Effective field theories for topological insulators by functional bosonization

Effective field theories that describes the dynamics of a conserved U(1) current in terms of “hydrodynamic” degrees of freedom of topological phases in condensed matter are discussed in general dimension $D = d+1$ using the functional bosonization technique. For non-interacting topological insulators (superconductors) with a conserved U(1) charge and characterized by an integer topological invariant, we derive the BF-type topological field theories supplemented with the Chern-Simons (when $D$ is odd) or the axion term (when $D$ is even). For topological insulators characterized by a Z2 topological invariant (the first and second descendants of the primary series), their topological field theories are obtained by dimensional reduction. We also discuss the putative “fractional” topological insulators and their possible effective field theories.