X-ray Magnetic Circular Dichroism detected by Resonant Inelastic X-ray Scattering: a *2D photon-in, photon-out* magnetic spectroscopy

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ABSTRACT

XMCD is a powerful, well-established tool, for the element-specific study of the magnetic structure of complex systems. At absorption edges split by spin-orbit coupling (such as $L_{2,3}$ edges), it enables us the determination of the spin and orbital magnetic moments by means of sum rules. The magnetic moments of *3d* transition metal ions are generally studied at the $L_{2,3}$ absorption edges using soft X-rays whose short penetration depth limits the number of possible applications, such as high pressure studies. X-rays are used at the *K* edge but the very weak XMCD signal and the absence of spin-orbit split edges do not allow for a detailed quantitative interpretation. Recently, we have developed a novel approach, which consists in coupling XMCD and RIXS spectroscopies at the *K* edge of *3d* ions.[1] In particular, we have focused on *1s2p* RIXS at the *K* pre-edge ($1s^2\ 2p^6\ 3d^N \rightarrow 1s^1\ 2p^6\ 3d^{N+1} \rightarrow 1s^2\ 2p^5\ 3d^{N+1}$). We have shown that the RIXS-MCD signal measured at room temperature at the Fe *K* pre-edge in Fe oxides such as magnetite Fe_3O_4 and YIG is of the same order of magnitude as $L_{2,3}$-edge XMCD.

In this talk we will discuss the possibilities offered by the combination of RIXS and XMCD, in particular using hard x-rays, from both experimental and theoretical aspects. RIXS-MCD has been used to investigate systems for which the use of soft x-rays is rather challenging: thin magnetic multilayers, bimagnetic core-shell particles.[2,3] From the theoretical point of view, it is not yet fully clear whether the use of RIXS-MCD can provide similar (and possibly additional) information as compared to $L_{2,3}$ XMCD. As a first step to address this question, we have derived a general, coordinateless spherical tensor form of the RIXS cross-section, without any approximation.[4] Some special cases will illustrate the ability of this expression to (i) disentangle the properties of the sample from those of the measurement, and (ii) determine specific experimental arrangements aiming at the observation of specific properties.

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