	<b>Experiment title:</b> X-ray magnetic circular and linear dichroism (XMCD and XMLD) experiment on the magnetic phases of Sr4Ru3O10.	<b>Experiment number:</b> HE-3290
<b>Beamline:</b> ID12	<b>Date of experiment:</b> from: 12-05-2010 to: 18-05-2010	<b>Date of report:</b> 27-08-2010
<b>Shifts:</b> 15	<b>Local contact(s):</b> Andrei Rogalev	<i>Received at ESRF:</i>
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## Report:

We proposed an X-ray magnetic circular dichroism (XMCD) experiment on the magnetic phases of Sr<sub>4</sub>Ru<sub>3</sub>O<sub>10</sub>. This system undergoes a ferromagnetic (FM) transition at T<sub>C</sub>=105 K where canted magnetic moments align along the *c*-axis, followed by another metamagnetic transition at T\*=50 K for fields applied in the *ab* plane, associated to peculiar behaviors of the transport properties, whose nature has still to be clarified. The phase diagram of the Sr<sub>4</sub>Ru<sub>3</sub>O<sub>10</sub> compound is reported in figure 1. The aim of this experiment was to directly and simultaneously probe the orbital occupation and the local electronic structure of Ru ions in the RuO<sub>6</sub> octahedra in order to associate its change with the magnetic structure and to unambiguously determine the nature of the magnetic ordering below 50 K.

In order to investigate the FM phase and the metamagnetic phase transition in the Sr<sub>4</sub>Ru<sub>3</sub>O<sub>10</sub> compound we planned to measure the XMCD at the Ru L<sub>2,3</sub> (2*p*-4*d* dipole transition) absorption edge (2.8-2.9 keV) as a function of temperature and applied magnetic field's magnitude and orientation.

The samples were mounted with two different configurations in order to fully apply the magnetic field along the *c*-axis and the *ab*-plane (see figure 2).

Since the circular polarization rate at the Ru L<sub>3</sub> (2967 eV) was below 1% and at Ru L<sub>2</sub> (2838 eV) was 4% due to the dark window for the vertical polarization reflection of the channel-cut Si(111) monochromator of ID12, the resulting dichroic signal at the L<sub>3</sub> edge was undetectable (see figure 3) since it is comparable with the residual signal. For the same reason, the X-ray linear dichroism experiment which would provide us with the local structural information was not possible.

Thus we only measured the magnetization curves at the L<sub>2</sub> edge of Ru.

The lackness of the XMCD at the L<sub>3</sub> edge, limited the quantitative analysis of the character and the evolution of the orbital and spin angular momenta across the magnetic phase transitions.

The measurement strategy was then the following: first, we established the FM transition along the *c*-axis at T<sub>c</sub>=105 K by measuring the hysteresis signal at the L<sub>2</sub> edge of Ru with the magnetic field B fully applied along *c*.

Secondly, varying the angle between the *c*-axis of the sample and the direction of the beam, angle dependent

hysteresis loop measurements were carried out that allowed us to decouple the in-plane and out-of-plane magnetic phases. Finally, the magnetic field was fully applied along the ab-plane. By sweeping the magnetic field from -4 to 4 Tesla and varying the temperature in the 4-60K range we measured the hysteresis loops and we verified the presence of the metamagnetic (AFM to FM canted ordering) transition (see figure 4 and 5).

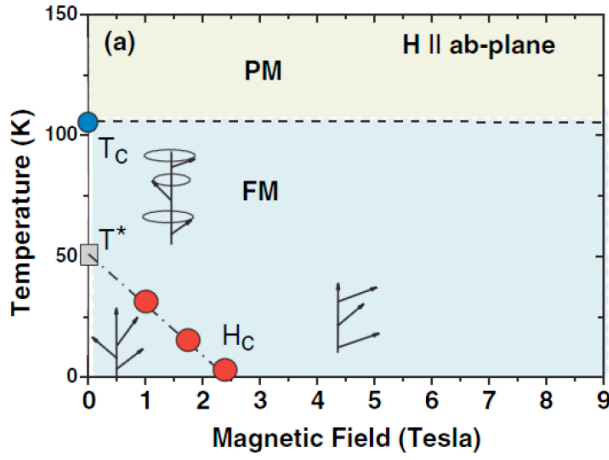


Figure 1 Phase diagram

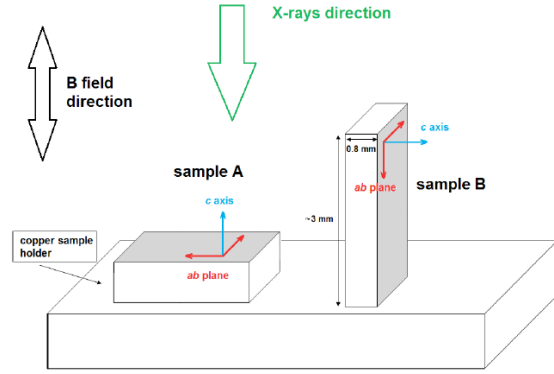


Figure 2 Mounting configurations

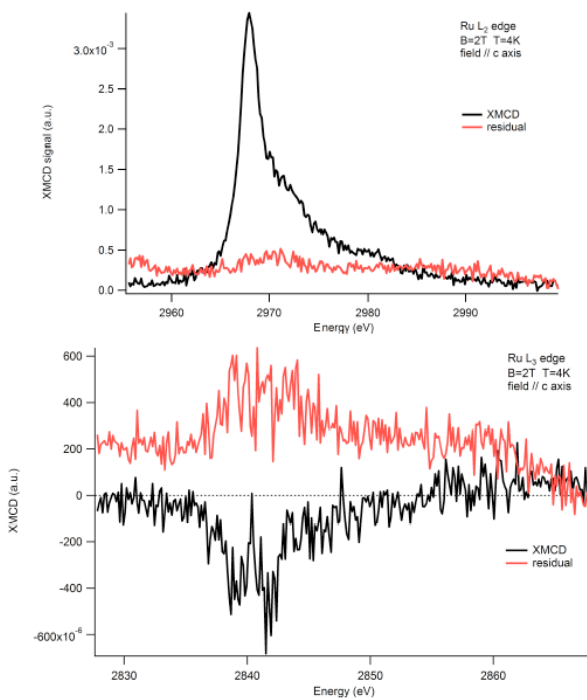


Figure 3 XMCD signals at the L23 edges of Ru (black curves) and the corresponding residuals (red curves)

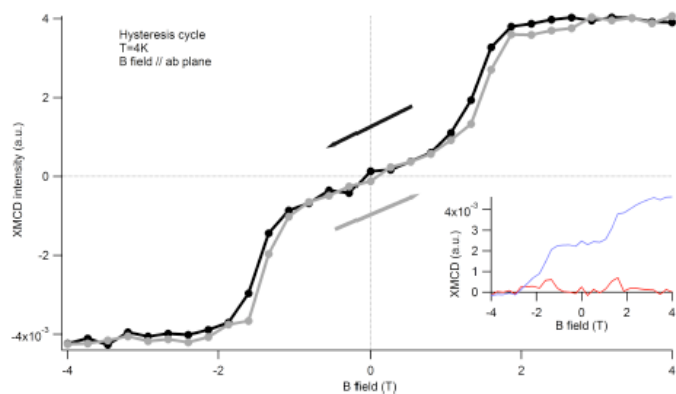


Figure 4 Hysteresis loop with the magnetic field applied along the  $ab$ -plane. The variation of the slope around 1.7 Tesla is the signature of the metamagnetic transition.

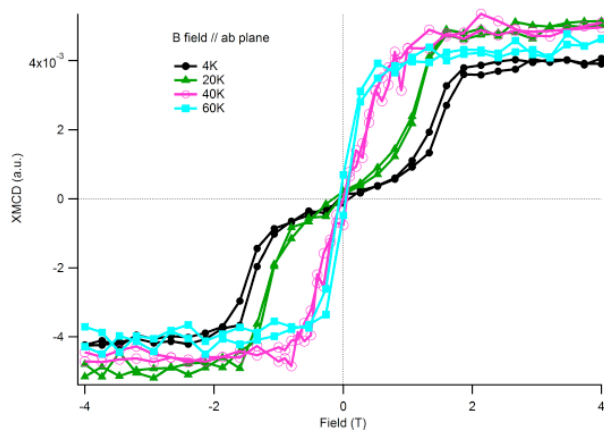


Figure 5 Hysteresis curves at different temperatures, with the magnetic field parallel to the  $ab$ -plane.