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Symmetric tensor networks and practical simulation algorithms to sharply identify classes of quantum phases distinguishable by short-range physics[1] YING RAN, SHENGHAN JIANG, Boston College — Phases of matter are sharply defined in the thermodynamic limit. One major challenge of accurately simulating quantum phase diagrams of interacting quantum systems is due to the fact that numerical simulations usually deal with the energy density, a local property of quantum wavefunctions, while identifying different quantum phases generally rely on long-range physics. In this paper we construct generic fully symmetric quantum wavefunctions under certain assumptions using a type of tensor networks: projected entangled pair states, and provide practical simulation algorithms based on them. We find that quantum phases can be organized into crude classes distinguished by short-range physics, which is related to the fractionalization of both on-site symmetries and space-group symmetries. Consequently, our simulation algorithms, which are useful to study long-range physics as well, are expected to be able to sharply determine crude classes in interacting quantum systems efficiently. Examples of these crude classes are demonstrated in half-integer quantum spin systems on the kagome lattice. Limitations and generalizations of our results are discussed.

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