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Polaronic behavior and electron-phonon interaction in cuprates[1]

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Photoemission and neutron scattering indicate a substantial electron-phonon coupling in high-T_c cuprates. To address the associated anomalous softening of a half-breathing Cu-O bond-stretching phonon, we derive a t-J model with electron-phonon coupling.[1] Using input parameters from band structure calculations and solving the model by exact diagonalization, we obtain a good description of the phonon softening.[1] We study the interplay of the electron-phonon and Coulomb interactions for a (weakly) doped Mott-Hubbard insulator. Using sum-rules, we find that that the effect of the electron-phonon interaction on the phonon self-energy is strongly suppressed, while there is no corresponding suppression for the electron self-energy or the phonon-induced carrier-carrier interaction.[2] Photoemission suggests polaronic behavior in undoped cuprates. Calculating the electron-phonon interaction in a shell model of an undoped cuprate, we find sufficiently strong coupling to give polaronic behavior. Using an adiabatic approximation, we discuss the dispersion and width of the corresponding phonon side-band.
[1]O. Rösch and O. Gunnarsson, Phys. Rev. Lett. **92**, 146403 (2004); [2]O. Rösch and O. Gunnarsson, Phys. Rev. Lett. (in press), cond-mat/0407064.

[1]In collaboration with Oliver Rösch.