



**Experiment title:** Spectroscopic studies of occupied valence states of magnetic 3d impurities in Co and Ni by means of resonantly excited emission dichroism.

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#### Report:

The experiment was based on the measure the energy distribution of the valence fluorescence from 3d magnetic Transition Metal (TM) impurities in magnetic TMs with dichroic excitation at grazing incidence. The aim was to see the signature of the difference in the energy distributions of the Mn majority and minority spin distributions using a method which was applied here for the first time to an impurity problem. This is an information which can hardly be recovered with other electron spectroscopies.

Among the various possibilities we have concentrated our work on Mn dilute in Ni (1.2 % atomic concentration). This is a convenient case because Mn has a strong magnetic moment in this system ( $3 \mu_B$ ) and because the calculations of Ref (2) show a marked peak near the Fermi level in the Mn majority which is typical of the interaction with Ni and which has never been observed.

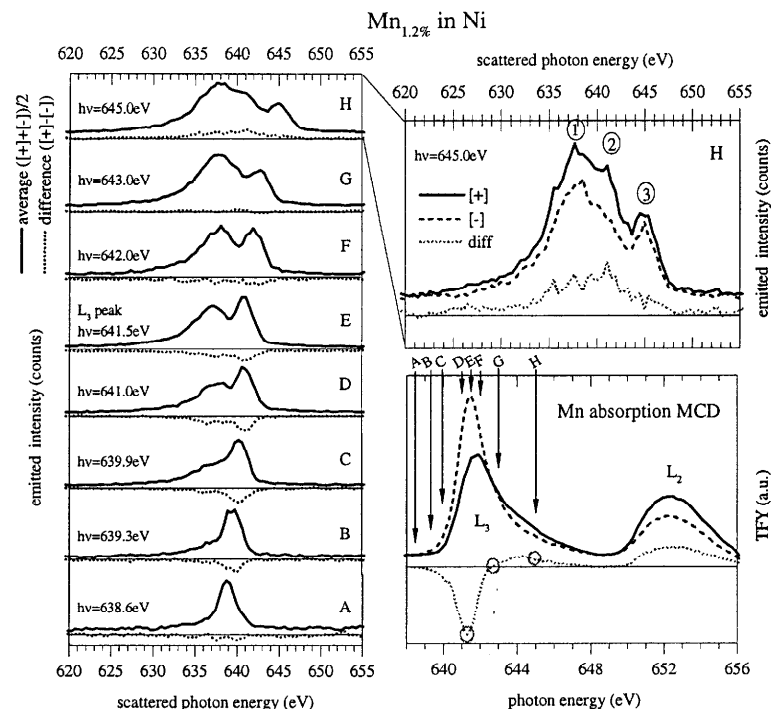
We have investigated many excitation energies along the absorption curve in the  $L_{2,3}$  region where a strong absorption dichroism (MCD) is seen, as expected (see the Figure). This has been done to identify the fluorescence and the elastic scattering contributions which are superimposed.

A selection of raw data is given by the stack of the Figure where the average spectrum and the emission dichroism are given with the excitations energy shown by the labelled arrows along the absorption curve. As it is known (1) these measurements contain a strong effect due to the absorption dichroism so that some data treatment is needed to point out the effect due to the occupied valence states. It is interesting that *already from the raw data the effect of the occupied states is seen qualitatively*. The argument is the following:

- The emission dichroism follows the trend of the absorption dichroism (XAS-MCD): it has the same sign and it is zero at the excitation G where the XAS-MCD is zero (crossing between the two absorption curves). However the emission dichroism with the excitations H (2 eV above the inversion point) and E (2 eV below i.e. at the  $L_3$  peak) are almost equal in absolute value while the XAS-MCD is much stronger in the second case. In the absorption dichroism curve these three points are marked with circles.

- Thus the integrated dichroism of the valence fluorescence is distorted with respect to the absorption dichroism i.e. it does not just trivially follow the absorption dichroism. This is due to the competition with the effect of the valence occupied states contributing to the emission.

- The spectral distribution of this effect is better seen with the excitation H since in this case one can separate safely the elastic peak which is at higher photon energies. In the expanded figure of the case H we report the fluorescence spectra excited with opposite **helicities** and the fluorescence dichroism. The feature number 3 is the elastic peak and the Fermi level is around the minimum at 643 eV below the elastic peak.



The two fluorescence spectra have different shape and the difference near the Fermi level is due to the feature number 2 which is reminiscent of the spin distributions calculated by Zeller et al (2).

In conclusion the experiment has reached two goals:

- a new specific information on the occupied valence states of Mn impurities in Ni
- the demonstration of the possibilities given by this method in the impurity case.

The above argument has to be refined by a complete data treatment which will be done in the next few months. The final discussion should also include the effect of the core hole which has been neglected in the approximate argument given here.

#### References

1. L.-C. Duda et al. Phys. Rev. B50, 16758 (1984)
2. R. Zeller, J. Phys. F17, 2123 (1987) and ref. quoted therein.