Local Plaquette Physics as Key Ingredient of High-Temperature Superconductivity in Cuprates

Alexander Lichtenstein
University of Hamburg

We introduce a strong coupling dual super-perturbation scheme starting from the general reference system optimized for a given many-body problem. We discuss the physics of high-temperature cuprate superconductors starting from the highly degenerate four-site plaquette of the Hubbard model as a reference system. The degeneracy causes strong fluctuations when a lattice of plaquettes is constructed. We show that there is a large binding energy between holes when a set of four plaquettes is considered. The next-nearest-neighbour hopping plays a crucial role in the formation of these strongly bound electronic bipolarons whose coherence at lower temperature could be the ex- planation for superconductivity. We also use a cluster dual fermion starting from a single degenerate plaquette, which contains the relevant short-ranged fluctuations from the beginning. It gives d-wave superconductivity as the leading instability under a reasonably broad range of parameters. The origin of the pseudogap is discussed in terms of the coupling of degenerate plaquettes. Generalizations of the present approach to the lattice Quantum Monte-Carlo scheme is presented.