DEPARTMENT OF PHYSICS
INDIAN INSTITUTE OF TECHNOLOGY
KANPUR

PHYSICS COLLOQUIUM

SEEING THE INVISIBLE: HIDDEN CURRENTS IN QUANTUM MATERIALS

PROF. SATYAJIT BANERJEE

Department of Physics,
IIT Kanpur

Insulators are often viewed as uneventful members of the materials family--systems that simply prevent the flow of electrons. Yet, over the past several decades, the seemingly simple question "what stops electrons from moving?" has led to a profound and unexpected richness in condensed matter physics. From band insulators to correlation-driven Mott systems, and more recently to topological phases, a rich diversity of insulating states has emerged. These developments have not only reshaped our conceptual understanding of quantum materials but are also driving new directions in quantum device technologies and the design of engineered systems such as artificial lattices and photonic structures.

Among these, topological insulators occupy a particularly intriguing place. They are insulating in the bulk yet host conducting states at their boundaries, protected by the topology of their electronic wavefunctions. Understanding how currents flow--and sometimes hide and redistribute--in such systems remains a central challenge. In this talk, I will discuss our efforts to probe these questions using magneto-optical imaging and other non-contact techniques we have developed in our laboratory at IIT Kanpur. This approach allows us to directly visualise current flow in quantum materials with high sensitivity and spatial resolution. I will show images of the current distribution in topological insulators, where we observe surface-state conduction and unravel a competition between surface and bulk conduction, as well as evidence of novel states arising from strong electron-electron interactions. If time permits, I may finally briefly present some examples of our imaging in other quantum materials that exhibit metal-insulator transitions and superconductivity.

ALL ARE CORDIALLY INVITED

FB-382 (Prof. Amal Kumar Raychaudhuri Seminar Room)

Friday, April 10, 2026, at 5:15 PM
(Refreshments at 5:00 PM)