凝縮系物理学ゼミナール
Condensed Matter Theory Seminar
Date: 13:30-15:00, Wednesday, 16, April 2025

Title: Quantum Chaos and Random Matrices:

Speaker: Dr. Tanay Pathak

Language: English

Abstract:

Quantum chaos and random matrix theory are intimately related [1]. The presence of eigenvalue correlations, in a quantum chaotic system, is often regarded as a key signature of quantum chaos. Bohigas-Giannoni-Schmit (BGS) conjecture dictates that these correlations are described by random matrix theory. Another way to look for signatures of quantum chaos is to examine the properties of eigenvectors of these systems. The eigenvectors can be used to obtain the entanglement spectrum, which has universal features of its own, and is described by well-known random matrix ensembles as well.

Most studies of eigenvalues and the entanglement spectrum focus on bulk properties. However, there are other important random matrix properties such as the extremal (maximum) eigenvalue which also has universal behavior described by certain extreme value distributions [2]. These extreme value statistics can serve as a stringent test of random matrix features in quantum chaotic models.

In this talk I will describe some of our recent explorations [3,4] of entanglement spectrum in certain quantum many-body models. Despite being quantum chaotic the maximum eigenvalue of the entanglement spectrum, in these models, shows deviations from random matrix theory expectations. I will then discuss in detail to what extent such deviations impact the thermalization properties of these systems, properties which should ideally follow the random matrix behavior.

References:

[1] Thomas Guhr, Axel Müller–Groeling, Hans A. Weidenmüller, Phys.Rept.299:189-425,1998.

[2] Satya N. Majumdar, Arnab Pal, Gregory Schehr, Physics Reports 840, 1 (2020).

[3] Tanay Pathak arXiv:2501.19244.

[4] Tanay Pathak, Masaki Tezuka – Work in progress.