Magnetic Spectroscopy with Soft X Rays

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X-ray magnetic dichroism is ideally suited to study correlated materials, since the electric-dipole (and -quadrupole) transitions excite a core electron into the empty valence state, which make the spectra sensitive to the local symmetry and electronic bonding. The polarized XAS spectra of correlated materials can be calculated using multiplet theory, where the spin-orbit interaction and the electrostatic Coulomb and exchange interactions are put on an equal footing using intermediate coupling. Describing the wave functions of the initial- and final-state configurations using an Anderson impurity-like approach provides a natural framework for electron-correlation and hybridization effects, directly providing the effective parameters from a simulation of the spectra.

Magnetic X-ray dichroism [1] has grown out to become a powerful technique for element-specific magnetometry, which was large aided by the postulation of the spin and orbital moment sum rules for X-ray magnetic circular dichroism (XMCD). The latter has been particularly beneficial to investigate the magnetic anisotropy in thin films and multilayers.

While most applications have been in solid-state physics and technology, over the last decade or so, the field of research has broadened considerably. New applications have emerged in areas such as chemistry, biology, and earth sciences. [2] For instance, in environmental sciences and microbiotechnology, XMCD has become a unique and powerful technique to determine the relative site occupations in (bio)spinels and other ternary oxides.

The presentation will start with a simple introduction into soft x-ray spectroscopy, highlighting the advantages of the techniques. Severale specific examples of magnetically doped topological insulator are discussed.

References

[1] B.T. Thole, G. van der Laan and G.A. Sawatzky, *Strong magnetic dichroism predicted in the $M_{4,5}$ X-ray absorption spectra of magnetic rare earth materials*, Phys. Rev. Lett. **55**, 2086 (1985). DOI: 10.1103/PhysRevLett.55.2086.

[2] G. van der Laan and A.I. Figueroa, *X-ray magnetic circular dichroism - a versatile tool to study magnetism*, Coord. Chem. Rev. **277-278**, 95-129 (2014). DOI: 10.1016/j.ccr.2014.03.018.