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Topological insulators and the QCD vacuum.

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There is considerable evidence, based on large N_c chiral dynamics, holographic QCD, and Monte Carlo studies, that the topological structure of the QCD vacuum consists of discrete quasivacua separated by domain walls across which the local value of the topological θ parameter jumps by $\pm 2\pi$.
Topological insulators are condensed matter systems which are bulk insulators with a mass gap but which can transport quantized units of charge via topologically protected boundary states. This is analogous to the QCD vacuum, where the pure glue theory has a bulk mass gap but, when light quarks are included, has Goldstone bosons associated with topological modes of the Dirac operator. As in topological insulators, Goldstone modes in QCD are boundary states on codimension one membranes or domain walls. Following this analogy, the U(1) chiral field in QCD is given by the closed loop integral of a Berry connection around the Brillouin zone in lattice momentum space. This berry phase describes the local polarization of the topological charge membranes.

Summary

I discuss the similarities between the topological structure of the QCD vacuum and that of topological insulators.

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