Qudit quantum computation on matrix product states with global symmetry

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Resource states that contain nontrivial symmetry-protected topological order are identified for universal measurement-based quantum computation. Our resource states fall into two classes: one as the qudit generalizations of the qubit cluster state, and the other as the higher-symmetry generalizations of the spin-1 Affleck-Kennedy-Lieb-Tasaki (AKLT) state, namely, with unitary, orthogonal, or symplectic symmetry. The symmetry in cluster states protects information propagation (identity gate), while the higher symmetry in AKLT-type states enables nontrivial gate computation. This work demonstrates a close connection between measurement-based quantum computation and symmetry-protected topological order.