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Understanding how strain engineering shapes spin-orbital interactions and charge gap in Sr2IrO4 by Resonant Inelastic X-Ray Scattering

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Understanding the relationship between entangled degrees of freedom (DOF) is a central problem in correlated quantum materials and the possibility to influence their balance is promising toward realizing novel functionalities. In the single-layer iridate Sr2IrO4, the interaction between spin–orbit coupling and electron correlations induces an exotic ground state with magnetotransport properties promising for antiferromagnetic spintronics applications. Moreover, the coupling between orbital and spin DOF renders the magnetic structure sensitive to the Ir–O bond environment. We use strain engineering to perturb the local lattice environment and, by tracking the response of the low-energy elementary excitations by Resonant Inelastic X-Ray Scattering (RIXS), we unveil the response of the microscopic spin and charge interactions. By applying tensile strain, we observe a large softening of the spin(-orbital) wave dispersion along the [h,0] direction and a simultaneous hardening along the [h,h] direction. This evolution entails a strain-driven crossover from anisotropic to isotropic interactions between the magnetic moments. We also show how the charge excitations are coupled to the lattice in Sr2IrO4. We unveil the evolution of a dispersive electron-hole pair excitonic mode which shifts to lower (higher) energies upon compressive (tensile) strain, manifesting a reduction (increase) in the size of the charge gap.1

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