Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

"Topological phases and Lieb-Schultz-Mattis Theorem"

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Abstract: The Lieb-Schultz-Mattis (LSM) theorem dictates that emergent low-energy states from a lattice model cannot be a trivial symmetric insulator if the filling per unit cell is not integral and if the lattice translation symmetry and particle number conservation are strictly imposed. In this talk, we will compare the one-dimensional gapless states enforced by the LSM theorem and the boundaries of one-higher dimensional strong symmetry-protected topological (SPT) phases from the perspective of quantum anomalies. We first note that, they can be both described by the same low-energy effective field theory with the same effective symmetry realizations on low-energy modes, wherein non-on-site lattice translation symmetry is encoded as if it is a local symmetry. In spite of the identical form of the low-energy effective field theories, we show that the quantum anomalies of the theories play different roles in the two systems. In particular, we find that the chiral anomaly is equivalent to the LSM theorem, whereas there is another anomaly, which is not related to the LSM theorem but is intrinsic to the SPT states. As an application, we extend the conventional LSM theorem to multiple-charge multiple-species problems and construct several exotic symmetric insulators. We also find that the (3+1)d chiral anomaly provides only the perturbative stability of the gapless-ness local in the parameter space. We will conclude the talk with a few future research topics stemming from the discussed topics.

12:00pm
Tuesday, October 31, 2017
Duboc Room (4-331)

Host: Max Metlitski