Numerical Study of Bulk-Edge correspondence in Topological Insulators

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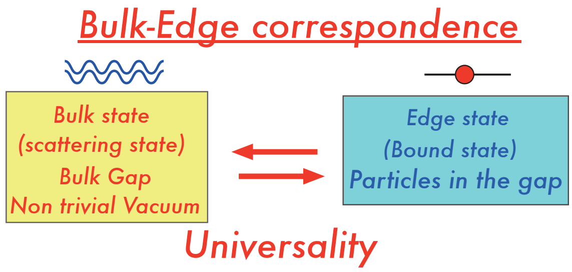
Recent studies have revealed that a class of *generic insulators* is quite nontrivial and has a lots of varieties. Here we define the *generic insulator* as a quantum ground state with a finite excitation gap. This class includes quantum (spin) Hall states, Haldane spin chains, half-filled Kondo lattice and orthogonal dimers as the Sutherland-Shastry model. Mott insulator can be also in this list if one focuses on the charge sector. Although we are interested in such a gapped state, it is clear that the standard concept of the theory of phases as the Ginzburg-Landu-Wilson paradigm is not sufficient enough where diverging fluctuation described by a local order parameter is essential. In the generic insulators, however, any local fluctuation is not important and then we need other concepts to characterize. Geometrical phases by the Berry connections and topological order discussed in the study of the quantum Hall states are such tools. Then the insulators with non trivial structure are (generic) topological insulators.

Another important feature of the topological insulators is that although the bulk looks like featureless, the systems with boundaries show characteristic local physics by appearance of edge states. It includes edge states of quantum (spin) Hall states, Kennedy triplets in the Haldnae spin chains and the Fujita states of the graphene as well. These edge states exist by the non trivial topological properties of the bulk. Conversely, the topologically non trivial bulk of the topological insulators is characterized by the edge state. The relation is summarized as the *bulk-edge correspondence*[1]. This bulk-edge correspondence is a fundamental property of the topological insulators. We numerically studied this bulk-edge correspondence and related concepts for several topological phases[2-9].



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