Unconstrained tree tensor network: An adaptive gauge picture for enhanced performance

Thu, 2016-03-03 16:34 - Werner Weiss [1] **Date:** 2014-09-29

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Reference:
Phys. Rev. B 90, 125154 (2014)
http://dx.doi.org/10.1103/PhysRevB.90.125154 [2]

URL:
http://journals.aps.org/prb/abstract/10.1103/PhysRevB.90.125154 [3]

We introduce a variational algorithm to simulate quantum many-body states based on a tree tensor network ansatz which releases the isometry constraint usually imposed by the real-space renormalization coarse graining. This additional numerical freedom, combined with the loop-free topology of the tree network, allows one to maximally exploit the internal gauge invariance of tensor networks, ultimately leading to a computationally flexible and efficient algorithm able to treat open and periodic boundary conditions on the same footing. We benchmark the novel approach against the 1D Ising model in transverse field with periodic boundary conditions and discuss the strategy to cope with the broken translational invariance generated by the network structure. We then perform investigations on a state-of-the-art problem, namely, the bilinear-biquadratic model in the transition between dimer and ferromagnetic phases. Our results clearly display an exponentially diverging correlation length and thus support the most recent guesses on the peculiarity of the transition.

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