

# Resonant Inelastic X-ray Scattering Study of Excitations in Cuprate Superconductors

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The mechanism of high- $T_c$  superconductivity in cuprates remains an unsolved question since its discovery in 1986. Answering the question of its microscopic origin turns out to be a great challenge, complexity arises from the coexistence of several phases along with the superconductivity. Although electron-phonon coupling may not be the main origin of the Cooper pairing, its role across the phase diagram is still controversial, particularly in the under-doped region [1-3]. A direct way to probe the electron-phonon coupling has emerged thanks to the recent progress made in high resolution Resonant inelastic X-ray scattering (RIXS), which now allows to resolve phonons [4]. Theoretical studies suggested that the RIXS phonon cross-section directly reflects the momentum-dependent electron-phonon coupling strength [5,6]. In this talk, we will focus on the dynamical properties of the under-doped cuprate  $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ . Low energy excitations were investigated using RIXS at the Cu  $L_3$ -edge with an energy resolution of 40–45 meV [4]. In the quasi-elastic region, an incommensurate charge density wave (CDW) was observed in this system, confirming its existence in this compound. In addition, this RIXS study resolved the bond-stretching phonon in the energy-momentum space. Importantly, it also revealed that the phonon dispersion changes at the CDW wave-vector indicating that the CDW unambiguously affects the lattice. RIXS measurements on another superconducting cuprate,  $\text{Ca}_{2-x}\text{Na}_x\text{CuO}_2\text{Cl}_2$ , will be also discussed.

## References

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