MAR06-2005-002130

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

d-wave resonating valence bond states of ultracold fermionic atoms in optical lattices

MATTHIAS TROYER, ETH Zurich

In view of the apparently exponential complexity of fermionic simulations in two and more dimensions, we consider a controlled quantum simulation to probe the ground state properties of the two-dimensional Hubbard model. We present a controlled experimental setup to adiabatically construct superfluid d-wave resonating valence bond (RVB) states of fermionic atoms confined in a 2D optical lattice. The key idea is to start from a pure initial state which is adiabatically transformed to d-wave RVB states at ultralow temperatures of a few percent of the Fermi temperature. We discuss hole doping techniques and describe a simple experimental measurement to study d-wave pairing.The proposed experiment can be used to effectively probe ground state properties of the repulsive Hubbard model on (coupled) plaquettes, ladders and the 2D square lattice. The proposal is within the capabilities of current technology, and shows how an adiabatic quantum simulator could answer a question that cannot currently be reliably answered by classical computational methods. Reference: S. Trebst, U. Schollwöck, M. Troyer and P. Zoller, cond-mat/0506809.