 ESRF	Experiment title: Soft X-ray magnetic circular dichroism on transition metal oxides. Part I: colossal magnetoresistance compounds.	Experiment number: HE44
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Report:

We have performed a soft X-ray magnetic circular dichroism (SXMCD) study on the MnL absorption edges of the colossal magnetoresistance compounds $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ and $\text{Pr}_{0.5}\text{Sr}_{0.5}\text{MnO}_3$. As an example we show in the upper panel of Fig. 1 the MnL SXMCD spectrum of $\text{Pr}_{0.5}\text{Sr}_{0.5}\text{MnO}_3$ ($T_{\text{Curie}} = 270$ K) taken at 20 K and at a magnetic field of 6.5 Tesla. In the lower panel the corresponding temperature-dependent SXMCD difference spectra can be seen. Surprisingly, the data show a considerable SXMCD effect at 300 K considerably above the Curie temperature. This gives evidence for superparamagnetic behaviour of this system for $T > T_{\text{Curie}}$.

In Fig. 3 we present the results from a study of the field- and temperature-dependence of the MnL SXMCD of $\text{La}_{0.85}\text{Sr}_{0.15}\text{MnO}_3$ ($T_{\text{Curie}} = 238$ K) and $\text{La}_{0.6}\text{Sr}_{0.4}\text{MnO}_3$ ($T_{\text{Curie}} = 371$ K). Fig. 2 shows the field-dependence of the MnL SXMCD effect (defined as $(\mu_+ - \mu_-)/(\mu_+ + \mu_-)$) at the photon energy of the minimum of the difference spectrum) at various temperatures from 20 K up to 300 K for both samples. The general behaviour of the dichroic signal is quite similar to the field- and temperature-dependence of the macroscopic magnetic moment that has been observed from magnetometry since former is proportional to the expectation value of the magnetic moment.

From the decrease of the dichroic signal at 20 K when going from $x=0.15$ to $x=0.4$ we conclude that the Mn magnetic moment is reduced due to the depletion of the Mn3d shell by doping. Here again, the occurrence of a considerable SXMCD effect of about 7% for $\text{La}_{0.85}\text{Sr}_{0.15}\text{MnO}_3$ at a temperature of 300 K well above the Curie temperature of 238 K points out that these systems should be considered as superparamagnetic for $T > T_{\text{Curie}}$.

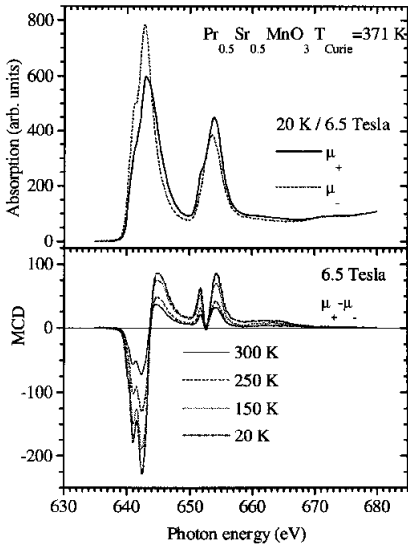


Fig. 1: Temperature-dependent MnL SXMCD of $\text{Pr}_{0.5}\text{Sr}_{0.5}\text{MnO}_3$.

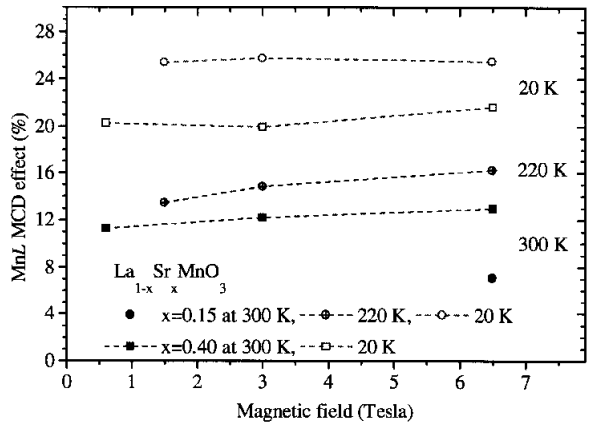


Fig. 2: Temperature- and field-dependence of the MnL SXMCD effect in $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$.

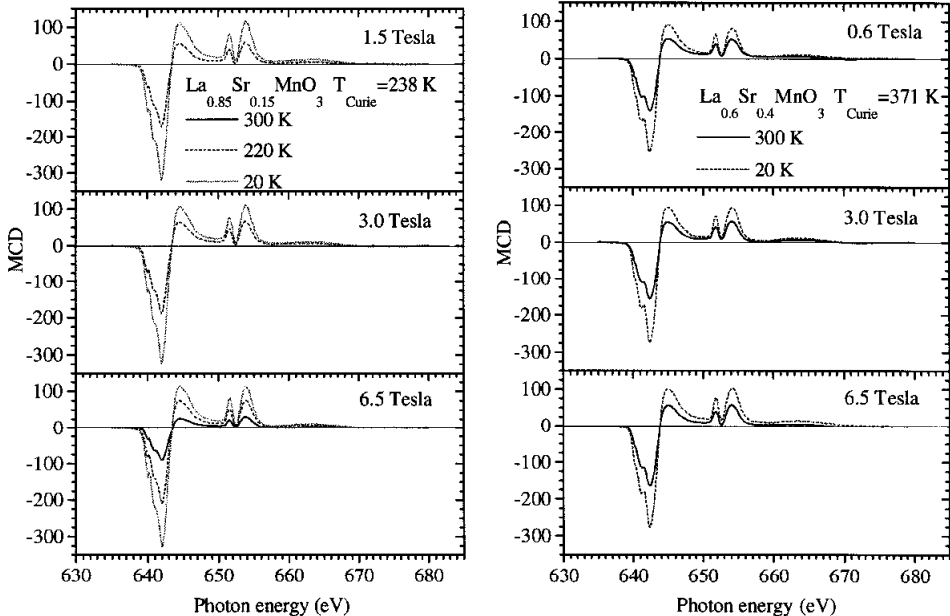


Fig. 3: MnL SXMCD difference spectra of $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ taken at different temperatures and magn. fields.