筑波大学
University of Tsukuba

Condensed Matter Seminar
物性論セミナー

Supported by Variety and universality of bulk-edge correspondence in topological phases: From solid state physics to transdisciplinary concepts
Grant-in-Aid for Scientific Research (S) Project No.17H06138

2019年5月15日 (水), May 15 (Wed), 2019
16:00-17:00
自然系学系棟B棟６階: ６０２号室
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Spectral bulk-boundary correspondence and topological criticality in chiral-symmetric superconductors

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Recently, the topological materials are recognized as one of the most important issues in condensed matter physics for their interesting concepts and potentials for application. As for the topological superconductors, the presence of surface Andreev bound state (SABS) in e.g. p/d-wave superconductor and Rashba nanowire-based systems proximately coupled to s-wave superconductor attracts considerable interests, some of which are promising candidates for a platform of the topological quantum computation due to the emergence of Mojorana fermions. Recent studies have clarified that the SABS accumulated at the edges is closely related to the presence of the odd-frequency pairs which have odd-function pair amplitude in frequency/time as first proposed by Berezinskii in 1974. However, the roles of odd-frequency pairs in topological superconductors have not yet been studied, and little is known about it.

Taking typical topological superconductors having chiral symmetry which allow us to define the topological winding number, we have developed the two important concepts for odd-frequency pairing. (1) Spectral bulk-boundary correspondence (SBBC): A conventional bulk-boundary correspondence tells us that the topological number in bulk is related to the number of edge states. We extend this concept to the finite frequencies, which connects the generalized winding number in bulk to odd-frequency pair amplitude at the boundary. (2) Topological criticality: The coefficients of odd-frequency pair amplitudes show a power-law divergence at the topological phase transition, indicating a degree of proximity to the topological phase transition. These results have extended the preexisting concepts of topological material and odd-frequency pairs, and will be useful for the further exploration of this issue.

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