Resonant x-ray scattering studies on nickel and copper oxides

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In this talk, I will illustrate my research on transition metal oxides by using resonant scattering techniques. I will start describing our work on the spin ordering in rare-earth nickelates studied by a novel developed soft x-rays nano-probe. We developed a tunable nanobeam to map out the reciprocal space fingerprints of magnetism with a nanoscopic real space resolution. We uncovered the presence of magnetic inhomogeneity and the unconventional distribution of the magnetic texture in $NdNiO_3$ resembling a fractal distribution. These results cast new light on the granular nature of the electronic and magnetic texture of correlated materials whose ground state is characterized by the existence of multiple competing orders.

I will move on to resonant inelastic x-ray scattering studies on T'-cuprates where superconductivity is achieved by oxygen annealing. Resonant inelastic X-ray scattering (RIXS) has recently risen to become a versatile probe of elementary bosonic excitations in strongly correlated electron systems. However, various excitations of different nature (charge, spin, and orbital) are widely entangled in RIXS spectral axis, often complicating its interpretation. I will show a systematic method for the extraction of the character of excitations as imprinted in the azimuthal dependence of the RIXS signal. Using this novel approach, we resolve the charge, spin, and orbital nature of elastic scattering, (para-)magnon/bimagnon modes, and higher energy dd excitations in magnetically-ordered and superconducting copper-oxide perovskites (Nd_2CuO_4 and $YBa_2Cu_3O_{6.75}$). In particular, we use the characteristic tensorial nature of each excitation to precisely and reliably disentangle the charge and spin contributions to the low energy RIXS spectrum. This procedure enables to separately track the evolution of spin and charge spectral distributions in cuprates with doping. Using this procedure, we observe a hardening of the spin waves and the enhancement of charge excitations in the superconducting phase. Remarkably, the hardening of the low energy excitations is strongly anisotropic, and a spectral weight redistribution between the antinodal and nodal directions is observed bringing important information on the dynamics of the superconducting state. The evolution of the low energy dynamics is then discussed in comparison with other cuprates as well as Fe-based superconductors.