S N BOSE NATIONAL CENTRE
FOR BASIC SCIENCES
Block JD, Sector III, Salt Lake, Kolkata 700 106

DEPARTMENTAL SEMINAR

Condensed Matter and Materials Physics

10th November,2022 **4.00 PM** **ONLINE/ FERMION**

SPEAKER

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TITLE OF THE TALK

SPIN-ORBITRONICS WITH METALLIC ANTIFERROMAGNETS

ABSTRACT

Louis Néel famously described antiferromagnets (AFMs), a class of magnetic materials for which he was awarded the Nobel prize, as "interesting but useless". The alternating arrangement of moments and net-zero magnetization have left AFMs virtually unexploited or poorly explored, in striking contrast to the thousands of years of fascination and utility of their counterparts (i.e., ferromagnets (FMs)). On the other hand, several unique features prevalent in AFMs such as ultrafast spin dynamics, macroscopic relativistic and quantum-mechanical effects, and robustness against external perturbation makes them outstanding candidates for the investigations of radically new spin manipulation and transport concepts in condensed matter physics, leading to the development of future spintronic devices and applications.

Here, I will present our arduous yet rewarding progress on antiferromagnet (AFM)-based spintronics. First, we will briefly elucidate the manifestations of spin-orbit interactions in metallic AFMs, a crucial ingredient for harnessing charge-to-spin conversion phenomena and stabilizing topologically protected chiral magnetic textures, both enormously important owing to their potential for future spintronic devices. Using this charge-to-spin conversion effect, we will demonstrate magnetization switching of an adjacent FM in AFM/FM heterostructure [1,2]. Contrary to convention, magnetization switching occurs in an analog manner, controllable from a multi-level to binary nature, and enabling the demonstration of proof-of-concept synapse and neuron, promising for the development of spintronics-based neuromorphic architectures [3]. Building from these results, we will then introduce a novel pathway where AFMs emerge as the active component of spintronic devices, enabling the transfer of information in a FM-free architecture. Pertinent questions concern electrical detection and manipulation of AFMs and spin textures without net magnetization. Using an AFM/heavy metal (HM) structure, we will show all-electrical reversible switching and detection of the antiferromagnetic Néel vector and

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its associated switching dynamics [4]. We will also show the realization of topologically protected chiral skyrmion bubbles in an AFM, which could be set into motion by much smaller current densities compared to FM counterparts [5]. Our results offer significant insights towards the understanding of spin-transport, manipulation, and dynamics of AFMs, facilitating the development of next-generation magnetic memories, neuromorphic and quantum-inspired computing architectures.

References:
(1) S. Fukami, S. DuttaGupta et al., Nature Materials 15, 535 (2016).
(2) S. DuttaGupta et al., Applied Physics Letters 111, 182412 (2017).
(3) A. Kurenkov, S. DuttaGupta et al., Advanced Materials 31, 1900636 (2019).
(4) S. DuttaGupta et al., Nature Communications 11, 5715 (2020).
(5) T. Dohi, S. DuttaGupta et al., Nature Communications 10, 5153 (2019).

HOST FACULTY

Prof. Priya Mahadevan, Sr. Professor & HoD : CMMP

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