Theoretical design of Topological Materials

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Recently, the geometrical properties of electrons in solids attract much attention both from the scientific and technological viewpoints. Especially the topological insulator (TI) is a new state of matter realized by the relativistic spin-orbit interaction in the nonmagnetic system.

Up to now, several candidate materials have been proposed and actually confirmed experimentally to be TI's. However, all of these materials are based on the s- and p-orbitals, and also centrosymmetric systems.

In this talk, I will discuss the possibility of TI in d-electron systems and noncentrosymmetric systems. In the former case, we expect a variety of phenomena related to the magnetism, ferroelectricity, and superconductivity due to the many-body interactions, and the interplay between the topology and correlation can be studied in depth. Especially, the possible TI at the hetero-structures of transition metal oxides are studied in details.

For the latter category, some novel effects such as the magneto-electric effect, spin Galvanic effect, and spin Hall effect are expected even without the TI, and hence the additional features added by the TI are of interests.

I will discuss some candidate materials including their quantum critical behavior and spintronics functions.

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