Quantum phase transitions between a class of symmetry protected topological states

LOKMAN TSUI, Department of Physics, University of California, Berkeley, HONG-CHEN JIANG, Stanford Institute for Materials and Energy Sciences; SLAC National Accelerator Laboratory, YUAN-MING LU, Department of Physics, The Ohio State University, DUNG-HAI LEE, Department of Physics, University of California, Berkeley; Materials Science Division, Lawrence Berkeley National Laboratories.

The subject of this paper is the phase transition between symmetry protected topological states (SPTs). We consider spatial dimension $d$ and symmetry group $G$ so that the cohomology group, $H^{d+1}(G, U(1))$, contains at least one $\mathbb{Z}_2^n$ or $\mathbb{Z}$ factor. We show that the phase transition between the trivial SPT and the root states that generate the $\mathbb{Z}_2^n$ or $\mathbb{Z}$ groups can be induced on the boundary of a $d+1$ dimensional $G \times \mathbb{Z}_2^T$-symmetric SPT by a $\mathbb{Z}_2^T$ symmetry breaking field. Moreover we show these boundary phase transitions can be “transplanted” to $d$ dimensions and realized in lattice models as a function of a tuning parameter. The price one pays is for the critical value of the tuning parameter there is an extra non-local (duality-like) symmetry. In the case where the phase transition is continuous, our theory predicts the presence of unusual (sometimes fractionalized) excitations corresponding to delocalized boundary excitations of the non-trivial SPT on one side of the transition. This theory also predicts other phase transition scenarios including first order transition and transition via an intermediate symmetry breaking phase.

Lokman Tsui
University of California, Berkeley

Date submitted: 10 Nov 2016

Electronic form version 1.4