Enhancement of d-wave superconducting correlations in the three-band Hubbard model coupled to apical oxygen phonons

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We study the hole binding energy and pairing correlations in the three-band Hubbard model coupled to an apical oxygen phonon, by exact diagonalization and constrained-path Monte Carlo simulations. In the physically relevant charge-transfer regime, we find that the hole binding energy is strongly enhanced by the electron-phonon interaction, which is due to a novel potential-energy-driven pairing mechanism involving reduction of both electronic potential energy and phonon related energy. The enhancement of hole binding energy, in combination with a phonon-induced increase of quasiparticle weight, leads to a dramatic enhancement of the long-range part of d-wave pairing correlations. Our results indicate that the apical oxygen phonon plays a significant role in the superconductivity of high-T_c cuprates.