Topological Phases in Transition Metal Chalcogenides

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The discovery of quantum spin Hall effect engendered a new chapter of topological materials research in condensed matter physics and materials science. In this talk, I will introduce some of our recent theoretical works about the topological phases in 2D and 3D transition metal chalcogenides. We predict monolayer MX$_2$ (M=Mo, W; X=S, Se, Te) of 1T’ structure could realize quantum spin Hall insulator. Moreover, their topology can be easily tuned by external electric field, which motivated us to propose a new type of transistor, called topological field transistor. More recently, we found another new class of transition metal chalcogenides MM’TTe$_4$ (M=Nb, Ta; M’=Ir, Rh) could be quantum spin Hall insulators in 2D and Weyl semimetals in 3D. I will also discuss some recent transport, ARPES and STM experiments on monolayer WTe$_2$, where many of the observations are consistent with monolayer WTe$_2$ being a 2D TI.

Junwei Liu has a broad interest in condensed matter physics, from the traditional phenomena like ferroelectricity to the exotic topological phases like quantum spin Hall insulators. Currently, his research mainly focuses on two parts: 1) the novel topological phases of matter, especially the symmetry-related topological phases, and their material realizations and experimental signatures; 2) applications of advanced machine learning techniques in physics, especially the combination of machine learning techniques and quantum Monte Carlo simulations.