviour determined from neutron scattering experiments (see **Fig. 1**).

References

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