Strong K-edge Magnetic Circular Dichroism detected by Resonant Inelastic X-ray Scattering

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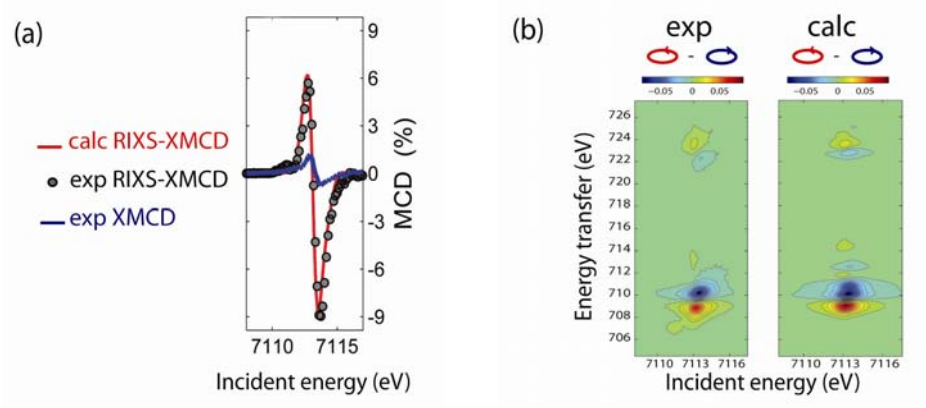
X-ray magnetic circular dichroism (XMCD) is a powerful tool for the element-specific study of the magnetic structure of complex systems.[1] It enables at spin-orbit split absorption edges to determine spin and orbital magnetic moments by means of sum rules.[2] The magnetic moments of *3d* transition metals (TM) are generally studied at the $L_{2,3}$ absorption edges using soft X-rays whose short penetration depth limits the number of possible applications. Hard 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.
We show that XMCD combined with resonant inelastic scattering (RIXS) of hard X-rays at the K pre-edge of Fe in magnetite yields a dichroic signal that is of the same order of magnitude as L-edge XMCD (Fig.a). Crystal field multiplet calculations are in good agreement with experiment (Fig.b) and revealed that the effect arises from intraatomic *2p-3d* Coulomb repulsions, *2p* and 3*d* spin-orbit coupling. A strong MCD effect in the hard X-ray range opens new opportunities for earth sciences and condensed matter physics, allowing for truly bulk sensitive, element- and site-selective measurements of *3d* TM magnetic moments and their ordering under demanding sample environments such as high pressure cells.[3]



(a) Comparison between XMCD and RIXS-XMCD at the Fe K pre edge in Fe_3O_4.
(b) Comparison between experimental and theoretical RIXS-XMCD.

References

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