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Spin Sensitive Fermi Level Mapping by Angle-Resolved Photoelectron Spectroscopy with Variable Polarization Synchrotron Light

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Introduction

New Approach:

the polarisation dependence of core level photoemission spectra gives a direct access to the local properties of ferromagnets.

New Experimental Tool:

Spin resolution of energy and momentum selected photoelectrons (by adding Mott scattering to PES) allows for the direct measurement of the polarisation of magnetic systems.

But: the interpretation of the spin-polarised angular maps of valence band photoemission is complex and measuring spin polarisation by Mott scattering is inefficient, with counting times are a factor 1000 longer than spin integrated maps.

Motivation

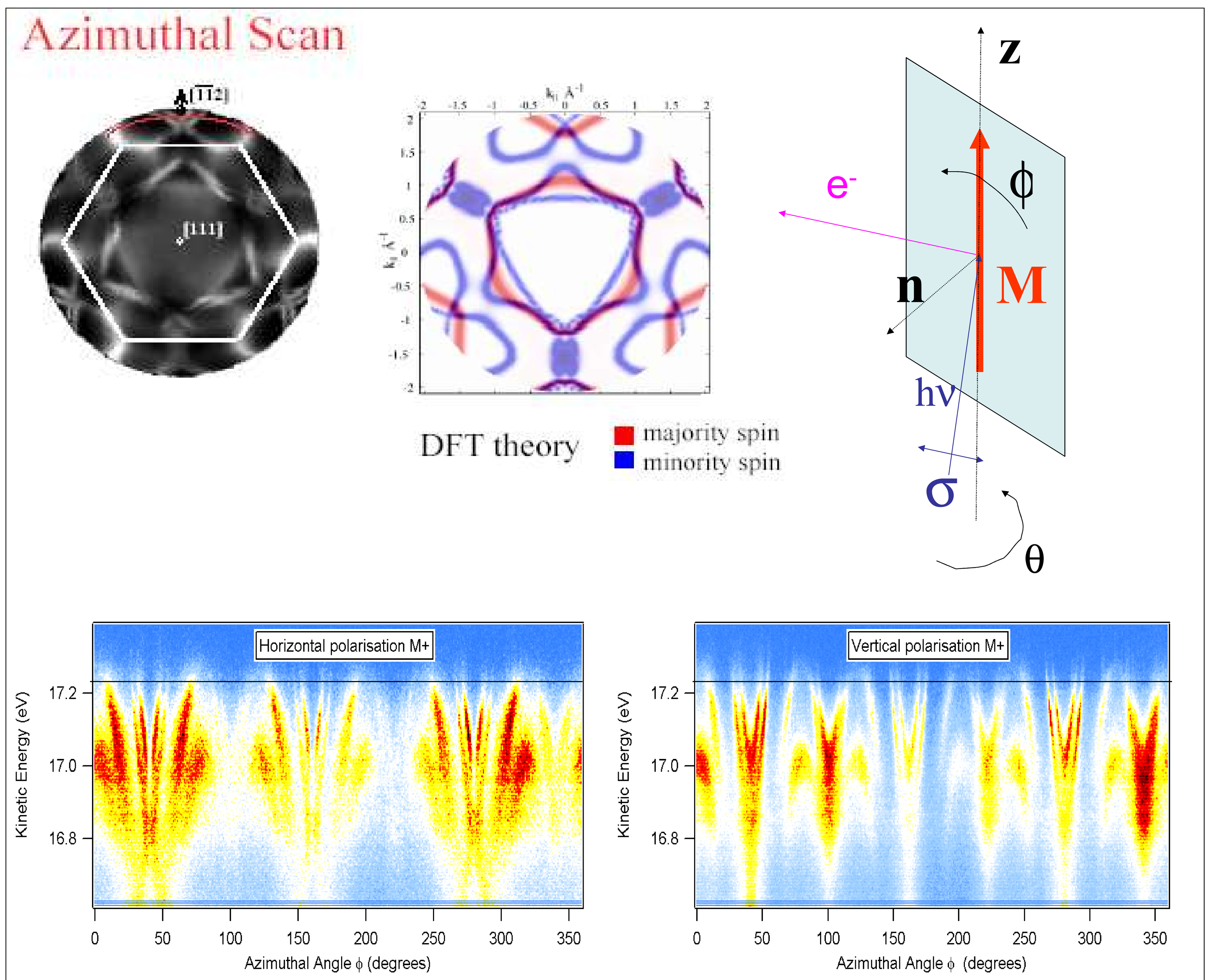
alternatively, if a polarization-tuneable source is available one can measure photon-spin dependent photoemission maps that bear information on the initial state spin polarisation of band states.

Experimental

System: Ni(111), it shows *sp* apin-split states in angular photoemission maps. The spin-up and spin-down sensitivity of the technique can be tested by mapping these states.

Technique: angle and energy resolved photoemission with polarised X-rays in chiral geometries, i.e. mantaining a non-coplanar geometry for the magnetisation, the light polarisation and the electron momentum vectors. Under a change of chirality the angular distribution of the photoelectron changes in such a way that electrons spin polarisation contrast is gained.

Azimuthal scans have been measured at 21.5eV and 30eV, with the different light polarisation from the APE-LE undulator: linearly (horizontal and vertical) as well as right and left-handed circularly polarised radiation. The magnetisation direction was also reversed along the (-1,-1,2) crystal axis.

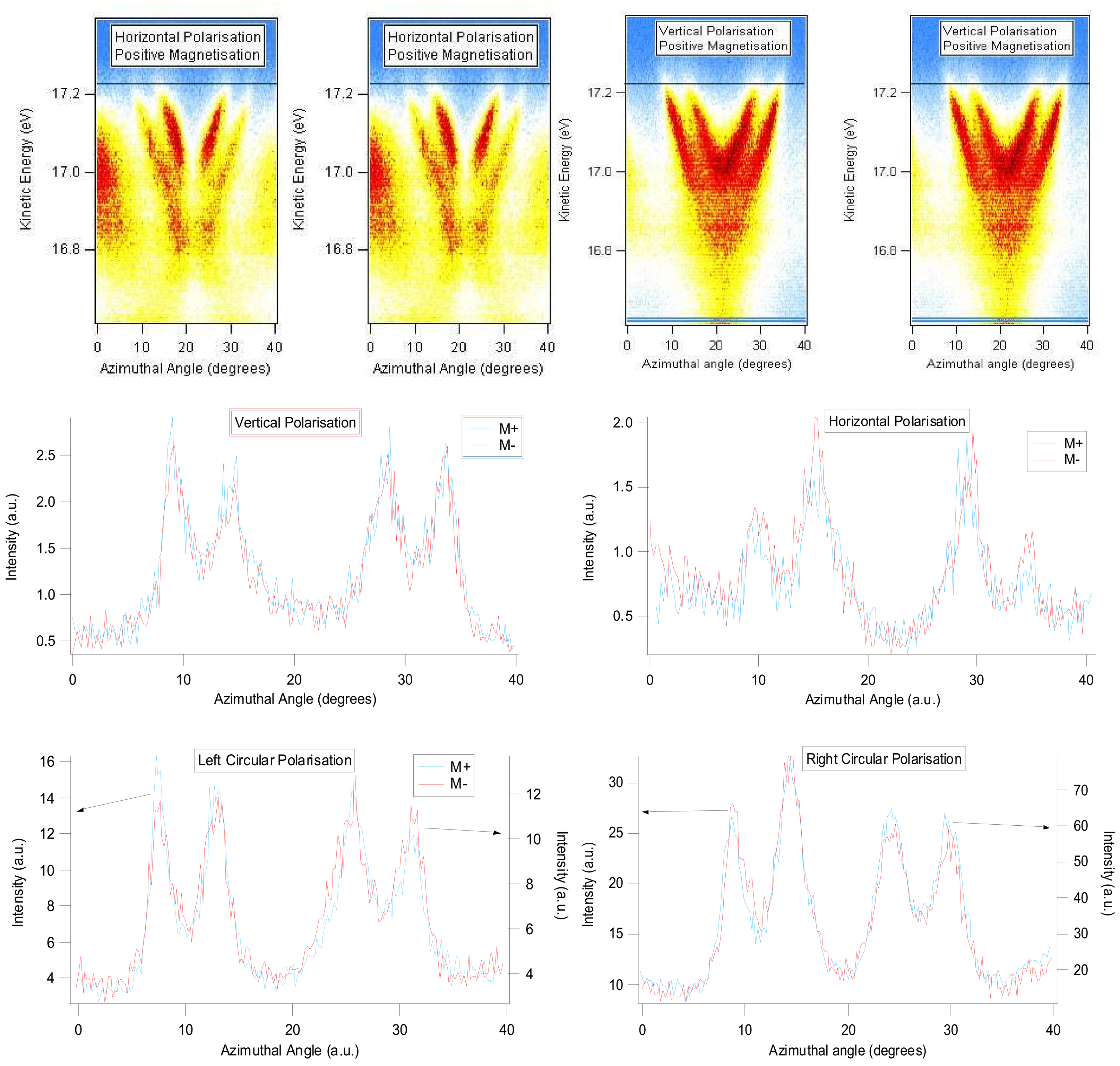


Large polarisation effects from initial states of different parity. The *d* bands are more intense in the horizontal polarisation scan, while the analysis of the *sp* states is more complex due to the interplay of symmetry and spin splitting.

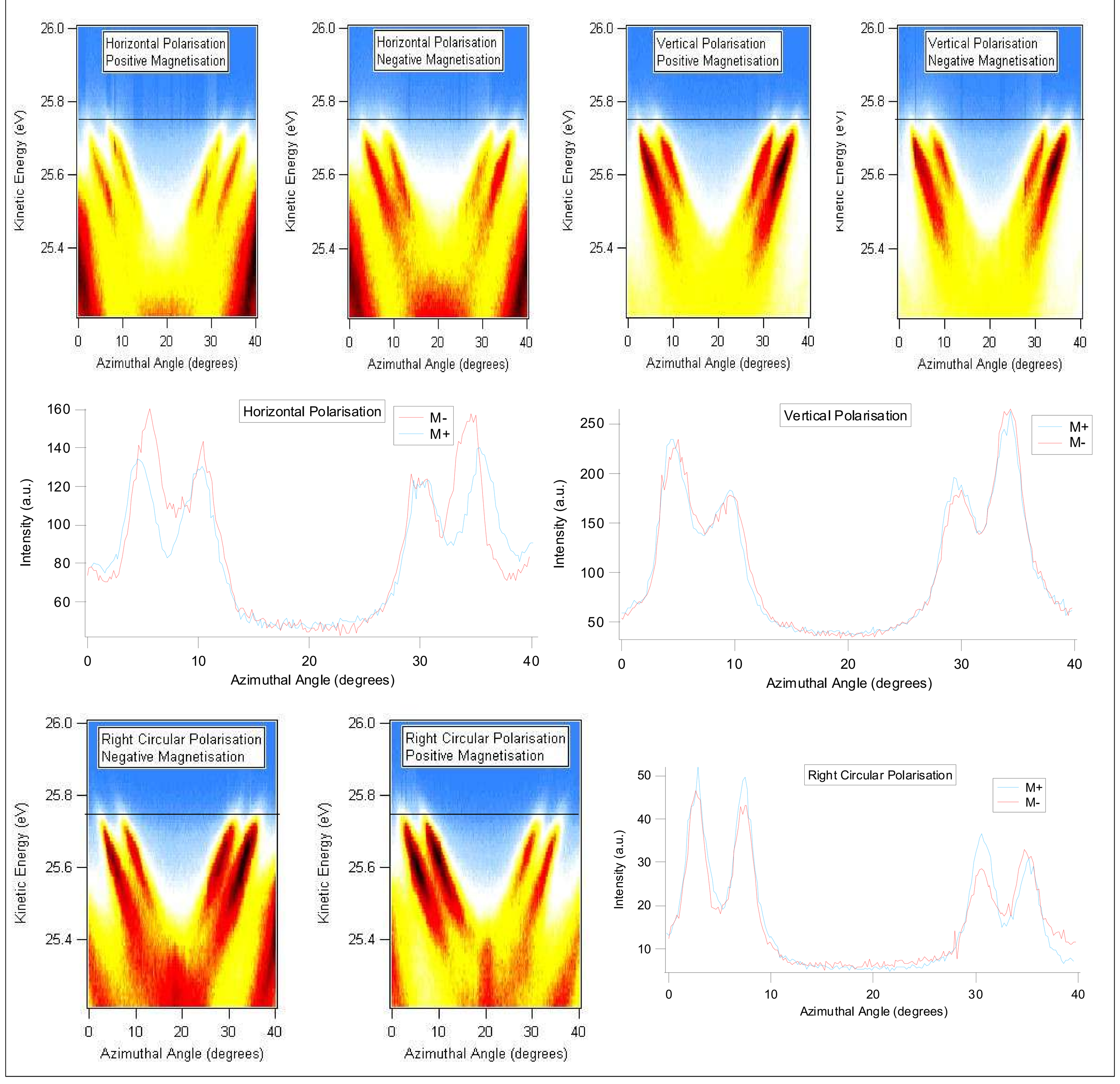
Analysis

A change in the magnetisation direction causes a change in the angular distribution of the electrons → line profiles for kinetic energies near the Fermi level.

Scans at hν=21.5eV



Scans at hν=30eV



Conclusions and Future Perspectives

At hν=21.5eV the linear dichroism very faint, while the circular is well evident. At hν=30eV the circular dichroism is stronger and also differences in the vertical polarisation spectra are clearer. **The technique is definitively capable to resolve spin-up and spin-down states and can then be considered complementary to the measurement of the photoelectron spin.** Follow-up experiments, will explore photon energy dependence of dichroism in extended states. Photoemission spectra calculations by layer-KKR method are being attempted with the aim of deepening the understanding of the mapped intensities.