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Symmetry-protected topologically ordered states for universal quantum computation[1] HENDRIK POULSEN NAUTRUP, Department of Physics and Astronomy, Stony Brook University, TZU-CHIEH WEI, C. N. Yang Institute for Theoretical Physics, Stony Brook University — Measurement-based quantum computation (MBQC) is a model for quantum information processing utilizing only local measurements on suitably entangled resource states for the implementation of quantum gates. A complete characterization for universal resource states is still missing. It has been shown that symmetry-protected topological order (SPTO) in one dimension can be exploited for the protection of certain quantum gates in MBQC. Here we investigate whether any 2D nontrivial SPTO states can serve as resource for MBQC. In particular, we show that the nontrivial SPTO ground state of the CZX model on the square lattice by Chen et al. [Phys. Rev. B **84**, 235141 (2011)] can be reduced to a 2D cluster state by local measurement, hence a universal resource state. Such ground states have been generalized to qudits with symmetry action described by three cocycles of a finite group G of order d and shown to exhibit nontrivial SPTO. We also extend these to arbitary lattices and show that the generalized two-dimensional plaquette states on arbitrary lattices exhibit nontrivial SPTO in terms of symmetry fractionalization and that they are universal resource states for quantum computation. SPTO states therefore can provide a new playground for measurement-based quantum computation.

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Tzu-Chieh Wei
C. N. Yang Institute for Theoretical Physics, Stony Brook University

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