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Classification and Edge States of Symmetry Protected Topological Phases

XIE CHEN, UC Berkeley

Symmetry protected topological (SPT) phases are gapped and nonfractionalized in the bulk but can have nontrivial edge states protected by the anomalous symmetry action on the boundary. In this talk, I discuss the classification of bosonic SPT phases using group cohomology and what their edge states are like in one, two and three dimensions. In 1D, edge states of SPT chains are degenerate and carry projective representations of the symmetry. In 2D SPT systems, the edge state is either symmetry breaking or gapless which can be protected by the chiral symmetry action on the 1D boundary. For 3D SPT states, a new possibility arises on the 2D boundary besides being symmetry breaking or gapless. The edge can be both gapped and symmetric and have fractional excitations. The fractional excitations transform under symmetry in a way that is not possible in 2D and hence reflect the nontrivial SPT order in the bulk. Explicit examples are given to illustrate the possibilities in different dimensions.