ESRF	**Experiment title:** *Correlation between hybridisation and resonant Raman scattering from Cerium compuonds in the M_5 region with final state 4p hole*	**Experiment number:** HE546
Beamline: ID12B	**Date of experiment:** from: 4/2/1999 to: 9/2/1999	**Date of report:** 29/2/2000
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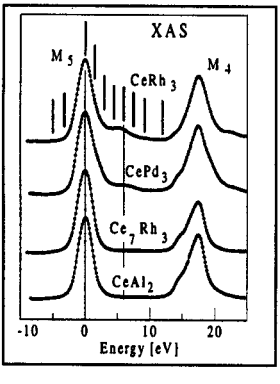
Report:

Aim of the experiment

The aim of the experiment was a first exploration, in different Ce intermetallics, of the behaviour of Ce resonant Raman scattering with M_5 excitation and $4p$ final hole. The process is $3d^{10}4f^n \rightarrow 3d^9 4f^{n+1} \rightarrow 3d^{10}4f^{n+1}4p^5$ in a simplified notation where n is the $4f$ occupation in the ground state and the final state configuration interaction (CI) with the $4d^8 4f^{n+2}$ is neglected. We will call this process $4p$-RRS [1]. The experiment was motivated by an hint we obtained previously in the comparison between a γ-like i.e. a poorly hybridised system (Ce_7Rh_3) and an α-like compound i.e. a strongly hybridised system ($CeRh_2$). We noticed that the $4p$-RRS spectra with excitation in the satellite about 6 eV above M_5 are sensitive to the change from γ to α-like systems. This motivated a general assessment of this effect by exploring the $4p$-RRS in a variety of Ce compounds ranging from α to γ-like and with a variety of excitation energies in each compound. This work has been done in the present experiment.



Results and Discussion

We have measured the $4p$-RRS in the following samples going from more α-like to more γ-like: $CeRh_3$, $CeNi_2$, $CePd_3$, Ce_7Rh_3 and $CeAl_2$. For space reasons we report only a selection of the data which is sufficient to show the main conclusions.

The $M_{4,5}$ absorption curves (XAS) are reported in figure 1, where the vertical bars indicate the excitation energies used in the Raman experiment. The broad bandwidth used for the XAS of figure 1 and for all the $4p$-RRS was dictated by the need of having a reasonable counting rate in the emission spectra. In figure 2 we give a set of 4p-RRS spectra in the

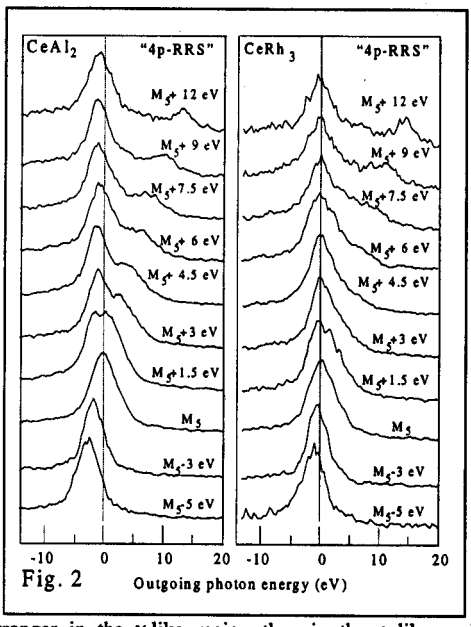


Fig. 2

two extreme cases of $CeAl_2$ and $CeRh_3$. The results show the following points supported also by the 4p-spectra of the other compounds.

- The behaviour of α-like and γ-like systems is very similar in the M_5 region from below threshold to about 2 eV above threshold. The same happens also with excitation far above threshold (typically 12 eV).
- A clear difference is seen when the excitation is between about 3 eV and 7 eV above M_5 i.e. in the satellite region of the α-like XAS. This is probably due to the spread of the multiplet splitting, at this excitation, in strongly hybridised systems. Thus we arrive to the new conclusion that this is a general behaviour and that only this excitation energy range is useful to distinguish between systems having different ground state properties.

With the excitation energy in the 6 eV satellite an even more interesting result has been obtained in the comparison between the different compounds. This is shown in Fig 3 where four compounds are compared. The sensitivity of the 4*p*-RRS spectra to the change of the 4*f* population is considerably stronger in the γ-like region than in the α-like region of the parameters space. In fact the 4*p*-RRS distinguishes rather well between two γ-like compounds (Ce_7Rh_3) and $CeAl_2$ whereas the difference is very small in other bulk sensitive spectroscopies such as XAS. In this case the 4*p*-RRS acts as an "amplifier" of the effect of tiny changes of the 4*f* occupation in the region just below unity. This is a theoretically challenging result that candidates the 4*p*-RRS as a new bulk sensitive tool in the study of poorly hybridised Ce systems.

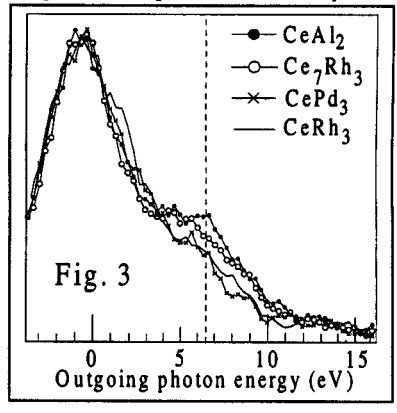


Fig. 3

References

[1] A. Tagliaferri *et al.*, Phys. Rev. **B60**, 5728 (1999).