

光電子および中性子分光の相補的利用による高温超伝導体の研究

Cooperative photoemission and neutron spectroscopy study of high-temperature superconductors

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We have performed cooperative photoemission and neutron scattering experiments on cuprate high- T_c superconductors to study the low-energy excitation responsible for and/or relevant to the mechanism of superconductivity.

We have experimentally determined the full energy dispersion and the coherence factors of the Bogoliubov quasiparticles in $\text{Bi}_2\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_{10}$ (Fig. 1) by angle-resolved photoemission spectroscopy (ARPES). The results show a good quantitative agreement with the prediction from the BCS theory. This proves the basic validity of the BCS theory in the wide meaning to describe the high- T_c superconductivity. We have experimentally identified two different bosonic modes in Bi-system high- T_c superconductors. One produces the “small” kink in the limited momentum region around the node, and another is related to the “large” kink which exists in a relatively wide momentum region with the stronger magnitude closer to the $(\pi, 0)$ point. The observed momentum and temperature dependence of the kinks as well as the impurity effect show that the large kink is of magnetic origin and closely related to the high- T_c superconductivity, while the small kink around the node has no direct correlation to the superconductivity.

We have also performed systematic neutron scattering experiments on both hole- and electron-doped high- T_c cuprates to search for the generic feature of spin excitations which could play an important role for the superconductivity. Particularly, in a wide momentum and energy space pulsed neutron scattering experiments revealed a new aspect. The observed spin excitation spectrum in the hole-doped $\text{La}_{2-x}\text{Ba}_x\text{CuO}_4$ ($x \sim 1/8$) shows an interesting dispersion relation (Fig.2), which is similar to that of $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$. The energy range at around 50meV approximately corresponds to the energy scale of so-called kink anomaly observed in ARPES measurement.

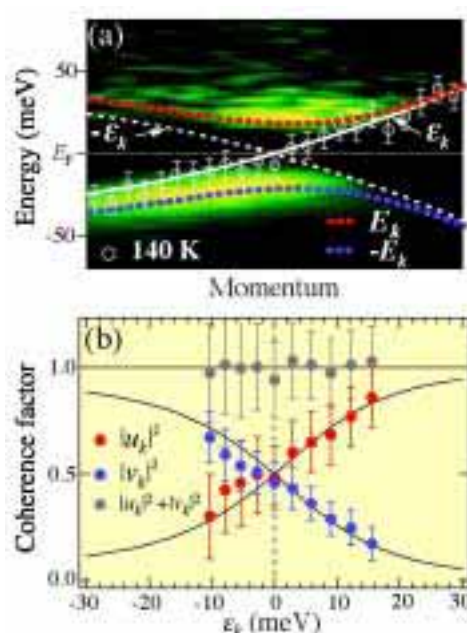


Fig. 1 (a) Band dispersion of Bogoliubov quasiparticles and (b) coherence factors determined by ARPES

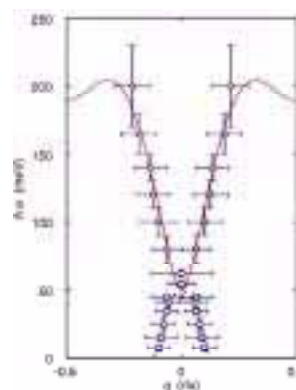


Fig. 2 Spin excitation spectrum in $\text{La}_{2-x}\text{Ba}_x\text{CuO}_4$ ($x \sim 1/8$)