DEPARTMENT OF PHYSICS
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

PHYSICS COLLOQUIUM

MAGNETIC ANISOTROPY: THE "SWISS ARMY KNIFE" FOR SPINTRONICS

ABSTRACT

Magnetic anisotropy, originating from symmetry breaking in magnetic materials, is a fundamental parameter governing the equilibrium and dynamic behavior of magnetization. It plays a decisive role in determining spin configurations and spin-transport phenomena, thereby directly impacting both fundamental magnetism and spintronic device functionality. Despite its central importance, exploiting magnetic anisotropy as an active control knob for spin-current generation and manipulation in realistic device architectures remains a significant challenge. In this talk, I will demonstrate how magnetic anisotropy can be deliberately engineered and utilized to control the generation, directionality, and propagation of spin currents. I will show that anisotropic spin–orbit torque-driven generation of pure spin currents enables highly directional and efficient spin transport. This anisotropic spin current results in controlled anisotropic magnon propagation, opening pathways toward reconfigurable and tunable magnonic devices, logic elements, and integrated magnonic circuits. Building on this concept, I will present our recent work on uniaxial anisotropy–based spin Hall nano-oscillators (SHNOs) that operate without the need for an external magnetic field. The absence of an applied field significantly enhances device scalability and energy efficiency. These field-free SHNOs exhibit distinctive current-driven auto-oscillation characteristics, with their frequency, threshold current, and mode profiles strongly dependent on device dimensions and the strength of uniaxial anisotropy. Furthermore, I will discuss the nonlinear magnetization dynamics of field-free SHNOs, revealing a robust bistable regime that gives rise to stochastic dynamics. Such behaviour enables these spintronic oscillators to be promising candidates for energy-efficient probabilistic computing, neuromorphic architectures, and hardware-based true random number generators.

SPEAKER

Prof. Rohit Medwal
Department of Physics
IIT Kanpur

ALL ARE CORDIALLY INVITED

FRIDAY
16th Jan, 2026

05:15 PM
(Refreshments at 05:00 PM)

FB 382 (Prof. Amal Kumar Raychaudhuri Seminar Room)