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Physics of three dimensional bosonic topological insulators I

ASHVIN VISHWANATH, UC Berkeley, TODADRI SENTHIL, MIT — We discuss physical properties of "integer" topological phases of bosons in D=3+1 dimensions, protected by internal symmetries like time reversal and/or charge conservation. These phases invoke interactions in a fundamental way but do not possess topological order and are bosonic analogs of free fermion topological insulators and superconductors. Here we develop a field theoretic description of several of these states and show that they possess unusual surface states, which if gapped, must either break the underlying symmetry, or develop topological order. In certain cases the topological phases are characterized by a quantized magneto-electric response θ, which, somewhat surprisingly, is an odd multiple of 2π. A surface theory in which vortices transform under a projective representation of the symmetry group is shown to capture these properties. A bulk field theory of these states is also identified, which furthermore predicts phases characterized by the thermal analog of the magneto-electric effect, that lie beyond the current cohomology description.

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