論文 / 著書情報
Article / Book Information

題目(和文)	トポロジカル結晶絶縁体における、２次のバルク・境界対応
Title(English)	Second-order bulk-boundary correspondence in topological crystalline insulators
著者(和文)	髙橋亮
Author(English)	Ryo Takahashi
出典(和文)	学位:博士(理学), 学位授与機関:東京工業大学, 報告番号:甲第11876号, 授与年月日:2021年3月26日, 学位の種別:課程博士, 審査員:村上 修一,齋藤 晋,西田 祐介,石塚 大晃,打田 正輝
Citation(English)	Degree:Doctor (Science), Conferring organization: Tokyo Institute of Technology, Report number:甲第11876号, Conferred date:2021/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

Conventional topological insulators have anomalous surface states due to the bulk-edge correspondence. In recent years, new kind of topological insulators with unconventional bulk-boundary correspondence are found. They are called second-order topological insulators (SOTIs). Three-dimensional SOTIs are insulating in bulk and surfaces, but they have anomalous gapless hinge states at the hinges, which are intersections of two surfaces. Two-dimensional SOTIs are insulating in bulk and edges, but they have excess fractional charges on the corners and often corner states as well. In this thesis, we study the second-order bulk-boundary correspondence from a general standpoint for two important types of SOTIs: three-dimensional SOTIs protected by inversion symmetry and two-dimensional SOTIs protected by rotational symmetry.

Firstly, we show that a slab of a 3D inversion-symmetric SOTI in class A is a 2D Chern insulator. We prove it by considering a process of cutting the 3D inversion-symmetric SOTI along a plane, and study the spectral flow in the cutting process. We show that the indicators, which characterize 3D inversion-symmetric SOTIs in class A is directly related to the indicators for the corresponding two-dimensional slabs with inversion symmetry, i.e. the Chern number parity. The existence of the gapless hinge states is understood from the conventional bulk-edge correspondence between the slab system and the hinge states. We have also obtained similar results for 3D inversion-symmetric SOTIs with time-reversal symmetry (class AII).

Secondly, we derive a general formula for the quantized fractional corner charge in 2D Cn-symmetric SOTIs. We assume that the edges are charge-neutral, but we do not assume vanishing bulk electric polarization. We expand the scope of the corner charge formula by considering more general surface conditions, such as surfaces with higher Miller index and surfaces with surface reconstruction. Our theory applies to insulators with non-vanishing bulk polarization, and we find that in such cases the value of the corner charge depends on the surface termination even for the same bulk crystal, via a difference in the Wyckoff position of the center of the Cn-symmetric crystal. Our results can be helpful in finding new candidate materials with corner charges.