Lattice control of charge and spin-orbital dynamics in distorted perovskite iridates

Unraveling the relationship between entangled electronic degrees of freedom is central to understanding correlated materials, as well as unlocking the possibility to materialize them into next-generation devices featuring novel functionalities. In the enclosed presentation, I will focus on the spin-orbit-coupled Ruddlesden-Popper iridate $Sr_{n+1}Ir_nO_{3n+1}$ of n =1 (Sr_2IrO_4). This family compounds exhibit a ground state that is highly sensitive to the nuances of the local lattice structures, demonstrating high potential for direct control of the functional properties by introducing local lattice distortions. We employ epitaxial strain to tune the Ir–O bond geometry in Sr_2IrO_4, and monitor the low-energy elementary excitations using momentum-dependent resonant inelastic X-ray scattering (RIXS). At the Ir metal and O ligand site, we observe pseudospin-wave and electron-hole pair excitations, respectively, to undergo dramatic renormalization in dispersions and mode energies. This overall behavior entails the intimate coupling between the spin/charge excitations to the lattice distortions, which we ascribe to be originated from modified electronic hopping. Lastly, I will cover the extension case to an interesting limit for Ruddlesden-Popper iridate $Sr_{n+1}Ir_nO_{3n+1}$, with n approaching infinity ($SrIrO_3$). We employ dimensional confinement via $SrIrO_3/SrTiO_3$ heterostructure configuration, and systematically vary the respective iridate/titanate thickness that was reported to show distinct metallicity. The observed pseudospin-wave and spin-orbital excitations, as well as the implications to their spectral developments with confinement tuning, is discussed here.