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ARPES Study of Nodal Quasiparticles Using Low-Energy Tunable Photons

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Low-energy quasiparticle excitations govern the thermodynamic properties of a superconductor both in the zero-field and vortex-mixed states. For a *d*-wave superconductor, nodal quasiparticles are crucial excitations starting from zero energy. So far, however, the nodal quasiparticle dynamics of high-Tc cuprates has been controversial. For example, it has been reported by an angle-resolved-photoemission (ARPES) experiment that the marginal-Fermi-liquid behavior persists into the superconducting state without appreciable change in the scattering rate, while microwave conductivity increases upon the superconducting transition. Here, we show a new ARPES result that solves the controversies with unprecedented momentum-resolution. Low-energy tunable photons have enabled us to resolve a small nodal bilayer splitting clearly, and to reveal the detailed temperature- and energy-dependence of the scattering rate, indicating the behaviors unique to the nodal quasiparticles. Due to the opening of the *d*-wave gap, the nodal scattering rate is remarkably suppressed, and shows a linear energy dependence. The difference in the energy-linear term between the bilayer-resolved scattering rates hints the nature of impurities involved. This work was done in collaboration with T. Yamasaki, T. Kamo, K. Yamazaki, H. Anzai, M. Arita, H. Namatame, M. Taniguchi, *Grad. Sch. of Science and Hiroshima Synchrotron Radiation Center, Hiroshima Univ.*, A. Fujimori, *Dept. of Complexity Science and Engineering, Univ. of Tokyo*, Z.-X. Shen, *Dept. of Physics, Applied Physics and SSRL, Stanford Univ.*, M. Ishikado, K. Fujita, and S. Uchida, *Dept. of Physics, Univ. of Tokyo.*