The effects of disorder on topological insulators

摘要：Topological states are robust to continuous deformation, which includes disorder scattering. Nonetheless, disorder plays an important role in electronic transport and phase transitions in topological insulators (TI). In this talk, I would like to introduce the intriguing effects of disorder on three TI systems. In the one-dimensional model, it is shown that disorder drives topological phase transitions between different topological indices. The phase diagram is identified with the calculation of winding number, localization length and self-energy. The mechanism is explained by band gap renormalization and Anderson localization, as a consequence of disorder scattering. In a TI nanowire threaded by magnetic flux, the surface wave function gains Berry phase due to spin-orbit coupling and Peierls phase due to magnetic flux. The theoretical results based on the Landauer-Buttiker formalism show that Aharonov–Bohm oscillation appears in the disordered limit. By analyzing the localization length, it is shown that the bulk states are localized by disorder scattering and fail to contribute to transport. Lastly, in the presence of a rotating magnetic field, a reentrant quantum spin Hall effect is predicted. The numerical simulation shows that the reentrant quantum spin Hall effect survives the disorder strength up to eight times the energy gap, confirming its robustness.