# 北京大学量子材料科学中心
# International Center for Quantum Materials, PKU

## Seminar

# Manipulating Strong Light-Matter Interactions In Graphene and 2D Semiconductors

**Sufei Shi**

*UC Berkeley/Lawrence Berkeley National Laboratory*

Time: 4:00pm, Mar. 24, 2015 (Tuesday)

时间： 2015年3月24日（周二）下午4:00

Venue: Room W563, Physics Building, Peking University

地点： 北京大学物理楼 西563

## Abstract

Graphene, a single atomic layer of carbon atoms arranged in a honeycomb lattice, has linear bandstructure which leads to its unique electronic and optical properties. Light matter interaction is particularly strong in graphene. We exploit this interaction in the visible to infrared regime for graphene based optoelectronic devices. We use both scanning photocurrent microscopy and optical pump terahertz (THz) probe spectroscopy to reveal hot carrier behavior in graphene. This hot carrier behavior is crucial to understand the effect of optical excitation on graphene and can potentially lead to efficient solar energy conversion and ultrafast optoelectronic devices. We also exploit the strong light matter interaction in THz regime to make graphene based THz modulator.

Transitional metal dichalcogenide (TMD), labelled as $MX_2$ (M - Mo, W; X - S, Se), is a new class of 2D semiconductors which undergo an indirect bandgap to direct bandgap transition when it is thinned down to one monolayer layer. $MX_2$ exhibits intriguing optical phenomena such as valley selective circular dichroism, exotic excitonic physics, etc. In particular, MX2 show unprecedentedly strong optical absorption, with one single layer absorbing more than 10% of the light. We combine optical spectroscopy and scanning tunneling microscopy to determine the extraordinarily large exciton binding energy of $MoS_2$, which is more than one order of magnitude larger that of traditional semiconductors. This large binding energy results from the strong Coulomb interaction in 2D, and $MX_2$ provides a unique platform to study exotic exciton physics. However, the giant exciton binding energy also presents a challenge for efficient carrier separation in solar cell applications. We demonstrate that, by using $MoS_2$/$WS_2$ heterostructure, we can achieve type-II band alignment and realize extremely fast carrier separation.

## About the Speaker

Sufei Shi is a Postdoc fellow at the Physics Department of UC Berkeley, working on optical spectroscopy study of two-dimensional (2D) materials. He obtained his Ph.D. degree under the guidance of Prof. Dan Ralph at Cornell Univ. in Jan, 2012. His Ph.D. research was focused on spatially-resolved and time-resolved scanning photocurrent microscopy on graphene based devices, fabrication of metal nano-contact and single electron transistor devices, as well as electrical transport measurement of these devices at ~ 10 mK and high magnetic field. Dr. Shi is currently working on optical spectroscopy of 2D materials, with a particular focus on terahertz (THz) spectroscopy. Dr. Shi will start as an Assistant Professor at the Chemical and Biological Engineering Department of Renssellaer Polytechnic Institute (RPI) from July, 2015.