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:** Resonant X-ray inelastic scattering (RIXS) from $AmFe_2$	**Experiment number**: HC–5321
Beamline: ID26	**Date of experiment**: from: 27/06/2023 to: 3/07/2023	**Date of report**: 30/10/2023
Shifts: 18	**Local contact(s)**: Blanka Detlefs	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

E. Lawrence Bright*(ESRF), R. Caciuffo*(ITU, Karlsruhe), G. van der Laan*(Diamond), J. Lashley*(U. of Cambridge), G. H. Lander*(ITU, Karlsruhe), R. Eliordi (ITU, Karlsruhe) and J-C. Griveau (ITU, Karlsruhe), and M. Sundermann (U. of Cologne, Germany)

Report: These experiments were the first to attempt RIXS of a transuranium system. The sample of 11 μg of Am in the compound $AmFe_2$ was prepared at ITU, Karlsruhe. The same sample had been used previously on the ID12 beamline to investigate the ground state of the material [1]. The present experiments were conducted at the M_5 and M_4 edges of Am (3.887 and 4.095 keV, respectfully) and aimed to study the higher-energy states of this material. Because of the safety containment, which included ~ 60 μm of Kapton windows, this experiment could not be conducted at the ID32 beamline, where the resolution is < 0.1 eV, but instead ID26 was used with the resolution of 0.55 and 0.73 eV at the respective *M* edges listed above.

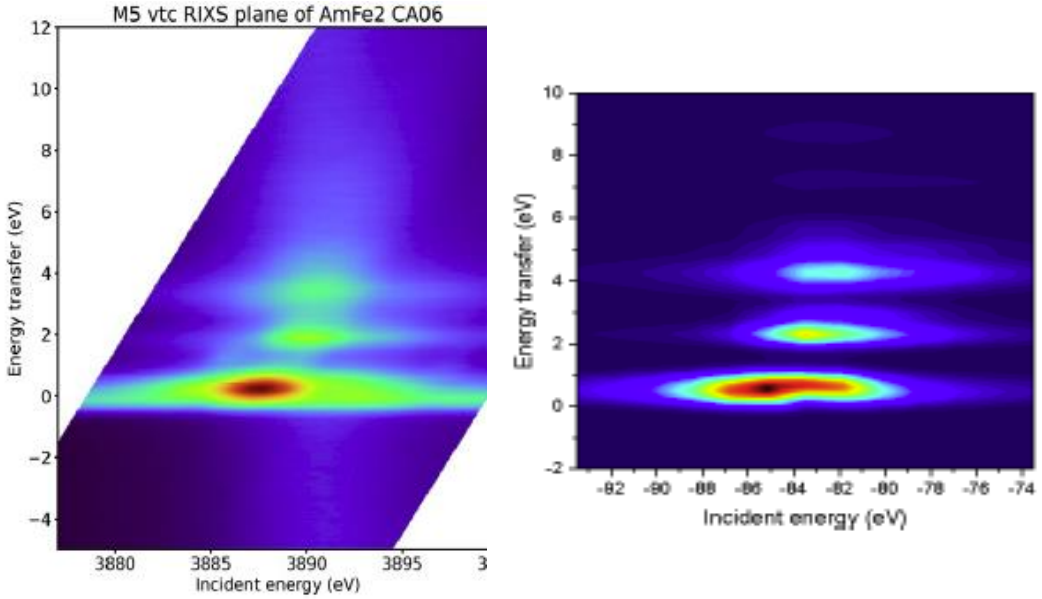

Figure 1
Spectra at M_5 edge at 3.887 keV. Left-hand is experiment, right-hand is theory.

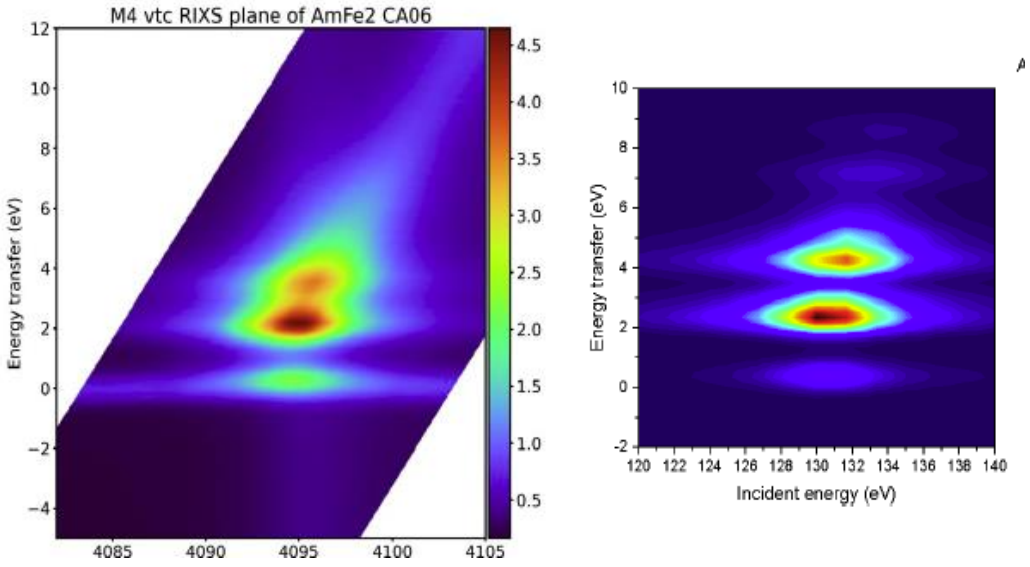

Figure 2
Spectra at M_4 edge at 4.095 keV. Left-hand is experiment, right-hand is theory.

The experiment was a considerable success. Clear spectra have been observed, and agree qualitatively with theory by Martin Sundermann at U. of Cologne. Am^{3+} has a J = 0 ground state [1] and the j = 5/2 substate is almost full so that the inelastic spectra at zero energy transfer at the M_4 edge is weak, and this is clearly observed. The first inelastic peak at the M_5 is at < 1 eV and merged with the inelastic response at E = 0, which is presently not understood.

Detailed modeling is now underway.

What is clear from this experiment is that the excited 5*f* states can be observed clearly, despite the presence of conduction electrons, as this material is a metal. Previously, work at the *N* edges has had difficulty observing spectra from systems with conduction electrons [2].

Attempts were also made at other edges, including the *K* edge of Fe, but no signal was observed.

[1] N. Magnani *et al.*, Phys. Rev. Lett. **114**, 097203 (2015)
[2] E. Lawrence Bright *et al.*, J. Phys. Cond. Matt. **35**, 175501 (2023)