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A classification of symmetry enriched topological phases with exactly solvable models YING RAN, ANDREJ MESAROS, Department of Physics, Boston College, Chestnut Hill, MA 02467, USA — Recently a new class of quantum phases of matter: symmetry protected topological phases, such as topological insulators, attracted much attention. In presence of interactions, group cohomology provides their classification. These phases are only short-range entangled, while phases with long-range entangled topological order (having topological ground state degeneracy and/or anyons in the bulk) in presence of global symmetries are much less understood. We present a classification of bosonic gapped quantum phases with or without long-range entanglement, in the presence or absence of on-site global symmetries. In 2+1 dimensions, the quantum phases with global symmetry group SG, and with topological order described by finite gauge group GG, are classified by the cohomology group $H^3(SG \times GG, U(1))$. We present an exactly solvable local bosonic model for each class. When global symmetry is absent our models are described by Dijkgraaf-Witten discrete gauge theories. When topological order is absent, they become models for symmetry protected topological phases. When both global symmetry and topological order are present, the models describe symmetry enriched topological phases. Our classification includes, but goes beyond the projective symmetry group classification.

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