Fermi surface splittings in multilayered high-$T_c$ cuprates with charge imbalance

M. MORI, T. TOHYAMA, S. MAEKAWA, IMR, Tohoku Univ; CREST, JST — Cuprate superconductors have layered structure of CuO$_2$ planes, which makes conducting blocks separated by an charge- reservoir block. Multilayered high-$T_c$ cuprates, e.g., Ba$_2$Ca$_3$Cu$_4$O$_8$(O$_{1-y}$F$_y$)$_2$ and HgBa$_2$Ca$_4$Cu$_5$O$_{y}$, have two kinds of CuO$_2$ planes in a unit cell; the outer-pyramidal-coordinated-planes (OP’s) and the inner- square-coordinated-planes (IP’s). The carrier density in the OP is generally different from that in the IP. We call such an inhomogeneous charge-distribution ‘charge imbalance’. We study doping dependence of interlayer hoppings, $t_{\perp}$, in such a charge-imbalance system in the Gutzwiller approximation. When the double occupancy is forbidden in the CuO$_2$ plane, an effective amplitude of $t_{\perp}$ is shown to be proportional to the square root of the product of doping rates in adjacent two planes. Therefore, the charge imbalance in more than three-layered cuprates results in two different values of $t_{\perp}^{\text{eff}}$, i.e., $t_{\perp}^{\text{eff}} \propto t_{\perp} \sqrt{\delta_{\text{IP}} \delta_{\text{IP}}}$ between IP’s, and $t_{\perp/2}^{\text{eff}} \propto t_{\perp} \sqrt{\delta_{\text{IP}} \delta_{\text{OP}}}$ between IP and OP, where $\delta_{\text{IP}}$ ($\delta_{\text{OP}}$) is the doping rates in IP (OP). Fermi surfaces are calculated in the four-layered $t$-$t'$-$t''$-$J$ model by the mean-field theory. The order parameters, the renormalization factor of $t_{\perp}$, and the site-potential making the charge imbalance between IP and OP are self-consistently determined for several doping rates. We show the interlayer splitting of the Fermi surfaces, which may be observed in the angle resolved photoemission spectroscopy measurement. *cond-mat/0511249.

M. Mori
IMR, Tohoku Univ.

Date submitted: 25 Nov 2005
Electronic form version 1.4