MAR16-2015-005144

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Tensor network studies of the two-dimensional t-J and Hubbard models

PHILIPPE CORBOZ, Institute for Theoretical Physics, University of Amsterdam

Tensor networks are a class of variational wave functions enabling an efficient representation of quantum many-body states, where the accuracy can be systematically controlled by the bond dimension of the tensors. A well-known example are matrix product states, the underlying ansatz of the density matrix renormalization group (DMRG) method, which has become the state-of-the-art tool to study (quasi-) 1D systems. Progress in quantum information theory, in particular a better understanding of entanglement in quantum many-body systems, has led to the development of 2D tensor networks, including projected entangled-pair states (PEPS) or the 2D multi-scale entanglement renormalization ansatz (MERA). These methods provide one of the most promising routes for the simulation of strongly correlated systems in 2D, in particular models where Quantum Monte Carlo fails due to the negative sign problem. In this talk I report on recent progress in simulating the 2D t-J and Hubbard models with infinite PEPS (iPEPS) which is a tensor network ansatz for a 2D wave function in the thermodynamic limit. Our results reveal an extremely close competition between a uniform d-wave superconducting state and different types of stripe states, where iPEPS yields better variational energies than other state-of-the-art variational methods for large 2D systems.[1] The stripes are site-centered with coexisting charge-, spin-, and superconducting order, where stripes with in-phase d-wave order have an equal or only slightly lower energy than stripes with anti-phase d-wave order. Finally, a nematic anisotropy reduces the pairing amplitude and the energies of stripe states are lowered relative to the uniform state with increasing nematicity.

[1] P. Corboz, T. M. Rice, and M. Troyer, Phys. Rev. Lett. 113, 046402 (2014); P. Corboz, arXiv:1508.04003.