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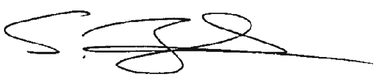
EDITORIAL

Advances in topological materials

Great leaps of civilization have always been enabled by important discoveries of new materials and their functionalities. It is only fitting that the Bronze and Iron Ages are named after the materials themselves. The Information Age based on silicon processing has brought great advances to our civilization; however, the pace of the rapid progress cannot be sustained any longer. The random motion of electrons inside the semiconductor chips generate vast amounts of heat which prevents the scaling according to Moore's law. However, this unprecedented crisis also offers opportunities to search for new principles and new materials for information processing. The discovery of topological materials offers a new platform in which electrons move just like automobiles on a highway, where counter-moving traffics are spatially separated into different lanes. This type of motion is enabled by the spin–orbit coupling in topological materials with heavy elements, and could dramatically reduce the dissipation. In recent years, topological materials have been theoretically predicted and experimentally observed. The frontier of the field has now moved to controlled material processing and the discovery of novel properties associated with these materials.

Even though the periodic table contains only a little more than one hundred elements, the number of compounds they can form is virtually infinite. Our ability to synthesize compound materials has vastly improved in the past years, but it is still hard to perform an exhaustive search for materials with desired properties. It has always been a dream to design and predict new materials theoretically, motivated by deep concepts and possibly aided by computer simulations. However, such a dream has not really been realized before. For example, superconductors and giant magneto-resistance materials have all been discovered experimentally first. The discovery of topological materials marks an important milestone in the scientific history, in which all of them, starting with HgTe, have been theoretically predicted first. The success of theory in this field is an inspiration to the rest of condensed matter physics, leading towards a new era of materials research guided by theoretical designs and predictions.

This special topic of *Frontiers of Physics* has collected nine manuscripts from the forefront of this active research field, to which Chinese scientists have made ground breaking contributions. The theoretical prediction of Bi_2Te_3, Sb_2Te_3 and Bi_2Se_3 topological materials, the MBE growth of topological materials and the experimental observation of Landau levels of the Dirac surface states are examples among a long and distinguished list. The manuscripts of this special topic present new theoretical concepts and report experimental advances in topological materials. Indeed, this young field is expanding at an amazing pace, and this timely special topic will bring readers up to date with some of the most important advances.

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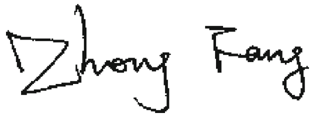

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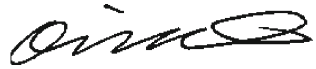

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