College of Natural Sciences & Mathematics
UNIVERSITY OF DENVER

Physics & Astronomy Colloquium

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Quantum Materials and Devices for Noise-Resilient Quantum Technologies

Quantum technologies promise to transform computation, communication, and sensing, much as the transistor and the internet reshaped modern society. At the heart of this transformation lies a central challenge: building quantum bits (qubits) that reliably store and process information while remaining resilient to environmental noise.

In this talk, I will present our experimental efforts to understand and mitigate noise in quantum materials, with the goal of enabling robust qubit platforms. I will outline three complementary approaches: materials with intrinsic protection, ultra-clean device fabrication, and statistically driven analysis of noise mechanisms.

The main focus will be on accessing topological properties in tellurium, a one-dimensional helical crystal. I will discuss the key experimental ingredients needed to reach the topological regime and present two sets of measurements. First, transport measurements reveal ambipolar and phase coherent transport in tellurium. Because tellurium is strongly anisotropic, we measure Zeeman splitting under in-plane and out-of-plane magnetic fields to extract its anisotropic g-factor, which is a key ingredient for engineering the topological regime. Second, in quantum dot–superconductor hybrid devices operating in the ballistic regime, we observe a magnetic-field-driven transition from 2e- to 1e-periodic charging. This is a signature of fermion parity that remains well defined on experimental timescales. Together, these results point to a promising pathway toward topological superconductivity in helical materials.