北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Terahertz emission probe of spin-to-charge conversion in topological materials

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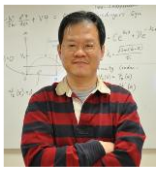

Time: 14：00 pm, July. 21, 2025 (Monday)

时间：2025年7月21日（周一）下午14：00

Venue: Room w563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

In this talk I will demonstrate some examples where terahertz (THz) emission spectroscopy were used as a probe of the spin-to-charge conversion processes in topological materials. In the ferromagnetic/topological insulator (TI) bilayer Co/Bi2Se3, we observe a giant THz emission that is predominantly spin-mediated and dominated by the topological surface states, and identify a 0.12-picosecond timescale that sets a technological speed limit of spin-to-charge conversion processes in TIs (Adv. Mater. 2018). Replacing Bi2Se3 by a monolayer semiconductor MoS2, in Co/MoS2, we demonstrate a giant spin injection from a ferromagnet into a semiconductor that is orders of magnitude larger than state-of-the-art, that is a consequence of the strongly out-of-equilibrium character of the injected spins, thus overcoming the crippling problem of impedance mismatch (Nat. Phys. 2019). A follow-up question is: can this spintronic THz emitter architecture be integrated with silicon? Our data shows the formation of silicide layer at the Co/Si interface that also shows large spin-to-charge conversion (Phys. Rev. Appl. 2022). Another follow-up question is: can we tune the THz emission of topological materials by electrical means, via controlling its quantum geometry? The answer is yes. In PMN-PT/NiFe/PtTe2, we electrically modulate the Fermi level and Berry curvature, thereby controlling its spin Hall conductivity and yielded a 20% modulation of the THz emission amplitude, performed under a constant magnetic field without field cycling or remanent magnetization (Nano Lett. 2025).

About the speaker

Elbert Chia (谢一鸣) received his B.Sc. degree (Hons 1st Class) in Mathematics from University of Auckland, New Zealand in 1991, and M.S. and Ph.D. degrees in physics from University of Illinois at Urbana-Champaign in 1999 and 2004, respectively. He was a Seaborg Postdoctoral Fellow and Postdoctoral Research Associate in Los Alamos National Laboratory from 2004 to 2007. In 2007, he joined the Division of Physics and Applied Physics, School of Physical and Mathematical Sciences, Nanyang Technological University (NTU), Singapore. He served as the Division Head from 2019 – 2022, and is the Director of the Centre for Emergent Quantum Materials (CEQM) in NTU, where they harness quantum geometry and topology to create/enhance device functionalities. His research uses visible and terahertz pulses to probe halide perovskite, topological and superconductors, as well as using a tunnel-diode-based penetration depth technique to elucidate the pairing symmetry of unconventional superconductors.