

**Stony Brook University
The Graduate School**

Doctoral Defense Announcement

Abstract

Theories and Applications of Topological Insulators

By

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As a new kind of state of the materials, topological insulators have been intensively studied by researchers very recently. The concept of topology coming from the pure mathematics, captures the key aspect of the phase term of the wave functions of topological insulators. In other branches of physics, the topology properties have been studied for some famous objects--such as magnetic monopoles and quantum Hall effects. Our study in topological insulator, a close cousin of quantum Hall effect, reveals its topological characteristic and phase transition property from the complex crystal momentum point of view. In fact, using the analytic continuation method, we found that the effective magnetic monopole distributes in the complex momentum space, and its swapping mechanism during the topological phase transition, guarantees robust metallic states at the critical point. Several important aspects of topological insulators have been studied--such as intrinsic instability due to Mexican hat bands structure, higher Chern number model and its exact supersymmetry of quantum mechanics. Based on the above results, further possible applications have been proposed. Lastly, I introduce some recently inspiring experiments and the future possibilities.

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