ESRF	**Experiment title:** MAGNETIC MOMENTS on Cr, Co and Ni in doped PRASEODYMIUM MANGANITES as seen by XMCD.	**Experiment number:** **HE-366**
Beamline: **ID12B**	**Date of experiment:** from: 16/04/98 to: 22/04/98	**Date of report:** 28/09/98
Shifts: 15	**Local contact(s):** **J.Goedkoop and N.Brookes**	*Received at ESRF:* 0 8 OCT. 1998

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Report:

Of the 15 shifts officially scheduled from april the 16th to the 22nd, 12 were actually obtained for soft XMCD experiments at M (M = Cr, Mn, Fe, Co and Ni) $L_{2,3}$-, Ln (Pr, Nd, Sm) $M_{4,5}$- and 0 K-edges using the flipping magnet system. High vacuum problems and software troubles in the command of the magnetic flipping system allowed a second experiment of 3 shifts to be performed from may the 10th to the 11th

The aim of this experiment, as described in the proposal, was to investigate by soft XMCD the existence and orientation of magnetic moments on the doped transition metals in the CMR manganites $Ln_{0.5}Ca_{0.5}(Mn_{1-x}B_x)O_3$ (Ln = Pr, Nd, Sm; B = Cr, Fe, Co, Ni; $0 < x$ 0.12). The CMR properties result from doping of the manganese sites of the charge ordered compounds $Ln_{0.5}Ca_{0.5}MnO_3$ which keep insulating in the whole temperature range($4 \leq T \leq 300$K).

Experimentally the dichroic signals at M $L_{2,3}$-edges were recorded at 20K for both light helicities and magnetic field orientations on ceramic samples in order to minimize systematic errors. The flipping of light helicities was only used for measuring the dichroic signals of a thin films with nominal composition $Pr_{0.7}Sr_{0.3}MnO_3$ first without any applied magnetic field in order to check for the existence of a spontaneous magnetization in the as-synthesized thin film.

Results were obtained on the four doping transition elements but they were more complete for chromium doping since four doping amounts (0.05, 0.09, 0.1 and 0.12) could be recorded at Cr $L_{2,3}$-edges. They show that magnetic moments do exist on all the doping metals below Tc (ferromagnetic transition) but with different orientations: Cr^{3+} and Fe^{3+} cations are antiparallel whereas Co^{2+} and Ni^{2+} cations turn to be parallel to the manganese network assumed to be parallel to the applied magnetic field. The reverse sign of the chromium magnetic dichroic signal compared to the Mn one is shown on figures 1 (a and b) for the $Sm_{0.5}Ca_{0.5}(Mn_{0.9}Cr_{0.1})O_3$ composition. Taking into account the antiferromagnetism of Cr, a model can be proposed for the variations of the total magnetization with the chromium doping for the Cr doped CMR manganites.

Also the presence of a dichroic signal at 0 K-edge was checked for a few compositions (Fig. 1 c). Although very weak ($\leq$ 1 %), its presence only visible on the prepeak signs the double exchange interaction between M 3d orbitals via the O 2p orbitals which carry a weak moment parallel to the Mn network.

The presence of a magnetic moment on the rare earths at low temperature (< 60K) is still an open question because it turns to be too weak to be seen by neutron diffraction. We had already shown the existence of a clear dichroic signal at Nd $M_{4,5}$-edges for temperatures below 60K using a single crystal of composition $Nd_{0.7}Ba_{0.3}MnO_3$ but this was under a strong magnetic field (H = 6.5T). During the latest experiment, good dichroic signals were observed at Pr, Nd and Sm $M_{4,5}$-edges (0.6% as shown on fig. 1 d) at 20K in a magnetic field of 0.6T which showed that magnetic moments do exist on the rare earths which aligned parallel to the manganese network for Pr and Nd and antiparallel for Sm.

As suggested in a recent paper on the magnetic properties of $Nd_{0.7}Ba_{0.3}MnO_3$ (O.Toulemonde et al, JMMM (1998) in press), the magnetic ordering of the Nd subnetwork below 70K can be linked to a phase transition from a metallic to a insulating phase. But this behaviour is far from being a general one and magnetic moments have been observed also on Pr and Sm CMR compounds without any significant change of the transport properties at low temperature.

Figure 1.