Magnetic Circular Dichroism effects in the Resonant Inelastic X-ray Scattering at the K (pre) edge of *3d* transition metal ions: an outlook

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Transition metal elements play an essential role in physics (magnetic materials, superconductors), chemistry (catalysis) and geophysics (*3d* elements are major constituents of the Earth and planets). Properties such as magnetism, catalytic activity and optical absorption are governed by the *3d* orbitals, which can be probed by X-ray spectroscopies at the K pre-edge (*1s* → *3d +4p* transitions), such as X-ray Natural Linear Dichroism, Resonant Inelastic X-ray Scattering and X-ray Magnetic Circular Dichroism. Compared with the $L_{2,3}$ edges (2*p* → *3d* transitions), the smaller interaction between the core-hole and the *3d* orbitals enables to make a more direct connection to the ground state properties. However, XMCD effects are very small, due to the absence of spin-orbit coupling in *1s* core-hole. This drawback has so far hampered the interpretation of XMCD at the K-edge.

Here, I will present results obtained on Cr-containing oxides with K pre-edge spectroscopies performed at ID26 beamline. The XNLD has been recorded on a single crystal of $MgAl_2O_4$:$Cr^{3+,}$ and a theoretical approach combining monoelectronic and multielectronic methods has enabled us to fully interpret the dichroic signature of Cr^{3+}. Crystal field excitations (*3d*-*3d* transitions) have been measured with RIXS on $MgCr_2O_4$, with an energy resolution of 0.6 eV.

Finally, our project to couple XMCD and RIXS spectroscopies at the K edge of *3d* ions will be discussed. Preliminary calculations performed on CoO in the multiplet approach show that large XMCD effects are visible, both in the 1s*3p* RIXS (Kβ fluorescence) and also directly in the pre-edge structure when measured with a high-resolution fluorescence detector. These theoretical simulations suggest that RIXS-MCD could be used in the future to measure magnetic polarization of the *3d* orbitals, with bulk sensitivity, high energy resolution, and the possibility to study samples in demanding environments such as high-pressure cells.