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Evidence for a charge collective mode associated with superconductivity in copper oxides from neutron and x-ray scattering measurements of $La_{2-x}Sr_xCuO_4$ SEUNG RYONG PARK, Department of Physics, Incheon National University, T. FUKUDA, A.Q.R. BARON, RIKEN SPring-8 Center, A. HAMANN, Karlsruhe Institute für Technologie, D. LAMAGO, Laboratoire Leon Brillouin, L. PINTSCHOVIUS, Karlsruhe Institute für Technologie, M. FUJITA, Institute for Materials Research, Tohoku University, K. YAMADA, IWPI Research Center, Advanced Institute for Materials Research, D. REZNIK, Department of physics, University of Colorado at Boulder — In superconducting copper oxides some Cu-O bond-stretching phonons around 70meV show anomalous giant softening and broadening of electronic origin and electronic dispersions have large renormalization kinks near the same energy. These observations suggest that phonon broadening originates from quasiparticle excitations across the Fermi surface and the electronic dispersion kinks originate from coupling to anomalous phonons. We measured the phonon anomaly in underdoped (x=0.05) and overdoped (x=0.20,0.25) $La_{2-x}Sr_xCuO_4$ by inelastic neutron and x-ray scattering with high resolution. Combining these and previously published data, we found that doping-dependence of the magnitude of the giant phonon anomaly is very different from that of the ARPES kink, i.e. the two phenomena are not connected. We show that the phonon anomaly likely originates from novel collective charge excitations as opposed to interactions with electron-hole pairs. Their amplitude follows the superconducting dome so these charge modes may be important for superconductivity.

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