ESRF	**Experiment title:** XMCD of Gd garnets and Laves phases under high pressure	**Experiment number:** HE371
Beamline: ID24	**Date of experiment:** from: July 10^{th} to: July 18^{th} 1998	**Date of report:** 31.8.1998
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Names and affiliations of applicants (* indicates experimentalists):

H. Giefers*, M. Strecker*, G. Wortmann*; Universitat-GH Paderborn;
K. Attenkofer*, Universität Würzburg / HASYLAB; G. Schütz (Würzburg);
F. Baudelet; LURE; A. Fontaine*, ESRF; J. Przewoznik*, AGH Cracow;

Report:

X-ray magnetic circular dichroism (XMCD) experiments provide a detailed element-specific mapping of spin and orbital densities in solids using the magnetic absorption characteristics of circularly polarized SR. The development of dedicated beamlines providing a high flux with a high degree of circularly polarized SR [l] enables new applications of XMCD spectroscopy such as high-pressure studies, as recently demonstrated by a Pt L_{III}-edge (11.56 keV) study of a $Pt_{28}Fe_{72}$ invar alloy [2]. We report in the following on the first high-pressure XMCD studies at ESRF on the L-edges of a rare earth (RE) element, here on Gd-$L_{II,III}$ (7.93 and 7.24 keV) in $GdFe_2$ and $Gd_3Fe_5O_{12}$, probing the spin densities of Gd 5d-states, which are reflecting both the 4f moment magnetization as well as the exchange mechanisms with 3d/4f neighbours.

For the difficult energy range of 6 to 10 keV we developed a special small h.p. cell in Paderborn equipped with boroncarbide (B_4C) anvils allowing XMCD studies up to 15 GPa with a relatively large absorber diameter (1 mm) [3]. It turned up that the large area of the absorber allowed to measure x-ray absorption spectra without any fringe effects, which had seriously hampered similar studies performed by some of us at ID 24 using a diamond anvil cell with a much smaller absorber diameter. The only distortion of the Gd $L_{II,III}$-edge spectra resulted from a (small) decrease of energy resolution of the position-sensitive dectector due to small-angle scattering by our polycrystalline anvil and absorber materials [4]; this spectral broadening was kept constant within a pressure series. The h.p. experiments were performed at room temperature. The x-rays were circularly polarized by a diamond quarter-wave plate. Polarizing magnetic fields up to 0.35 T could be applied to the pressurized absorber with an electromagnet (see Fig. 1). The dichroic signal was produced by switching the direction of the magnetic field and summing up of about 100 XAS spectra in order to eliminate the impact of beam oscillations on the XMCD spectra [2]. The measuring time was about 1 h for a h.p. XMCD spectrum.

The Gd-L_{III} XMCD spectra (raw data in an energy range of about 50 eV) of ferrimagnetic $GdFe_2$ at various pressures in an external field of 0.33 T are shown in Fig. 2a.

The dichroic signal (2.5 %) of the 0.5 GPa spectrum corresponds well to that expected for $GdFe_2$ at this temperature and the applied field. For higher pressures we observed a clear decrease of the dichroic signal with increasing pressure. The corresponding spectra of ferrimagnetic $Gd_3Fe_5O_{12}$ are shown in Fig. 2b. The dichroic signals are considerably smaller than in Fig. 2a due to small-angle scattering effects and the relatively small polarizing field, indicating no changes or, at best, a small increase with pressure, opposite to the $GdFe_2$ case. The Gd-L_{II} spectra of $GdFe_2$ and $Gd_3Fe_5O_{12}$ (see also Ref. 3) exhibit the same pressure dependence as the corresponding L_{III}-spectra. The different pressure dependences of the dichroic signal in $GdFe_2$ and $Gd_3Fe_5O_{12}$ are attributed to the contributions of conduction electrons in $GdFe_2$ to the dichroic signal. This is an important finding for the interpretation of XMCD signals of RE systems. The present h.p. XMCD studies can easily be extended to low temperatures as well as to the Fe-K edge.

References: 1. M. Hagelstein et al., J. Physique IV, Vol. 7, C2-303 (1997). 2. F. Baudelet et al., J. Synchrotron Rad. 5, 992 (1998). 3. K. Attenkofer et al., HASYLAB Report 1997, p. 1035. 4. M. Hagelstein et al., J. Synchrotron Rad. 5, 753 (1998).

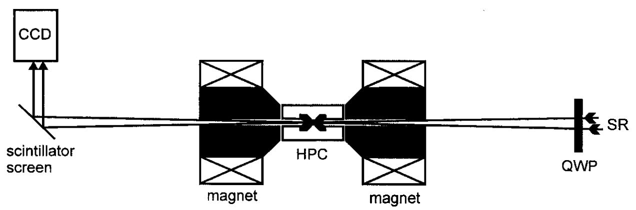

Fig 1: Schematic h.p. XMCD set-up at ID24 [1]. QWP is the diamond quarter-wave plate; HPC is the high pressure cell within the pole-shoes (black) of the magnet.

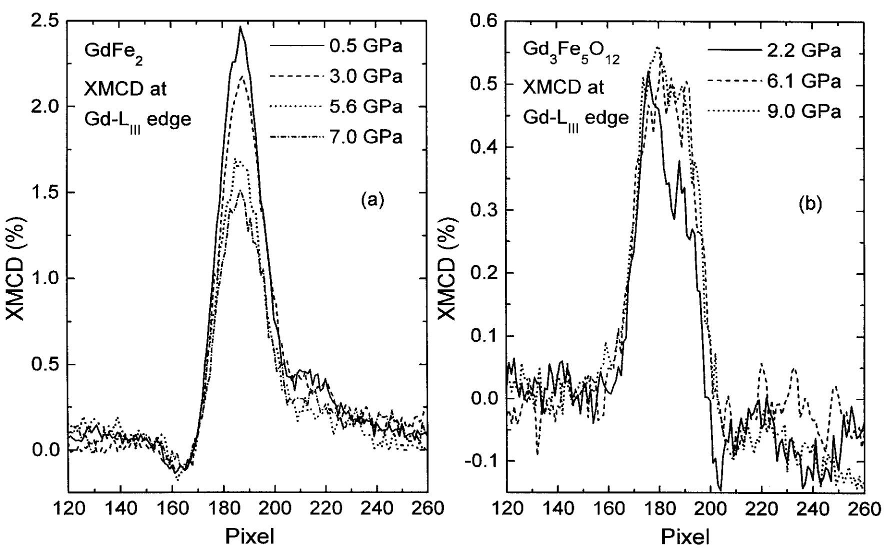

Fig. 2: Gd-L_{III} XMCD spectra of $GdFe_2$ (left) and $Gd_3Fe_5O_{12}$ (right) at various pressures