X-ray magnetic circular dichroism spectroscopy of size selected cluster ions: From spin coupling and orbital quenching to magnetic phase transitions

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X-ray spectroscopy of size-selected atomic, molecular, and cluster ions is challenging because of ultralow target densities. A viable approach is to perform X-ray spectroscopy in ion trap experiments [1–5] with sensitivity in the femtomol or 10^{-6} monolayer equivalent range.

To study spin and orbital contributions to magnetic moments of size-selected ions via X-ray magnetic circular dichroism (XMCD) spectroscopy, we have upgraded our linear ion trap setup [1–5] with liquid helium cooling and a 5 T magnetic field. This setup allows us to explore magnetic coupling of model systems in the molecular limit, where we could demonstrate ferromagnetically coupled local high spin states in the archetypical bulk antiferromagnets chromium and manganese. Vice versa, we observed antiferromagnetic alignment of the central atom to the outer shell in iron, the archetypical bulk ferromagnet. In small iron clusters, we also followed the rapid quenching of the orbital magnetic moment [6].

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