清华大学高等研究院

Institute for Advanced Study, Tsinghua University

物理学术报告

Physics Seminars (biweekly)

Title: **Valley and spin currents in 2D transition metal dichalcogenides**

Speaker: **Dr. Wang Yao**

The University of Hong Kong

Time: **4:00pm, Wednesday, Jan 14, 2015**

(3:30~4:00pm, Tea, Coffee, and Cookie)

Venue: **Conference Hall 322, Science Building, Tsinghua University**

Abstract

The recent emergence of two-dimensional (2D) transition metal dichalcogenides (TMDs) provides a new laboratory for exploring the internal quantum degrees of freedom of electrons for new electronics. These include the real electron spin and the valley pseudospin that labels the degenerate band extrema in momentum space. I will first give an overview of the physical properties associated with the spin and valley pseudospin which allow their optical and magnetic addressability in 2D TMDs. The generation and control of spin and valley pseudospin currents are at the heart of spin and valley based electronics. I will discuss mechanisms for generating spin and valley currents of electrons in 2D TMDs including: the valley and spin Hall current arising from the Berry curvatures; and the nonlinear valley and spin currents arising from Fermi pocket anisotropy. The two effects have distinct scaling with the field and different dependence of the current direction on the field direction and crystalline axis. The two effects can be observed and distinguished as distinct patterns of polarized electroluminescence at pn junction in monolayer TMDs. The nonlinear current response further allows unprecedented possibilities to generate pure spin and valley flows without net charge current. This points to a new route towards electrical and thermal generations of spin and valley currents for spintronic and valleytronic applications. I will also discuss the valley Hall effect of charged excitons in monolayer TMDs. The exchange interaction between the electron and hole constituents of the exciton gives rise to an effective coupling of the excitonic valley pseudospin to its center of mass motion, which results in a valley Hall effect. The valley Hall effect of charge excitons can be detected from the light emission with contrasted circular polarization on the opposite edges, which leave behind valley and spin polarized electrons.