



Title of Project : Frontiers of materials science spun from topology

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【Purpose of the Research Project】

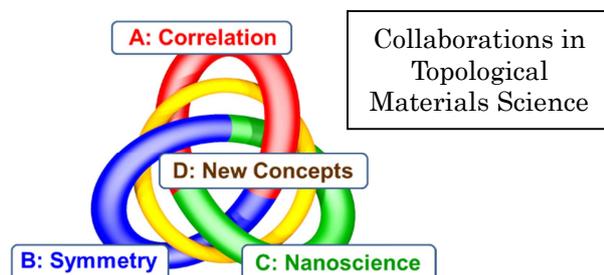
Focusing on topological nature of materials, we aim to develop novel quantum phenomena driven by interaction, symmetry of crystals and nanostructure of semiconductors, and explore exotic quasiparticles inherent in the topological quantum phenomena, thereby elucidating the underlying physics behind them.

Recent years have seen a tremendous growth of interest in topological quantum phenomena. However, quite a few issues still remain unexplored. In particular, (1) clarifying effects of **interactions** between electrons which would lead to diversity and functionality of materials, (2) exploring topological materials based on **symmetry** of crystals, and (3) systematic control of artificial topological phases in **nanostructured** systems, are indispensable for developing novel materials and establishing the fundamental concepts. This project systematically studies these issues at the frontiers of materials science.

【Content of the Research Project】

This project consists of four subprojects:

- A: Topology and Correlation
- B: Topology and Symmetry
- C: Topology and Nanoscience
- D: Topology and New Concepts



The subprojects A-C are closely related to real materials, and investigate strongly correlated systems, semiconductor systems and nanostructured systems. The subproject D consisting of a theory group aims to develop new concepts and stimulates collaborations among A-C. We also have some theorists in A-C, who will do research in intimate collaboration with experimentalists.

Physical systems studied in this project are not restricted to ordinary topological insulators

and superconductors, but widely include quantum systems, cold atomic systems, etc. where topological phases emerge.

In this project, we put particular emphasis on nurturing young researchers and promoting international collaborations: we introduce a special program to stimulate young researchers and international “alliance workshops”.

【Expected Research Achievements and Scientific Significance】

A significant feature of this project is our ambition to unify the basic concepts on topological phenomena found in different fields of condensed matter physics, and to provide a new versatile platform in materials science which can treat a variety of topological phenomena in the same framework.

Some concrete examples of the achievements we expect are:

1. Establishing topological phase transitions
2. Comprehensive understanding of topological insulators and superconductors
3. Realizing topological semimetals
4. Evidencing Majorana quasiparticles

By performing this project systematically, we will be able to solve the problems which have not been addressed in the preceding studies in each field, and stimulate the collaborations among different fields. This project will not only establish the basic notions of topological phenomena in condensed matter, but will also stimulate other research fields where the notion of topology will certainly become important in the near future.

【Key Words】

Topology, Materials science, Strong correlation, Symmetry, Nanoscience

【Term of Project】 FY2015-2019

【Budget Allocation】 1,003,600 Thousand Yen

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