PD Research Report for the 2017 year

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Research Theme Theoretical studies on electronic properties of atomically-thin materials

Research Period April, 2017 ~ September, 2017

Research Results

Publications of 2017:

1. F. Liu and K. Wakabayashi, “Novel topological phase with a zero Berry curvature”, Phys. Rev. Lett. 118, 076803 (2017).

2. F. Liu and K. Wakabayashi, “Topological edge states of honeycomb lattice with a zero Berry curvature”, submitted to Journal of Japan Physics Society

Result:

We have discovered a nontrivial topological phase resides in a 2D square lattice model with Peierl’s distortions based on Su-Schrieffer-Heeger model, where the hoppings are classified as intracellular and intercellular ones, receptively. When the intracellular hopping is smaller than the intercellular one, the system enters topological nontrivial phase characterized by Zak phase (π, π). The discovery of this novel topological phase offers a new view point for designing topological materials. We also extended this nontrivial topological phase to honeycomb lattice from square lattice. We found that like the square lattice case, topological edge states characterized by vectored Zak phase appear in honeycomb lattice both for armchair and zigzag edges when the intercellular hopping is larger than the intracellular hopping. Besides these two toy models for square and honeycomb lattices, we have considered how to realize this vectored Zak-phase-characterized topological phase experimentally. Based on normal dielectrics, we propose a design of photonic crystal that shows nontrivial topological edge states based on vectored Zak phase.

Another project that we are working on is the electronic properties of low-dimensional materials under light irradiations. We have found the valley-polarization in carbon nanotubes. Also, we studied one-dimensional chain under light irradiation. Several interesting phenomena have been confirmed such as the parity oscillation, the dynamic localization.