TIFR Centre for Interdisciplinary Sciences
21 Brundavan Colony, Narsingi, Hyderabad 500075

Seminar

Spin-orbitronics: Electrical control of magnets via spin-orbit interaction

Pramey Upadhyaya

University of California, USA

In the recent past, motivated by lowering dissipation in information processing devices, the quest for electrical control of magnetic order has resulted in a number of important fundamental discoveries, opening a subfield in condensed matter dubbed spintronics. More recently, in this regard, the ability to engineer relativistic spin-orbit interaction (SOI) in magnetic system has provided a completely new method to control magnetic order beyond traditional spintronics; similarly resulting in a field now referred to as spin-orbitronics. In this talk I will present this spin-orbitronic control of various magnetic systems interfaced with heavy elements, which, in turn, provide the required SOI.

First, experiments on electrical current-induced switching of magnetization will be presented in a magnetically-doped topological insulator. Topological insulators are a new state of matter harboring spin-polarized conduction at its surface, owing its existence to the presence of high SOI. We find that this SOI results in transfer of angular momentum to the magnets applying so-called spin-orbit torques (SOT), which are nearly three orders of magnitude larger than those found in heavy metallic systems (where SOT was recently discovered). Next, the first room temperature demonstration of spin-orbit-induced creation and motion of topological solitons, called skyrmions, will be presented. These skyrmions have been recently proposed as ideal candidates for information carriers in magnetic devices, motivated by which, I will then present a strategy to control skyrmions via electric-field-induced SOT. Uniquely, SOT can be applied even on insulating magnets, which can then be used to excite and transport information via collective excitations of magnets. In this regard I will then discuss the possibility of excitation of a spin-superfluid mode in magnets at room temperature. This spin-superfluid mode provides a method to transfer angular momentum in a nearly dissipationless fashion, which I will demonstrate in a specific model of superfluid-induced soliton motion. More importantly, this spin-superfluidity has many characteristics similar to its charge counterpart, opening up the possibility of exploring its spin analogues and possibly new applications. I will conclude by showing this specifically via demonstration of a Josephson-like phenomenon in a magnet controlled simultaneously by current and electric-field-induced SOT.

Tuesday, Oct 27th 2015

4:00 PM (Tea/Coffee at 3:45 PM)

Seminar Hall, TCIS