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Block JD, Sector III, Salt Lake, Kolkata 700 106

DEPARTMENTAL SEMINAR

Condensed Matter and Materials Physics

23 January,2024 **4.00 PM** **ONLINE/ FERMION**

SPEAKER
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TITLE OF THE TALK

MAGNETIC TUNNEL JUNCTIONS WITH SPIN-SPLIT COLLINEAR ANTIFERROMAGNETS

ABSTRACT

Magnetic tunnel junctions (MTJs) are key components in a spintronic device, such as magnetic random-access memories (MRAM) [1]. The key functional property of MTJs is tunnelling magnetoresistance (TMR) that is a change in MTJ's resistance when magnetization of the two electrodes alters from parallel to antiparallel. The relative orientation of these layers encodes binary data (0 or 1), and the electrical resistance varies accordingly. The conventional MRAM employs MTJs with two ferromagnetic layers separated by an insulating tunnel barrier. Compared to the FM-based MTJs, antiferromagnetic (AFM)-based MTJs can offer a new paradigm for next generation of magneto resistive RAM application. This is due to the advantages of antiferromagnets producing no stray fields and exhibiting ultrafast magnetization dynamics. Also, AFM-based MTJs have high endurance, low power consumption. The conventional AFM metals have spin-degenerate fermi surfaces, resulting in vanishing TMR. Thus, conventional AFM metal cannot be exploited as an electrode in the MTJs. In this direction, we have explored and demonstrated the possibility of designing a room temperature AFM tunnel junction with giant TMR [2], considering a collinear AFM metals, such as rutile RuO2, exhibiting a momentum dependent spin split polarization due the broken PT and $Ut_{1/2}$ symmetry (P is space inversion, T is time reversal, U is spin flip, and $t_{1/2}$ is half a unit cell translation). However, the detection of the AFM order parameter, known as the Néel vector, through magnetic or electric means poses a challenge for implementing AFM tunnel junction in practical MRAM devices. To overcome this issue and to offer a practical test for using the spin-split AFMs in practical functional spintronic devices, here I will talk about our recently proposed [3] an antisymmetric magnetic tunnel junction and show that large TMR can occur in antisymmetric MTJs with a single FM electrode provided that counter electrode is an AFM metal that supports a spin-split bands structure.

[1] E. Y. Tsymbal and I. Žutić, Eds., Spintronics Handbook: Spin Transport and Magnetism, 2nd edition (CRC press, 2019).
[2] YY. Jiang, ZA. Wang, K. Samanta, SH. Zhang, R. Xiao, W. J. Lu, Y. P. Sun, E. Y. Tsymbal, & DF Shao, Phys. Rev. B 108, 174439 (2023).
[3] K. Samanta, YY Jiang, T. R. Paudel, DF Shao and E Y. Tsymbal (arXiv:2310.02139, Review under Phys. Rev. Lett. , LK18311).

HOST FACULTY

Dr. Saquib Shamim, Assistant Professor

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