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Superconducting correlations and thermodynamic properties in 2D square and triangular t-J model[1]

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Equal-time superconducting correlation functions of the two-dimensional t-J model on the square lattice are studied using high-temperature expansion method.[1] The sum of the pairing correlation, its spatial dependence and correlation length are obtained down to $T \simeq 0.2t$. By comparison of single-particle contributions in the correlation functions, we find effective attractive interactions between quasi-particles in $d_{x^2-y^2}$-wave channel. It is shown that d-wave correlation grows rapidly at low temperatures for the doping $0.1 < \delta < 0.5$. The temperature for this growth is roughly scaled by $J/2$. This is in sharp contrast to the Hubbard model in a weak or intermediate coupling region, where there are few numerical evidences of superconductivity. We also study the possible d- and f-wave pairing in the triangular t-J model.[2] When $t > 0$ with hole doping, a rapid growth of effective d-wave paring interaction is found that indicates the resonating-valence-bond superconductivity. In contrast, when $t < 0$, where the ferromagnetic- and antiferromagnetic correlation compete, correlation lengths of the f-wave triplet paring tends to diverge around $\delta = 0.6$, although its effective interaction is small. This result is compared and discussed with the recently discovered superconductor, $Na_xCoO_2{\cdot}yH_2O$, where Co atoms form a triangular lattice. Specific heat in low temperatures are also obtained in the high-temperature expansion method. We will discuss that the doping dependence of the specific heat coefficient, γ, agrees with experimental data.

[1] T. Koretsune and M. Ogata, J. Phys. Soc. Japan **74**, 1390 (2005). [2] T. Koretsune and M. Ogata, Phys. Rev. Lett. **89**, 116401 (2002), and Phys. Rev. B**72**, 134513 (2005).

[1]In collaboration with T. Koretsune.