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ARPES and IPES Studies for the Electronic Structure Derived by Quantum Charge Fluctuations on the Single-layer Cuprate Superconductor

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To understand how the degrees of freedom in a solid (phonons, electron spins, orbitals, and charges) affect the electronic structure is essential for elucidating the microscopic mechanism behind the high superconducting transition temperature (T_c) in high-temperature superconductors. According to the previous studies by angle-resolved photoemission spectroscopy (ARPES), the electronic structure shows a kink in a band dispersion due to coupling with phonon and/or spin fluctuations [1, 2]. On the other hand, in recent resonant inelastic X-ray scattering (RIXS) studies, charge excitations have been observed in both hole-doped and electron-doped cuprates [4, 5]. However, direct experimental evidence how charge fluctuations affect the electronic structure for the high-T_c cuprates have been unclear so far.

In this study, we have performed an ARPES and an inverse photoemission spectroscopy (IPES) to directly observe the electronic structure in the occupied and unoccupied electronic states, respectively, of the single-layer copper oxide superconductor, $Bi_2Sr_{1.6}La_{0.4}CuO_{6+\delta}$ (Bi2201). If there is a contribution to the electronic structure from charge fluctuations, the experimental evidence could provide new key information into their role to the mechanism of superconductivity.

The ARPES and IPES results are shown in Figures 1 (left) and 1(right), respectively, and they reveal the electronic structure in both occupied and unoccupied energy regions. Notably, in the unoccupied states, we found that the structure exists around 1 eV and this result differs from the prediction of the density functional theory [6]. We believe that the present experimental results indicate that the structure above E_F around 1 eV is due to quantum charge fluctuations.

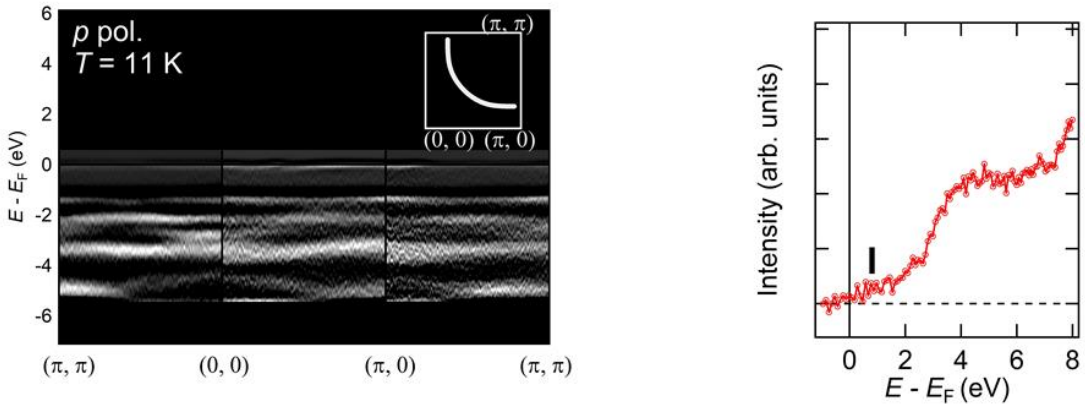

FIGURE 1. ARPES and IPES spectra for Bi2212. (Left) Intensity map of the first Brillouin zone of Bi2201 measured 21 eV. (Right**)** The IPES spectra observed in the unoccupied states of Bi2201at a certain momentum. Weak intensity is observed at the positions shown by a black bar.

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