Seminar

Anomalous Transport and Magnetic Properties in Topological Phases of Matter

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Time: 16:00pm, May 28, 2018 (Monday)

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Venue: Room W563, Physics Building, Peking University

地点：北京大学物理楼 西563

Abstract

The topological phases of matter have become one of the central fields in modern physics. The past decade has witnessed the explosion of the theoretical and experimental developments in this field, expanding from the traditional 2D and 3D TIs (topological insulators), to now including the topological semimetals, notably Dirac/Weyl semimetals [1], as well as candidate correlated magnetic systems.

In this talk, after a brief introduction to the concept of topological phases of matter, I will talk about two examples of Dirac/Weyl semimetals, $ZrTe_5$ [2] and PbSnTe under pressure [3], as well as a candidate correlated magnetic system $Ln_2Ir_2O_7$ [4,5].

The key concepts of the Dirac/Weyl semimetals are that they consist of Weyl nodes which can be regarded as the effective magnetic monopoles/anti-monopoles that live in k-space (momentum space). These Weyl nodes produce strong Berry curvature or equivalently the effective magnetic field in k-space. This allows the system to manifest large anomalous Hall effect even though the system has no magnetic ordering. In ZrTe5 [2], in-situ double-axis rotator was employed to detect the full 4π solid angular dependence of the anomalous Hall signals, or effectively the strength of the Berry curvature generated by the Weyl nodes. In PbSnTe [3], manipulation of the Weyl nodes was achieved by applying pressure and the existence of a topological metallic phase protected by the Weyl nodes over a finite pressure interval was confirmed.

Next, I will talk about pyrochlore iridate $Ln_2Ir_2O_7$. In $Ln_2Ir_2O_7$, all the dipole moments sitting on the tetrahedra point either “in” or “out” and they cancel with each other completely. Interestingly, the applied magnetic field in-plane generate higher order orthogonal magnetization perpendicular to the applied magnetic field. By flipping the field cooling direction, the sign of the orthogonal magnetization changes, suggesting the order parameter is the susceptibility rather than the conventional magnetization. Surprisingly [4], the shape of the d-wave lobe pattern of the orthogonal magnetization is sensitive to the field direction when the system is field cooled. This allows the system to have multiple types of magnetic domains which were directly detected via MIM (microwave impedance microscopy) [5], a scanning technique suitable to detect the evolution of domains, domain walls and the edge states etc.

[1] S. Murakami, New J. Phys. 9, 356 (2007)
[2] T. Liang *et al.*, Nat. Phys. 14, 451 (2018)
[3] T. Liang *et al.*, Sci. Adv. 3, e1602510 (2017)
[4] T. Liang *et al.*, Nat. Phys. 13, 599 (2017)
[5] T. Liang *et al.*, Unpublished (2018)

About the Speaker

Dr. Tian Liang (梁 田) obtained his Bachelor’s degree in physics from University of Tokyo, Japan in 2009, and his Master’s degree there in 2010. He received his Ph.D. degree in physics from Princeton University, in 2016. After graduation, he moved to Stanford University as a post-doctoral research associate until now. His PhD research focused on the transport and magnetic properties in the topological phases of matter and current research focuses on microwave impedance microscopy, angle-resolved photoemission spectroscopy.