Evidence for two energy scales in the superconducting state of optimally doped (Bi,Pb)$_2$(Sr,La)$_2$CuO$_{6+\delta}$

TAKESHI KONDO, TSUNEHIRO TAKEUCHI, SYUNSuke TSUDA, SHIK SHIN, ADAM KAMINSKI, Ames Lab. and Dept. of Physics and Astronomy, Iowa State University — We use angle-resolved photoemission spectroscopy (ARPES) to investigate the properties of energy gap(s) in the optimally doped (Bi,Pb)$_2$(Sr,La)$_2$CuO$_{6+\delta}$ (Bi2201). We find significant differences in the momentum- and temperature- dependence of the pseudogap and superconducting gap suggesting that these gaps have two separate energy scales.

The ARPES spectra slightly off the node have a sharp peak with a small gap below $T_c$, which closes at $T_c$. Around the antinode, the broad spectra with a large energy gap of $\sim 40\text{meV}$ are observed above and below $T_c$. The spectral shape and the gap size around the antinode are almost unchanged across $T_c$, indicating that the pseudogap state coexists with superconducting state below $T_c$, and it dominates the character of ARPES spectra around antinode. We speculate that the pseudogap state competes with superconductivity by diminishing spectral weight in the superconducting antinode.

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