Competition between superconductivity and the pseudogap phase in the t-J model

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9.7 cm

Extending the spin components from 2 to N and using 1/N as an expansion parameter the phase diagram of the t-J model on a square lattice consists of a d-wave flux phase for $\delta < \delta_c$, where δ is the doping away form half-filling, and a d-wave superconducting phase with a maximum T_c near δ_c. For $\delta < \delta_c$ the flux phase lies above the superconducting phase and can be considered as a pseudogap phase. In order to confront the above phase diagram with experiment we have calculated the three irreducible electronic Raman spectra of A_{1g}, B_{1g}, and B_{2g} symmetry as a function of doping in the presence of superconductivity and the flux phase. We find that the B_{1g} spectrum is determined by transitions over the total gap with the main peak always increasing in energy with decreasing doping. For the A_{1g} spectrum we find that the indirect coupling to the superconducting order parameter is the leading one because it is unscreened if particle-hole symmetry holds. As a consequence the peak in the A_{1g} spectrum is caused by amplitude fluctuations of the superconducting order parameter, it is tied to T_c and decreases with decreasing δ below δ_c, similar as in the case of the B_{1g} spectrum. The good agreement of these results with experiment also supports the applicability of the above phase diagram to real high-T_c superconductors.

13.4 cm

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