# 北京大学量子材料科学中心

## International Center for Quantum Materials, PKU

# Seminar

## First-principles study of Dzyaloshinskii-Moriya Interaction


## Prof. Hongxin Yang

*中国科学院磁性材料与器件重点实验室，宁波材料技术与工程研究所*


**Time: 10:00am, May 23, 2018 (Wednesday)**

**时间：2018年05月23日 （周三）上午10:00**

**Venue: Room W563, Physics building, Peking University**

**地点：北京大学物理楼，西563会议室**

## Abstract


The Dzyaloshinskii-Moriya Interaction (DMI) between spins induced by spin-orbit coupling (SOC) in magnetic materials lacking inversion symmetry and in particular at the interface between ferromagnetic (FM) and heavy nonmagnetic (NM) metals has become recently a subject of tremendous interest for both scientists and engineers. This is because the DMI is recognized to play the most prominent role for creating topologically non-trivial textures called magnetic skyrmions which are very attractive for ultra-dense information storage and spintronic devices. Furthermore, DMI plays an essential role for fast domain wall (DW) dynamics driven by spin-orbit torques. It has been shown that the DW velocity strongly depends on the relative parameters of exchange coupling, magnetic anisotropy and the DMI. Thus, much attention has been paid on searching efficient material combinations giving rise to large DMI values at FM/NM interfaces. The choice, however, is not obvious since there are few heavy metals matching with FM counterpart used in spintronics and spin orbitronics.

The study of DMI at Pt/Co interfaces has unveiled the main features and microscopic mechanisms of DMI in NM/FM bilayers. We found that the large anticlockwise (ACW) DMI of the Pt/Co bilayers has a predominant contribution from pair couplings between the spins of the interfacial Co layer. This DMI between the interface Co spins is directly related to the change of the SOC energy in the interface Pt atoms, demonstrating the picture of Fert-Levy type interfacial DMI from first-principles.

Based on the understanding of the DMI mechanism at FM/NM interfaces , we propose several approaches to control the DMI in ultrathin magnetic films and enhance its amplitude. First, the DMI can be enlarged via multilayer stacking of FM and NM metals possessing the required DMI chiralities in corresponding FM/NM bilayers. Next approach is adding an oxidized capping layer, such as MgO, on top of a Pt/Co bilaye. We show that the DMI in Pt/Co/MgO is much larger, about 1.6 times, compared to that in Pt/Co bilayers for all the Co thicknesses considered.

Moreover, we explore the possibility of electric field control of DMI in FM/NM/Oxide structures, which opens a route towards an efficient way for controlling skyrmions.

Finally, we report the Rashba effect induced interfacial Dzyaloshinskii-Moriya Interaction (DMI) at graphene /FM interfaces


## About the speaker

**杨洪新，青年千人，中国科学院宁波材料技术与工程研究所研究员，博士生导师，中国科学院磁性材料与器件重点实验室副主任。**12年于法国获得博士学位，后陆续在巴黎十一大，澳大利亚联邦科学与工业研究中心，法国的SPINTEC实验室，CNRS与泰雷兹集团（THALES）联合物理实验室，以及日本国立材料研究所从事科学研究工作,16年获得中组部青年千人计划资助，17年加入中国科学院宁波材料技术与工程研究所，并任中国科学院磁性材料与器件重点实验室副主任。

研究兴趣主要集中在自旋电子学，已在Nature Materials, Nature Nanotech.，Phys. Rev. Lett.，Nano Letters，Advanced Materials等杂志上发表论文35篇，在铁磁金属与氧化物界面自旋电子学，5d和3d金属界面的自旋轨道电子学，自旋霍尔效应，以及石墨烯自旋电子学等领域都有文章入选ESI高引用论文。


Email: hongxin.yang@nimte.ac.cn