Condensed Matter Physics Seminar

Shining light on topological insulators and Weyl semimetals

Thursday

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Rm 184 NSH

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The last decade has witnessed an explosion of research investigating the role of topology in band-structure, as characterized for example by the Berry curvature in momentum space in the electronic response of topological insulators (TIs) to Weyl semimetals (WSMs). In this talk I hope to convince you that optical probes of solids give unique insight into these topological states of matter. First, I will discuss how we can probe the special low-energy electrodynamics of 3D TI thin films of Bi_2Se_3 using time-domain THz spectroscopy. By measuring the low frequency optical response, we can follow their transport lifetimes as we drive these materials via chemical substitution through a quantum phase transition into a topologically trivial regime [1]. I will then discuss our work following the evolution of the response as a function of magnetic field from the semi-classical transport regime [2] to the quantum regime [3]. In the later case, although DC transport is still semi-classical, we find evidence for Faraday and Kerr rotation angles quantized in units of the fine structure constant [3]. This is consistent with the long-sought axion electrodynamics and the topological magneto-electric effect of 3D TIs. Among other aspects this give a purely solid-state measure of the fine structure constant as a topological invariant [3]. Finally, I will present our most recent discovery of giant anisotropic nonlinear optical response in transition monopnictide Weyl semimetals such as TaAs [4] and also talk about a new perspective of nonlinear optics in term of probing the Berry connection/curvature in momentum space [4]. (The focus of my talk will be on Refs. [3, 4]).

1. Wu, et al, Nat. Phys. 9, 410 (2013).
2. Wu, et al, Phy. Rev. Lett. 115, 217602 (2015).
3. Wu, et al, arXiv: 1603.04317, To appear in Science (2016).
4. Wu, et al, arXiv: 1609.04894 To appear in Nat. Phys. (2016)

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