Global phase diagram of the checkerboard Hubbard model

HONG YAO, Stanford, WEI-FENG TSAI, UCLA, STEVEN KIVELSON, Stanford — Local electronic structure (self-organized inhomogeneity) may play an essential role for the “mechanism” of high-$T_c$ superconductivity. Moreover, in the limit of large inhomogeneity, well-controlled theoretical solutions of strongly interacting models can be obtained. We have computed the phase diagram of the checkerboard Hubbard model in the limit of small inter-cluster electron hopping, $t'$, for all doping ($x=$ hole density per site) and for all interaction strengths, $0 < U/t$. For $0(t') < U < U_c = 4.58t$, and all $0 \leq x \leq 1/2$, the existence of an effective pair attraction results in one of two d-wave superconducting ground states - either with nodal or without nodal quasiparticles. For $U_c < U < U_t = 18.6t$, the ground state is a Fermi liquid of spin $1/2$ fermions with two possible orbital flavors. Interestingly, around $x=1/4$ the ground state is a spin-$1/2$ antiferromagnet which also possesses alternating orbital currents on every other plaquette that spontaneously break time reversal symmetry. For $U > U_t$, the ground state is a Fermi liquid of fermions with spin-$3/2$, with a spin-$3/2$ antiferromagnet is favored near $x=1/4$. By including next nearest neighbor hopping, $t_2$, within clusters, we can study the physics of particle-hole asymmetry. Strikingly, we find that increasing $t_2$ increases the range of $U$ for which hole doping leads to a superconducting state, but suppresses the range of $U$ for electron doping. (For $t_2 \rightarrow -t_2$, the roles of electrons and holes are interchanged.)

Hong Yao
Stanford University

Date submitted: 20 Nov 2006    Electronic form version 1.4