PHYSICS COLLOQIUM:

Surprises in Transport of Particles and Energy

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Abstract

Inspired by the book "Surprises in theoretical physics" by Peierls, I will present three surprises in theoretical condensed matter physics, two of which are related to transport phenomena. The first surprise is actually from Peierls' book regarding canonical commutation relations involving operators whose eigenvalues are integers. Although Peierls gave an elegant proof of its impossibility, similar commutators are popular in the literature of superconductors. The second surprise comes from local currents of particles or energy in multi-path geometries. With suitable setups, a local current flowing against the overall driving can survive in the steady state. Moreover, the geometry-induced atypical local current can be found in quantum as well as classical systems, and their behavior contradicts the macroscopic laws. I will end with a surprise in topological edge states and their effects on transport. For topological insulators of electrons or cold-atoms, the topological edge states can be driven to transport particles through a bulk insulator. The recently realized Thouless pump is a concrete example showing quantized transport. In contrast, the topological edge states of classical mechanical systems can lead to quantized suppression of thermal transport.

About the Speaker

Chih-Chun Chien got his B.S. and M.S. in physics from National Taiwan University and his Ph.D in physics from University of Chicago. He was a director's postdoctoral fellow and then an Oppenheimer fellow at Los Alamos National Laboratory before he joined UC Merced as an assistant professor in 2014. His research mainly focuses on theoretical condensed matter physics, including superfluids and superconductors, quantum and thermal transport, topology and geometry in many-body systems, structural transitions, quantum field theory, mathematical physics, etc.