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Universal Characters of Superconductivity in the 2-D (Quasi-2-D) Systems of Strongly Correlated Electrons based on the SU(2) Gauge Theory of Slave-boson Approach to t-J Hamiltonian

The two-dimensional systems of strongly correlated electrons have been of great interest as various physical problems are still unresolved. As an example, one of the major theoretical challenges in 2-D (or quasi 2-D) high-Tc superconductivity is to reproduce the observed phase diagrams which display the monotonously decreasing pseudogap temperature and the dome shaped superconducting phase transition temperature. in the plane of temperature vs. hole concentration and, in addition, to consistently fit other observed physical properties of the cuprate superconductors. Earlier Lee and Salk [1,2] reported a successful reproduction of the phase diagrams by proposing a realistic gauge theoretic slave-boson approach to the Heisenberg term in the t-J Hamiltonian. Based on the same theory we have been able to consistently reproduce physical properties associated with both spin dynamics and charge dynamics, namely the spin susceptibility [3] and the optical conductivity [4] respectively. Most recently, Salk [5] presented comprehensive descriptions on the well predicted universal scaling behaviours of high temperature superconductivity and suggested a possibility of room temperature superconductivity. We first make a brief review of these works. Admitting the fact that electron has two apparent "faces", the spin and the charge degrees of freedom we pay attention to interplay between charge and spin dynamic to explain physics involved with the observed phased diagrams, optical conductivity and spin susceptibility among others. In connection, derived universal characteristics [5] of physical properties are further appraised in connection with the interplay of the two degrees of freedom involving the spin susceptibility and the optical conductivity. In extension, such universalities in association with the physically well predicted propensity of the larger the antiferromagnetic coupling J, the higher the superconducting transition temperature equally lead to the anticipation of feasible room temperature superconductivity.

References

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