



PhD Course 2026

FISICA MATEMATICA - 3.3 Modulo 3. Giorgio Cipolloni (Tor Vergata)

Titolo: The mystery of universality in random matrices

Periodo di erogazione: Marzo 2027 (3 o 4 settimane entro Pasqua)

Abstract

We begin with classical random matrix ensembles and the study of their eigenvalues and eigenvectors, introducing fundamental questions about spectral distributions, eigenvalue spacings, and eigenvector (de)localization. The central theme is the Wigner–Dyson–Mehta universality: for broad classes of random matrices, local eigenvalue statistics depend only on the symmetry class, i.e., they do not depend on the distributions of the matrix elements. We will present a proof of this phenomenon for Wigner matrices through a dynamical approach based on Dyson Brownian motion, explaining how relaxation to local equilibrium produces universal spectral statistics. The course will conclude with selected connections to disordered and interacting quantum systems, including random Schrödinger operators and examples drawn from the Sachdev–Ye–Kitaev (SYK) model. Time permitting, we will also discuss connections between random matrix statistics and the zeros of the Riemann zeta function as well as machine learning.

