Effects of the Hybridization on the pseudogap and on the Fermi surface of an Extended $d-p$ Hubbard Model

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The Fermi surface of an extended $d-p$ Hubbard model is investigated by a two-pole approximation in both situations with hole and electron doping. Using the factorization procedure proposed by Beenen and Edwards, superconductivity with singlet $d_{x^2-y^2}$-wave pairing is considered. The effects of the $d-p$ hybridization on the Fermi surface are the main focus in the present work. Nevertheless, the asymmetries between the hole- and electron-doped regimes and the effects of doping and Coulomb interaction on Fermi surface are also investigated. Particularly, it is shown that the crossover from hole-like to electron-like Fermi surface is deeply affected by the $d-p$ hybridization in the hole-doped case. It has been verified that the effect of the hybridization is very pronounced around the saddle points $(0, \pm \pi)$ and $(\pm \pi, 0)$, where the intensity of the superconducting order parameter is maximum in the particular case of $d_{x^2-y^2}$-wave symmetry. In the electron-doped case, the crossover in the Fermi surface is not verified. The doping dependence of the Fermi surface topology in the hole- and electron-doped regimes is in agreement with recent experimental ARPES results for La$_{2-x}$Sr$_x$CuO$_4$ (hole doping) and Nd$_{2-x}$Ce$_x$CuO$_4$ (electron doping). The effects of the hybridization on the pseudogap gap in both hole and electron doping regimes, have been also investigated. In the hole-doped case, the pseudogap emerges at the saddle points $(0, \pm \pi)$ and $(\pm \pi, 0)$ where the effects of the hybridization is stronger. On the other hand, for the electron doping regime, the pseudogap emerges at the nodal points $(\pm \pi, \pm \pi)$. 