Duality between Symmetry Protected Topological Order and Intrinsic Topological Order

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Abstract

Symmetry protected topological (SPT) phase is a generalization of topological insulator (TI). Different from the intrinsic topological phase, e.g., the fractional quantum hall (FQH) phase, SPT phase is only distinguishable from a trivial disordered phase when certain symmetry is preserved. Indeed, SPT phase has a long history in 1D, and it has been shown that the well known Haldane phase of S=1 Heisenberg chain belongs to this class. However, in higher dimensions, most of the previous studies focus on free electron systems. Until very recently, it was realized that SPT phase also exists in interacting boson/spin systems in higher dimensions. In this talk, I will show that there is an interesting duality map between intrinsic topological phase and SPT phase. I will focus on a simple model that realizes an Ising paramagnet with gapless edge modes protected by Ising symmetry. The duality provides us a simple physical construction that distinguishes this system from a conventional paramagnet: we couple the system to a Z2 gauge field and then show that the flux excitations have different braiding statistics from that of a usual paramagnet. In addition, these braiding statistics directly implies the existence of protected edge modes. The duality map also provides us a complementary way to derive topological terms of SPT phases, which classify different SPT phases in bosonic systems. Finally, I will discuss the possible generalization for interacting fermion/electron systems.

About the speaker

Dr Zheng-Cheng Gu obtained his Bachelor in Fundamental Sciences (Mathematics and Physics) at Tsinghua University in 2003 and PhD in Physics at the Center for Advanced Study, Tsinghua University (CASTU) in 2007. He was a Postdoctoral Fellow at Massachusetts Institute of Technology from 2007 to 2009. He then worked at Kavli Institute for Theoretical Physics, University of California at Santa Barbara as the Associate Specialist from 2009 to 2012. He has been a member at the Perimeter Institute for Theoretical Physics and the Institute for Quantum Information and Matter (IQIM) Fellow at California Institute of Technology since September 2012.