RMT Summer School in Japan 2025

September 8–12, 2025 — Kyoto University

Schedule

Time	8 (Mon)	9 (Tue)	10 (Wed)	11 (Thu)	12 (Fri)
09:20–10:40	—	Guionnet I	Guionnet II	Nahmod IV	Guionnet IV
11:10–12:30	—	Nahmod II	Erdős II	Guionnet III	Erdős IV
12:30–14:00 (Lunch)					
14:00–15:20	Erdős I	Nahmod III	—	Erdős III	—
15:50–17:10	Nahmod I	Poster session	—	Poster session	—

Location: Room 401, Building 6

Lecturers and Abstracts

Alice Guionnet (ENS Lyon)

Lecture: Large deviations for the largest eigenvalue of large random matrices, and applications

Abstract: In this mini-course I will review several recent large deviation results for large random matrices, and their relations with spin glasses and the study of the volume of local minima of random functions. We will discuss in particular their universality and how universality is broken by the localization phenomenon.

Andrea Nahmod (University of Massachusetts Amherst)

Lecture: Random Tensor Theory, Propagation of Randomness, and Nonlinear Dispersive PDE

Abstract: The study of randomness in partial differential equations (PDEs) goes back more than seventy years. Nonlinear dispersive PDEs naturally appear as models describing wave phenomena in quantum mechanics, nonlinear optics, plasma physics, water waves, and atmospheric sciences. One way in which randomness enters the field of nonlinear dispersive PDE is via the random data Cauchy initial value problem for (deterministic) equations, such as the nonlinear Schrödinger (NLS) and the nonlinear wave equations (NLW). The interest comes from two fundamental problems: (1) invariance of measures such as Gibbs measures which are physical equilibria for these systems; arising naturally in statistical mechanics and closely related also to QFT models such as the Φ^4, and (2) the study of generic behavior of solutions in the probabilistic sense, and how they are expected to be better than worst case (exceptional) scenarios.

The study of this subject in the context of dispersive PDEs can be traced back to Lebowitz–Rose–Speer (1988, 1989) and Bourgain (1994, 1996) concerning the Gibbs measure for NLS. Since then there have been substantial developments of their ideas by many different researchers, extending them in different directions (geometric, infinite volume, other dispersive relations). In recent years, this field has seen significant progress and many new ideas and methods have been introduced. In this mini-course we will explain the method of random averaging operators and the theory of random tensor (both by Y. Deng, A.N. and H. Yue) as well as new bilinear tensor norms introduced in subsequent work also with B. Bringmann. These new methods have led to the resolution of several important open questions in this field, and are expected to play more important roles in future developments. The aim of this course is to provide the foundations upon which these recent developments have built upon, in particular Bourgain's seminal work in the subject.

László Erdős (IST Austria)

Lecture: Multi-resolvent local laws and their applications

Abstract: Classical local laws in random matrix theory assert that the resolvents of large random matrices tend to be deterministic even for spectral parameters very close to the real axis. They are robust and provide essential a priori bounds for eigenvalue and eigenvector distributions that are routinely used in more sophisticated analysis. Products of resolvents also tend to be deterministic, but they are not simply given as a product of single resolvent approximations. In this series of lectures we present a theory of multi-resolvent local laws. The proofs are dynamical, they rely on the so-called zig-zag strategy; a successive alternate application of two different stochastic flows. In the second part of the lectures we focus on applications that include the proof of the Eigenstate Thermalisation Hypothesis and the Law of Fractional Logarithm for general Hermitian random matrices, as well as CLT for linear eigenvalue statistics and the Gumbel law for extremal eigenvalues for non-Hermitian random matrices.

Poster Sessions

Poster sessions will take place on Tuesday and Thursday from 15:50 to 17:10.