MAR05-2004-005117

Abstract for an Invited Paper
for the MAR05 Meeting of
the American Physical Society

On the matrix product formulation of DMRG and the extension of DMRG to two-dimensional quantum systems

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Matrix product states form the mathematical framework on which both Wilons's numerical renormalization group and White's density matrix renormalization group are build. This insight allows to turn these algorithms into variational methods and to generalize them in various ways. First of all it allows to treat systems with periodic boundary conditions and to calculate ground and excited states with a definite momentum. Secondly, it allows to extend DMRG to systems with finite temperature, and to devise a variational algorithm for doing real time-evolution and for calculating Green's functions. Most notably, we managed to extend the notion of matrix product states to projected entangled pair states for higher dimensional systems. This led to the creation of a variational algorithm to describe ground states and simulate real-time evolution of spin systems in two and higher dimensions.