

## RIXS study of Sr<sub>2</sub>CuO<sub>2</sub>Cl<sub>2</sub> at the mixed resonance

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Detailed measurements of the charge-transfer excitations in the 1-10eV range were performed on the model cuprate system Sr<sub>2</sub>CuO<sub>2</sub>Cl<sub>2</sub> (SCOC) using resonant inelastic X-ray scattering (RIXS). The momentum dependence, the scattering geometry dependence, and the incident energy dependence were investigated.

Keywords : Sr<sub>2</sub>CuO<sub>2</sub>Cl<sub>2</sub>, RIXS, charge-transfer, x-ray, momentum-resolved, polarization

### 1. Purpose

The identification and characterization of electronic excitations in the parent compounds of high-temperature superconductors is an important task. The charge-transfer excitations in the 1-5eV range can inform us on the nature of the strong electronic correlations and the physics of the Mott-Hubbard gap  $U$  and the inter-site hopping parameter  $t$ . RIXS, since the early days of its development, has studied these excitations with great successes [1] but the nature of the observed excitations and their behavior is still a controversial matter. In the present study, we targeted specifically the charge-transfer excitation of a model 2D undoped cuprate, SCOC, and studied their momentum, scattering geometry, and incident energy dependence.

### 2. Method

To establish the resonance profile of this system, we measured complete incident energy dependence over both the in-plane and the out-of-plane resonances on a fine grid. At the most intense feature, we measured detailed momentum dependence and constructed a dispersion diagram along the high-symmetry directions of the Brillouin zone. To study the internal details of the RIXS cross-section but also of the measured excitations, we look into scattering geometry dependence, i.e. the combined effects of incident photon and outgoing photon polarization.

### 3. Result

This study yielded important information on the nature and the dispersion of the charge-transfer gap in this undoped model cuprate. The incident energy dependence uncover an interesting and previously mislabeled resonance which is currently under close study to determine its nature and better understand previous experiments done in this special condition. Labeled the "mixed resonance", it appears as high intensity in the low energy-loss region in between the well-screened state of in-plane polarization and the poorly-screened state of out-of-plane polarization. The scattering geometry dependence provides interesting information on the nature of cross-sectional effects expected from the RIXS cross-section and will be an important part of our research in that direction.

### 4. Conclusion

The momentum dependent study of charge-transferred excitations in the undoped high-temperature superconductor parent compound SCOC has revealed interesting low-energy transfer physics as well as provided with a much needed independent and complementary measurement of a dispersion diagram. The scattering geometry dependence supports the conventional 4p-as-spectator approach to the photo-electron but also highlights its shortcomings.

### 5. Reference

[1] L. Lu, J. N. Hancock, G. Chabot-Couture, O. P. Vajk, G. Yu, K. Ishii, J. Mizuki, D. Casa, T. Gog, M. Greven, Phys. Rev. B **74**, 224509 (2006)