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Recent progress in the simulation of strongly correlated systems in two dimensions with tensor network algorithms

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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 so-called bond dimension. A well known example are matrix product states (MPS), the underlying tensor network of the density matrix renormalization group (DMRG) method, which has become the state-of-the-art tool to study (quasi-) one dimensional systems. Progress in quantum information theory, in particular a better understanding of entanglement in quantum many-body systems, led to the development of tensor networks for two-dimensional systems, including e.g. projected entangled-pair states (PEPS) or the 2D multi-scale entanglement renormalization ansatz (MERA). These methods have recently been generalized to fermionic systems, and provide a promising route for the simulation of strongly correlated systems in two dimensions. In this talk we present recent simulation results showing that infinite PEPS (iPEPS) can compete with the best known variational methods. In particular for the t-J model and the SU(4) Heisenberg model iPEPS yields better variational energies than obtained in previous variational- and fixed-node Monte Carlo studies.

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