EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

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 via the User Portal:
https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Deadlines for submission of Experimental Reports

Experimental reports must be submitted within the period of 3 months after the end of the experiment.

Experiment Report supporting a new proposal ("relevant report")

If you are submitting a proposal for a new project, or to continue a project for which you have previously been allocated beam time, you must submit a report on each of your previous measurement(s):

- even on those carried out close to the proposal submission deadline (it can be a *"preliminary report"),*
- even for experiments whose scientific area is different form the scientific area of the new proposal,
- carried out on CRG beamlines.

You must then register the report(s) as "relevant report(s)" in the new application form for beam time.

Deadlines for submitting a report supporting a new proposal

- 1st March Proposal Round - **5th March**
- 10th September Proposal Round - **13th September**

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.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report in English.
- include the experiment number 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:** XMCD characterization of epitaxial Chromium iodide ferromagnets	**Experiment number**: Ih-hc-3795
Beamline: ID32	**Date of experiment**: from: 23/08/2022 to: 04/09/2022	**Date of report**: 12/09/2022
Shifts:	**Local contact(s)**: Roberto Sant	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Roberto Sant

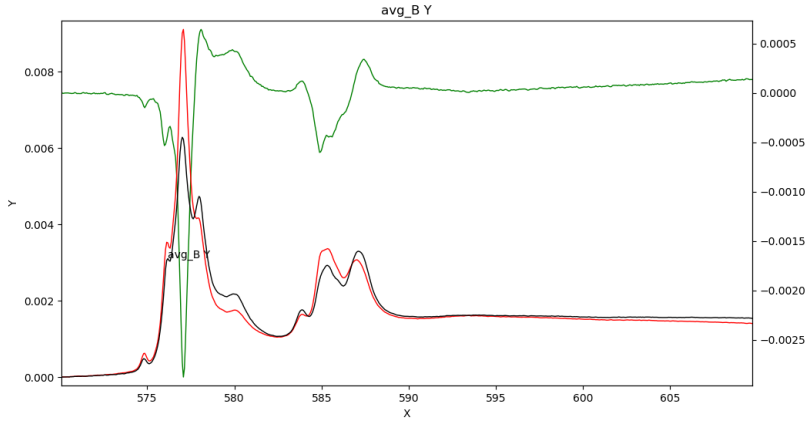
Report:

With the present report, we report selected spectra and preliminary analysis showing the main results obtained during the beamtime. XAS taken with right and left hand circular polarizations are in red and black respectively; calculated XMCD signal is in green. With X and Y we denote Energy (eV) and normalized Intensity measured in total electron yield (arb.un.).

The experiment concerned the study of the magnetic properties of Cr iodide (CrI_2) monolayer grown by MBE on metallic and insulating substrates. Although similar the two systems manifests some differences, notably in peak energy position and field dependence at low temperature (<20K).

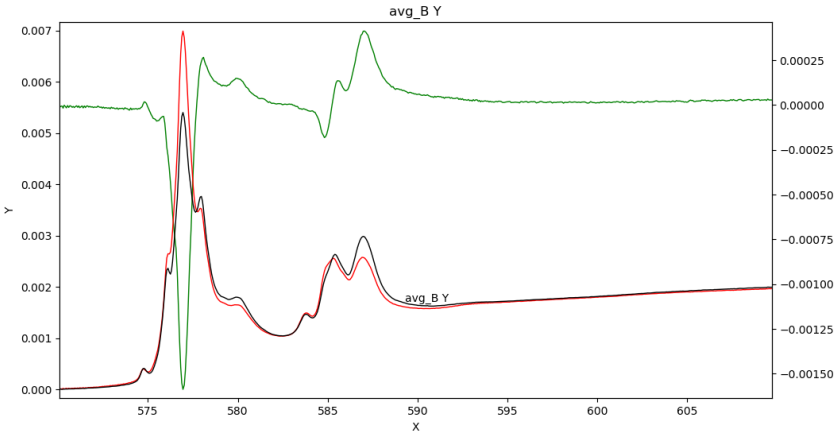
Part I: Epitaxial monolayer Chromium Iodide grown on Au(111)

XAS+XMCD, 4K, 9T, Normal Incidence



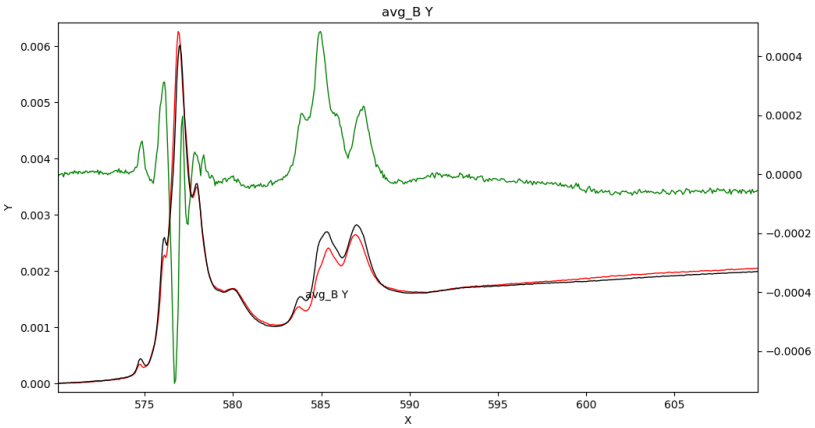
30% dichroism

XAS+XMCD, 4K, 9T, Grazing Incidence



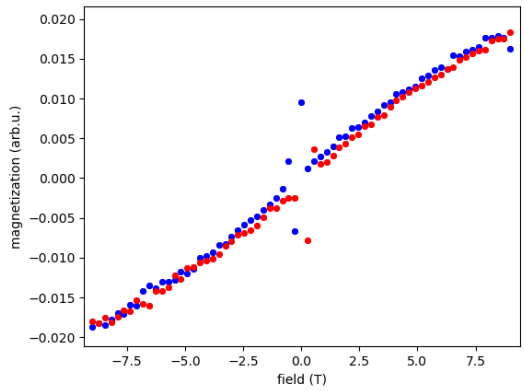
20% dichroism. XMCD shape very similar to Normal Incidence case.

XAS+XNLD, 4K, 0T, Grazing Incidence (30°)



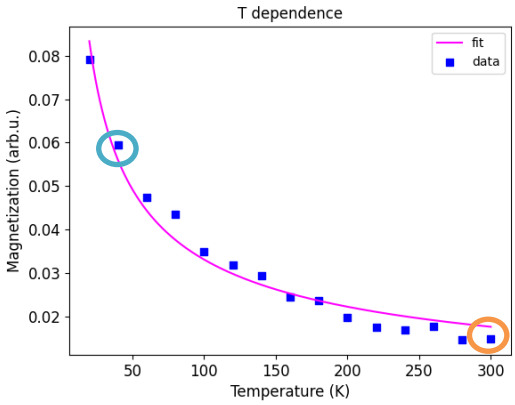
Finite linear dichroism suggests anisotropic electronic charge distribution, possibly due to local distortion of the pristine octahedral coordination expected for Cr.

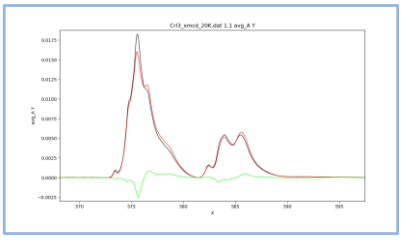
Hystersis loop between 9T and -9T at 4K

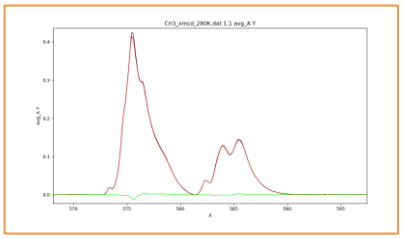


Linear field dependence suggests paramegnetic behaviour. Blue and red points correspond to magnetic field ramps from 9T to -9T and from -9T to 9T respectively. Points out of the guidline are aretefacts due to measuring in TEY at nearly zero magnetic field.

Temperature dependence

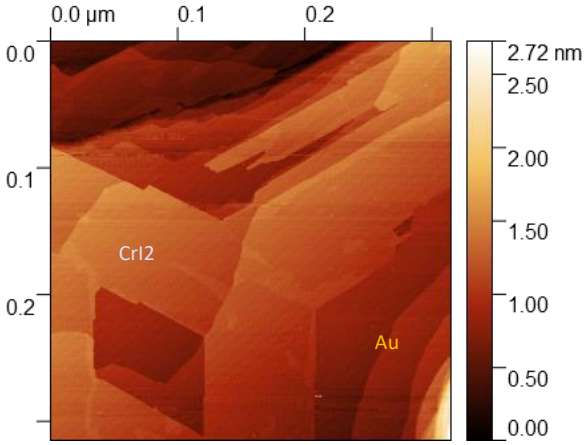






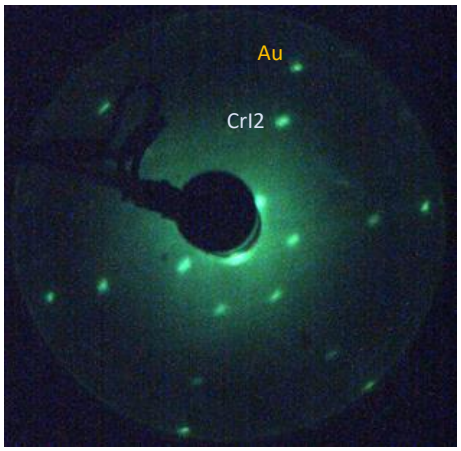
Fit tendance suggests 1/T dependence, typical of a paramagnetic phase.

STM image of epitaxial monolayer Chromium Iodide grown on Au(111)



The STM image taken at 1V and 0.5nA shows that CrI2 on Au111 forms long stipes of hundreds nm length. The Au surface is visible (although covered by iodine). The covergae is less than one monolayer.

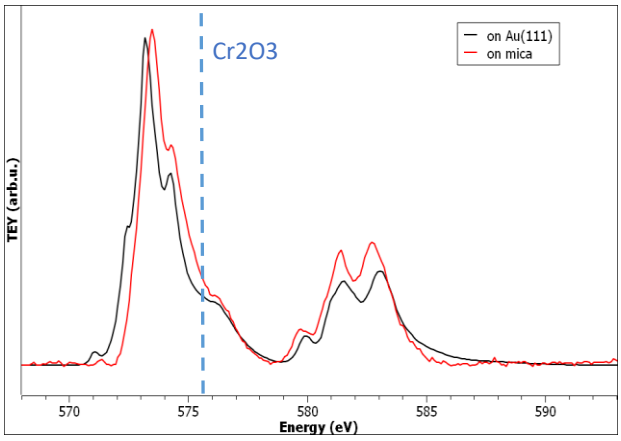
LEED pattern of epitaxial monolayer Chromium Iodide grown on Au(111)



The sharp diffraction pattern (50eV) is related to long range surface order and epitaxial alignment with the high symmetry directions of the substrate. Geometrical relationship between overlayer and substrate (Au111) spots is compatible with the in-plane periodicity of the CrI2 surface lattice, i.e. 3.929Å.
Tracy et al., Acta Crystallographica, 15.5 (1962)

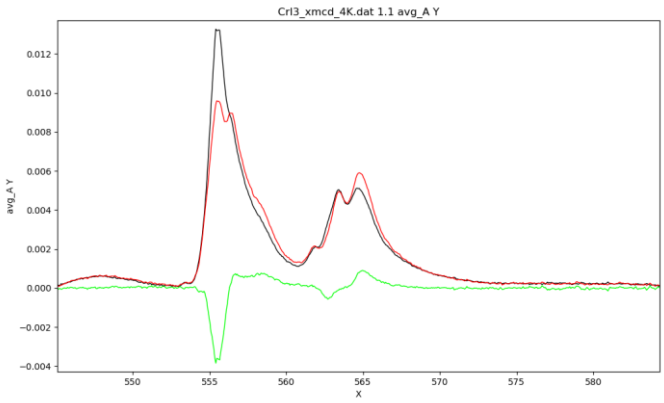
Part II: Epitaxial monolayer Chromium Iodides grown on mica(0001)

RT XAS comparing epitaxial monolayer Chromium Iodide grown on Au(111) and mica(0001)



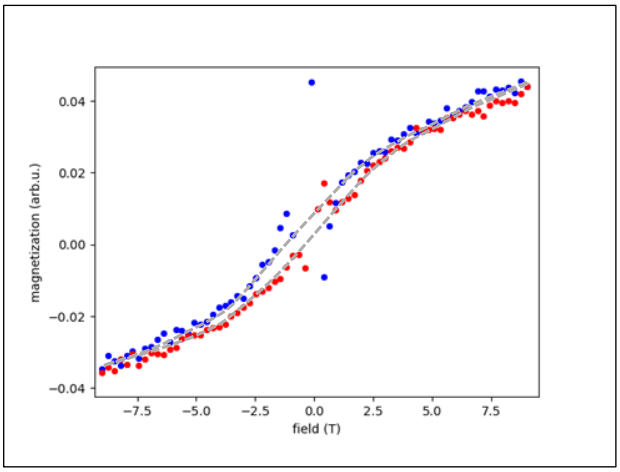
XAS are very similar for Cr iodide layer grown on the two different substrates. There is however a chemical shift of 0.3eV.

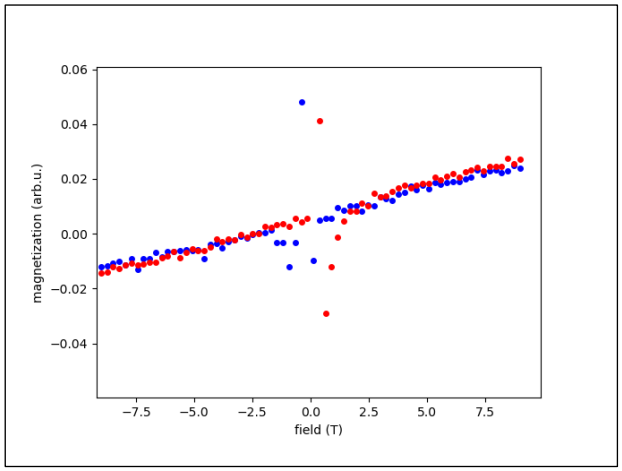
XAS+XMCD, 4K, 9T, Normal Incidence



20% dichroism
At 4K XAS is less sharp and the two polarizations manifest slightly different features compared to Au(111)

Hystersis loop between 9T and -9T at 4K (left) and 20K (right)





At 20K the field dependence is linear (like for CrI2 on Au111) and suggests paramegnetic behaviour. At 4K the hysteresis loop as S-shape and shows a small (~0.7T) coercive field. Blue and red points correspond to magnetic field ramps from 9T to -9T and from -9T to 9T respectively. Points out of the guidline (grey) are aretefacts due to measuring in TEY at nearly zero magnetic field.