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

SPEAKER

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TITLE OF THE TALK

ATTOSECOND VISION AND CONTROL OF ELECTRON DYNAMICS IN QUANTUM SYSTEMS

ABSTRACT

Direct access to the oscillations of the electric field within light grants a remarkable capability to achieve sub-cycle attosecond (1 as = 10-18 sec) time resolution, which has been recognized by the Physics Nobel Prize in 2023. This level of precision is essential for the observation and manipulation of electronic behavior in matter, operating on its natural timescale [1, 2]. In this presentation, I would like to present the fascinating realm of lightwave attosecond metrology [3, 4] and its profound impact on the ability to visualize ultrafast processes within unique quantum systems. These insights are virtually unattainable through conventional pump-probe spectroscopy methods. In particular, I shall show the attosecond time resolved dynamic information when an electron moves within a large molecular system probing its microscopic environment [5] or what happens to a plasmonic system in the quantum limit as it undergoes excitation into the collective modes [6]. Furthermore, I shall demonstrate how meticulously designed lightwaves, under sub-cycle control, can be harnessed to coherently engineer the band structure and topological properties of two-dimensional quantum systems [7]. This also manifests a new strong field regime of fundamental symmetry driven Valleytronic [8] operation, which makes it universal, non-material-specific, non-excitation light-specific [7]. This innovative approach holds the potential to serve as the foundation for the next generation of dissipation-less lightwave-electronics operating in the petahertz (PHz) range.

References:
1.Hentschel, M. et al. Attosecond metrology. Nature 414, 509-513 (2001).
2.Corkum, P. B. & Krausz, F. Attosecond science. Nature Physics 3, 381 (2007).
3.Mitra, S., Biswas, S. et al. Suppression of individual peaks in two-colour high harmonic generation. Journal of Physics B: Atomic Molecular and Optical Physics 53, 134004 (2020).
4. Schotz, J., Biswas, S. et al. Phase-Matching for Generation of Isolated Attosecond XUV and Soft-X-Ray Pulses with Few-Cycle Drivers. Physical Review X 10, 041011 (2020).
5.Biswas, S. et al. Probing molecular environment through photoemission delays. Nature Physics 16, 778-783 (2020).
6.Biswas, S. et al., Attosecond correlated electron dynamics at C60 giant plasmon resonance. arXiv:2111.14464 (2022) (Under review of Science).
7. Mitra, S. et al.,...., Biswas, S. Lightwave controlled band engineering in quantum materials. arXiv:2303.13044 (2023) (Under review of Nature).
8. Schaibley, J. R. et al. Valleytronics in 2D materials. Nature Reviews Materials 1, 16055 (2016)

HOST FACULTY

Prof. Anjan Barman, Senior Professor

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