Precursory effects in the pairing process due to particle-hole asymmetry

Piotr Wróbel[1], Artur Maciąg[1], Roman Micnas[2]

[1] *Institute for the Low Temperature and Structure Research, P.O. Box 1410 , 50-950 Wrocław 2*
[2] *Department of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań*

We analyze the two dimensional negative U (attractive) Hubbard model as a simplified model of the precursory effects in the pairing process in cuprates. Our analysis is motivated by the spin polaron scenario. Within that scenario, which is consistent with many experimental facts, the doping of an antiferromagnetic insulator described by the two-dimensional t-J model gives rise at low doping level to filling of a band formed by spin polarons. Since there exists effective attraction between quasiparticles, the formation of bound states below the two-particle continuum induces precursory phenomena related with pairing in such a system, because it is low dimensional and weakly filled and thus the superconducting transition is not favored in it. We demonstrate that bound states cease to exist when the filling level increases in the simplistic model in which many details irrelevant to the analyzed issue are neglected, as for example the explicit structure of the interaction, which favors a particular symmetry of the paired state, but which is capable of describing phenomena on which we concentrate here. The bound states disappear completely when the system becomes particle-hole symmetric at half-filling. In our opinion this kind of behavior determines the shape of the region on the phase diagram where precursory phenomena accompanying pairing in cuprates manifest themselves, for example as a strong Nernst effect. In particular, we suggest that the recovery of the particle-hole symmetry is responsible for the disappearance of those phenomena in highly doped systems.