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Classification of Gapped Symmetric Phases in 1D Spin Systems
XIE CHEN, Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA, ZHENG-CHENG GU, Kavli Institute for Theoretical Physics, University of California, Santa Barbara, CA 93106, USA, XIAO-GANG WEN, Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA — Topological phases exist in quantum many-body systems beyond the usual symmetry breaking understanding of phase and phase transition. The question of what kind of topological phases exist seems hard especially for strongly interacting systems. Here we make an attempt to answer this question for gapped interacting quantum spin systems whose ground states are short-range correlated. Based on the local unitary equivalence relation between short-range correlated states in the same phase, we classify possible quantum phases for 1D matrix product states, which represent well the class of 1D gapped ground states. We find that in the absence of any symmetry all states are equivalent to trivial product states, which means that there is no topological order in 1D. However, if certain symmetry is required, many phases exist with different symmetry protected topological orders. Understanding about topological order and symmetry breaking order in spin systems also allows us to obtain a classification of 1D fermion topological phases.

Xie Chen
Dept of Physics, Massachusetts Institute of Technology,
Cambridge, Massachusetts 02139, USA

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