Physics Colloquium

Quantized electro-dynamical response in topological materials

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Although solid-state systems are usually considered "dirty" with impurities and imperfections, it is still the case that macroscopic, quantized phenomena can be observed in the form of the Josephson effect in superconductors and the quantum Hall effect in 2DEG. Combinations of these measurements allow you to determine Planck's constant and the fundamental charge in a solid-state setting. In my talk, I will show you the observation of a new quantized response in units of the fine structure constant in a new class of material so called "topological insulators" (TIs). First, I will introduce what are TIs and discuss how we can probe the special low-energy electrodynamics of 3D TI thin films 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 insulator. I will then discuss our work following the evolution of the response as a function of magnetic field from a semi-classical transport regime to a quantum regime. In the latter 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. This shows that these materials may be regarded as unique magnetoelectrics with a quantized response and is consistent with the long-sought "axion electrodynamics" of 3D TIs. Among other aspects this give a purely solid-state measure of the fine structure constant based on a topological invariant. Finally, I will briefly talk about future directions of studies on quantized responses in other topological materials.

Thursday

March 9

4:00 P.M.

Rm 118 NSH

Refreshments
in Rm 202 NSH
@ 3:30 pm

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