Topological valley currents in gapped Dirac materials

By
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Host: Asst Prof Chong Yidong

Abstract

Charge carriers in materials are often described as quasiparticles similar to free electrons and can be characterized by effective quantities such as an effective mass. However, electrons in topological materials acquire an additional quantum mechanical property - Berry curvature - that can result in anomalous transport phenomena.

I will discuss how Berry curvature radically affects carrier dynamics in gapped Dirac systems, such as graphene on hexagonal-boron-nitride (G/h-BN), giving rise to transverse valley currents even in the absence of a magnetic field. Crucially, these valley currents do not depend on the presence of edge states, and persist even in the gapped system bulk. These anomalous carrier dynamics manifest naturally in G/h-BN, displaying large non-local resistances mediated by valley currents in G/h-BN devices. Importantly, topological currents in G/h-BN grant control over the valley index (an internal quantum degree of freedom), and provides a new platform/scheme to access topological characteristics in layered 2D stacks of materials.

Short Biography

Justin Song is a Burke prize fellow and Sherman Fairchild scholar in theoretical physics at Caltech. He received a BSc in physics from Imperial College London (2007), an AM in physics from Harvard (2011), and a Ph.D. in applied physics at Harvard (2014).

Justin's interests lie in developing new quantum materials, and unveiling their unique responses. These include novel charge/valley/spin/energy transport, controlling the interaction of light with matter, and utilizing electron interactions to realize new phenomena/ phases. He is also particularly attracted to theory that is intimately connected with experiments, and has predicted new phenomena for a variety of systems including two-dimensional materials such as Graphene, Dichalcogenides (MoS2, WSe2, ..) and their stacked heterostructures (e.g. G/hBN), 3D Weyl/Dirac semi-metals, and Topological Insulators.