

MONDAY

COLLOQUIUM

Nonlinear Transport in Quantum Materials: Interplay of Band Geometry, Symmetry, and Disorder

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03 Aug 2026 (Monday) | 16:00 Hrs (Tea / Coffee 15:45 Hrs) | Venue: TIFRH Auditorium

Transport measurements have long been one of the most powerful tools for exploring quantum materials. In recent years, nonlinear transport has emerged as a fundamentally new probe, revealing aspects of electronic structure that remain hidden in conventional linear response. By filtering responses through crystal symmetry and band geometry, nonlinear transport provides direct access to Berry curvature, quantum geometry, disorder-induced scattering, and magnetic order.

In this colloquium, I will present a unified framework for understanding nonlinear charge, spin, and thermoelectric transport in quantum materials. Starting from the semiclassical dynamics of Bloch electrons, I will show how symmetry determines the allowed responses, quantum geometry governs the intrinsic mechanisms, and disorder shapes the experimentally observed signals. I will illustrate these ideas through recent developments in graphene-based systems, topological materials, and magnetic quantum materials, demonstrating how nonlinear transport can uncover topological phase transitions, geometric electronic properties, and unconventional spin generation. I will conclude by discussing emerging opportunities in nonlinear spintronics and spin caloritronics, where nonlinear transport is opening new avenues for probing and controlling quantum matter.