MAR13-2012-008195

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Interacting topological phases and quantum anomalies

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Since the quantum Hall effect, the notion of topological phases of matter has been extended to those that are well-defined (or: "protected") in the presence of a certain set of symmetries, and that exist in dimensions higher than two. In the (fractional) quantum Hall effects (and in "chiral" topological phases in general), Laughlin's thought experiment provides a key insight into their topological characterization; it shows a close connection between topological phases and *quantum anomalies*. Compared to genuine topological phases, symmetry protected topological phases are more fragile and less entangled states of matter, and hence for their characterization we need to sharpen our understanding on how topological properties of the systems manifest themselves in the form of a quantum anomaly. By taking various kinds of symmetry protected topological phases as an example, I will demonstrate that quantum anomalies serve as a useful tool to diagnose (and even define) topological properties of the systems. I will also discuss quantum anomalies play an essential role when developing descriptions of these topological phases in terms bulk and boundary (effective) theories.