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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Probing electronic order in the zero field cool phase of Gd/La superlattices.	**Experiment number**: HE 1885
Beamline: ID12	**Date of experiment**: from: 03/10/2005 to: 07/10/2005	**Date of report**: 01/09/2006
Shifts: 12	**Local contact(s)**: F. Wilhelm, A. Rogalev	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

P.P. Deen*, Institut Laue-Langevin, France
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Report:

Gd/La multilayers were found to possess the interesting property of coexistent magnetism and superconductivity in Gd and La layers respectively. SQUID and magnetic neutron scattering techniques have shown that if a sample of composition $[Gd_{30}/La_{10}]_{60}$ is subjected to a zero field-cool (ZFC) to T=2K, the ferromagnetic Gd layers align antiferromagnetically with respect to successive blocks, and BCS superconductivity occurs within La layers. Alternatively, a field-cool (FC) to T=2K gives ferromagnetic alignment of Gd blocks and no superconductivity in the La blocks [1,2].

X-ray Magnetic Circular Dichroism (XMCD) was performed on instrument ID12 at the ESRF. XMCD signal was achieved by flipping the helicity of the incident radiation between left- and right-handed circular polarisation. The aim of the work was to probe the Gd and La magnetic order individually in both the FC and ZFC phases at the Gd L_{II} and L_{III} edges, and the La L_{II} and L_{III} edges. The field-cool measurements were performed by applying an in-plane magnetic field of 50 Oe as the sample was cooled.

XMCD spectra at temperatures above- and below- the La superconducting temperature (T=15K and T=3K respectively) in the zero-field cool phase are of particular interest, as shown in Figure 1. XMCD at the Gd L_{II} edge shows little qualitative change as the sample is cooled between T=15K and T=3K. The La XMCD signal is very weak, but shows a pronounced change in sign as the La layers become superconducting.

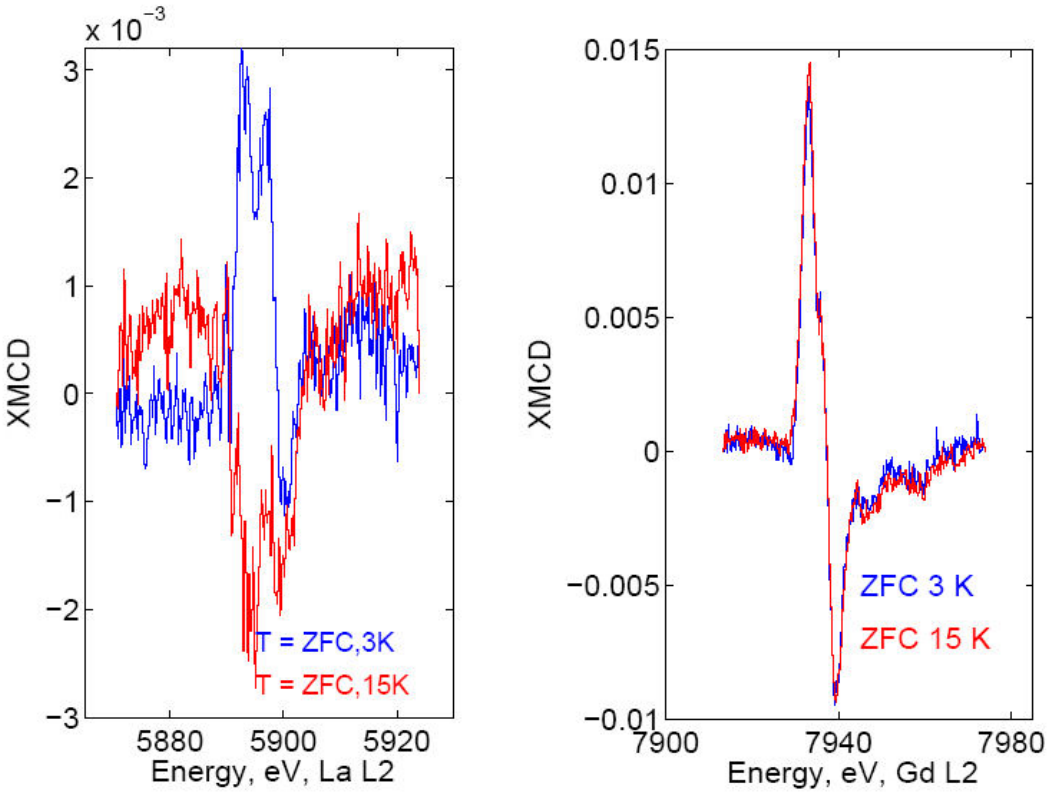

Figure 1. XMCD spectra in the ZFC phase for the Gd and La L_{II} edges

The magnetic ordering of the Gd layers is not perturbed as the superconducting order emerges. The change in sign of the XMCD signal at the La L_{II} edge is a direct measurement of the onset of diamagnetism in the La layers. Analysis of the data will include attempting to model the orbital and spin component of the La moment as the layers become superconducting. Additional measurements would also include measurement of circular dichroism as a function of depth within the layers by combining reflectometry and XMCD, following the work of Sève *et al* [3].

[1] P.P. Deen *et al.* J. Phys. – Cond. Mat.**17** 3305 (2005).
[2] J.P. Goff *et al.* J. Magn. Magn. Mater. **199**, 309, (1999).
[3] L. Sève *et al* Phys. Rev. B. **60**, 9662, (1999).