Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

"Anomalous Transport Properties in Topological Phases of Matter"

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Abstract: The notion of topological phases of matter has 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. The key concepts of the Dirac/Weyl semimetals are that they consist of 3D Weyl nodes which can be regarded as the monopoles/anti-monopoles that live in k-space (momentum space), producing strong Berry curvature (effective magnetic field in k-space).

Recently, one of the new routes to generate and manipulate the monopoles/anti-monopoles in Weyl semimetals was proposed by Murakami [1]. The picture of how a gap closes in a semiconductor has been radically transformed by topological concepts. Instead of the gap closing and immediately reopening, topological arguments predict that, in the absence of inversion symmetry, a metallic phase protected by Weyl nodes persists over a finite interval of the tuning parameter (for example, pressure P). The gap reappears when the Weyl nodes mutually annihilate. I will talk about evidence that Pb1−xSnxTe exhibits this topological metallic phase [2]. Using pressure to tune the gap, we have tracked the nucleation of a Fermi surface droplet that rapidly grows in volume with P. In the metallic state, we observe a large Berry curvature, which dominates the Hall effect. Moreover, a giant negative magnetoresistance is observed in the insulating side of phase boundaries, in accord with ab initio calculations. The results confirm the existence of a topological metallic phase over a finite pressure interval. Finally, possible future directions and some open questions are discussed.

[1] S. Murakami, New J. Phys. 9, 356 (2007)
[2] T. Liang et. al., Sci. Adv. 3, e1602510 (2017)

11:00am
Tuesday, January 16, 2018
Duboc Room (4-331)

Host: Liang Fu