



S N BOSE NATIONAL CENTRE
FOR BASIC SCIENCES

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

DEPARTMENTAL SEMINAR

Condensed Matter and Materials Physics

17th June 2026

12.00 Noon

ONLINE / FERMION

SPEAKER



Dr. Subhra Sen Gupta, Assistant Professor
Department of Physics, School of Natural Sciences,
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TITLE OF THE TALK

Quantum Chaos and the Nature of Eigenstates in Disordered Quantum Spin Systems and some Special Random Matrix Models

ABSTRACT

The physics of disordered, interacting systems is still an unsolved problem, as is expected, since even the problems with just strong correlations (no disorder) or arbitrary disorder (and no correlations) are themselves profound problems in their own right.

In this Talk, I will outline our investigations of Quantum Chaos and Integrable-to-Chaotic transitions in some interacting Quantum Spin models with intrinsic disorder and/or coupled to inhomogeneous random magnetic fields, as signalled by changes in both short-range and intermediate-range spectral (eigenvalue) correlations (Nearest Neighbour Spacings Distribution - NNSD, Ratio Distribution - RD, Next Nearest Neighbour Spacings Distribution - nNNSD etc.) within the Random Matrix Theory (RMT) framework [1-3]. We have also carried out a detailed analysis of corresponding eigenstates (wavefunctions) across the full spectral range, via a study of multifractal dimensions (generalised Shannon Entropies) as well as singularity spectra in these systems [4]. Based on this study we are able to trace transitions between Ergodic and Many-body Localized (MBL) phases in these systems. It turns out that the multifractal behaviour in the quantum chaotic regime is quite complex and differs significantly from that seen in the standard RMT ensembles. A further study of certain special Random Matrix models sheds more light on the origin of this complex behaviour [5].

I will try to keep the Talk at a level accessible to students and to a broader Physics audience in general, by introducing necessary concepts as and when needed.

References:

- [1] "Spectral crossovers and universality in quantum spin chains coupled to random fields": Debojyoti Kundu, Santosh Kumar, Subhra Sen Gupta*, Phys. Rev. B 105, 014205 (2022).
- [2] "Signatures of Spectral Crossovers in the Short- and Long-range Spectral Correlations of a Disordered Spin-chain with Kramers Degeneracy", Debojyoti Kundu, Santosh Kumar and Subhra Sen Gupta*, Phys. Rev. B 107, 094205 (2023).
- [3] "Beyond Nearest-neighbour Universality of Spectral Fluctuations in Quantum Chaotic and Complex Many-body Systems", Debojyoti Kundu, Santosh Kumar and Subhra Sen Gupta*, Chaos 35, 043122 (2025) [Editors' Pick].
- [4] "Non-uniform Wavefunction Multifractality in Disordered Quantum Spin models", Debojyoti Kundu, Deepak Kathyat and Subhra Sen Gupta* (Manuscript in Preparation).
- [5] "Non-uniform Eigenstate Multifractality in some Special Random Matrix models", Amrita Ahuja and Subhra Sen Gupta* (Manuscript in Preparation).

HOST FACULTY

Prof. Priya Mahadevan
