Polaron states in Cu-O chains and planes

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Ever since the discovery of high-temperature superconductivity in cuprates, the t-J model has been regarded as the prime candidate for the theoretical description of the phenomenon. This effective model arises from mapping the p-d model onto the copper $d_{x^2-y^2}$ states. Recent studies indicate, however, that oxygen p-orbital states strongly renormalize the quasiparticle energy, both for antiferromagnetic [1] and ferromagnetic [2] systems. This has led us to study the polaron dynamics in the extended t-J model which includes the oxygen states. We develop the Green's function method in the self-consistent Born approximation (SCBA) which was successfully used to study polarons in the regular t-J model. The inclusion of O($2p$) states in CuO_2 planes causes the vertex function to develop an integrable divergence at the (π, π) point in the Brillouin zone, which requires some creativity in numerical integration of the self-energy. We also obtain a toy model for CuO chains after scaling the problem down to one dimension and investigate whether the numerical integration of the aforementioned divergence may help to solve the actual 2D problem.

References:

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