

Valleytronics in two-dimensional Dirac materials

Di Xiao*

Department of Physics, Carnegie Mellon University, Pittsburgh PA, 15213, United States

*E-mail: dixiao@cmu.edu

In many crystals the Bloch bands have degenerate but inequivalent energy extrema in the momentum space, known as valleys. The valley index constitutes a well-defined discrete degree of freedom for low-energy carriers that may be used to encode information. This has led to the concept of valleytronics, a new type of electronics based on manipulating the valley index of carriers. In this talk, I will describe a general scheme based on inversion symmetry breaking to control the valley index, which is based on the Berry phase effect of massive Dirac electrons. A number of valley-dependent phenomena, such as valley Hall effect, valley-dependent optical selection rule, spin-valley coupling, optical generation of pure valley current, as well as Berry-phase induced energy splitting of valley excitons will be discussed in realistic materials such as graphene and monolayer transition metal dichalcogenides.