Evidence of Electron Coupling to High Energy Excitations in a High Temperature Superconductor

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We have carried out super-high resolution angle-resolved photoemission measurements on temperature evolution of the electron dynamics along the (0,0)\(-(\pi,\pi)\) nodal direction in an optimally-doped Bi$_2$Sr$_2$CaCu$_2$O$_8$ high temperature superconductor. The nodal photoemission spectra exhibit dramatic sharpening with decreasing temperature, with an obvious change in the scattering rate across T$_c$. New high energy features are found to develop at \(115\text{meV}\) and \(150\text{meV}\), besides the prominent \(70\text{meV}\) one, in the nodal electron self-energy in the superconducting state. These observations provide evidence that, in addition to coupling with low energy excitations like phonons or magnetic resonance mode, there are high-energy excitations involved in the electron coupling.

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