Quantum Phase Transition in Quasi one dimensional Strongly Correlated Electron Systems with Interchain Hopping

I. Maruyama and Y. Hatsugai

Department of Applied Physics, University of Tokyo, Hongo 7-3-1, Bunkyo-ku Tokyo 113-0033, Japan.

Interchain hopping of one-dimensional strongly correlated electron systems is studied with a mean field type approach. To decouple interchain hopping terms into bosonic ones we use string operators introduced as in the Jordan-Wingner transformation. Quantum mechanical average of this *bosonic* operator is treated as an effective field, which violates particle number conservation.

Due to the U(1) symmetry breaking, fluctuation of the total particle number is non-zero at zero temperature, which implies injection of electrons and holes from out of the chain. This “doping” effect can be relevant even at half-filling because the particle-hole symmetry is preserved with the finite effective field.

We have studied this “doping” effect at half-filling in the one-dimensional t-J-U model, motivated by the two-dimensional one [1] which was used to study the quantum phase transition from the Mott insulator to the Gossamer superconductor. Since the system is one-dimensional here, it is possible to use the Density Renormalization Group method extended to treat generic fermionic chain with the U(1) symmetry breaking. The fluctuation of the total particle number is proportional to the 1/U in the strong U limit if the effective field is fixed. After the self-consistent calculation there is a quantum phase transition from the one-dimensional Mott insulator at large Coulomb interaction to a “doped” phase with finite effective field.

[1] F. C. Zhang, Phys. Rev. Lett. 90, 207002 (2003)