Seminar

Terahertz Nonlinear Spectroscopy for Detecting Topological Quantum Matter

Xu Yang

Nanyang Technological University

Time: 3:00 pm, Sept.2, 2024 (Monday)

时间：2024年9月2日 （周一）下午3:00

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 discuss two applications of nonlinear responses in uncovering topological nature of quantum matter.
In the first part, I will focus on the shift current, a second order nonlinear optical response. The shift current shows a divergent behavior inversely proportional to light frequency in a clean type-II Weyl semimetal. The effects of temperature and doping are discussed, which introduce cut-off energy scales and result in peaks reminiscent of the divergent behaviour. This effect originates from the singular Berry's connection in the Weyl semimetal and the Pauli-blocking mechanism, and can be used to distinguish type-I and type-II Weyl semimetals which exhibit different Fermi surface topology.
In the second part, I will discuss the use of THz pump-probe response in 2d systems to detect fractional statistics of anyons. In a pump-probe experiment, anyons excited by the pump pulse and probe pulse can braid with each other constructively, resulting in a divergent piece which is proportional to t^{3/2} times the linear response, which will dominate the response at intermediate time-scale. I will present numerical simulations in a perturbed toric-code model based on exactly diagonalization and matrix-product states to explicitly demonstrate this phenomenon. At different parameter regimes, the perturbed toric-code model exhibits different phases, whose nature can be captured by their different behavior in the pump-probe response tensors.

About the speaker

Dr. Xu Yang obtained his bachelor's degree from Peking University and his PhD from Boston College. He completed his postdoctoral work at Ohio State University and is transitioning to Nanyang Technological University as a postdoctoral researcher.

Dr. Yang's research focuses on the theoretical characterization of topological phases of matter. Specifically, he is interested in classify topological phases and in applying response theory to study their experimental signatures. Recently, he has become interested in using numerical methods based on matrix product states to study nonlinear responses as new ways to reveal the topological nature of quantum matter.

Host: 陈钢<chenxray@pku.edu.cn>