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Soft X-ray Spectroscopy of Magnetic Nanostructures: New Phenomena and Applications[1]

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The delicate balance between charge, spin, orbital, and lattice degrees of freedom in transition metal oxides leads to unique phenomena such as colossal magnetoresistance, high temperature superconductivity, as well as a remarkable diversity of charge, spin, and orbital ordered phases. The rich phase diagrams are determined by the strong local interaction of electrons in transition metal d orbitals. Subtle changes in d occupancy and overlap—and thereby phase transitions—can be induced by variations in temperature, by external fields, through doping and lattice distortions. In particular, interfaces can hold surprising electronic and magnetic properties that differ remarkably from the adjacent layers. Soft x-ray based techniques are ideal tools to study these systems as they are inherently element-specific, allow characterizing the valence state and the symmetry of lattice sites and provide detailed information about the electronic and magnetic structure with nanometer spatial resolution and on ultrafast time scales. Here we show that the to-date little explored angular dependence of the x-ray magnetic dichroism provides unique insights in the correlation between atomic, magnetic and electronic structure in these systems [1-4]. Taking advantage of this approach will prove invaluable for the engineering of novel nanoarchitectures to be used in low cost and energy efficient devices with improved performance and multiple functionalities.

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