Topics in Random Matrix Theory (PHY684.1)

Jac Verbaarschot

First Meeting: Thursday, January 21th, 3.00 p.m. in C133

The main topic of this special topics lecture are Random Matrix Theory, QCD and Quantum Chaos. I will discuss the mathematical methods of Random Matrix theory and its applications different fields in physics ranging from atomic physics to quantum gravity. Students attending these lectures are recommended to attend the lecture of Prof. Aleiner as well.

I. Random Matrix Theory

1. Spectra of complex systems
2. Statistical theory of spectra
3. Random matrix ensembles
4. Orthogonal polynomials
5. Universality

II. Mathematical Methods

1. Super-symmetric method
2. Super-Riemannian manifolds
3. Super-group integrals and integration theorems
4. Itzykson-Zuber type integrals
5. Calegero-Sutherland-Moser models
6. Color-flavor transformations and Kontsevich integral
7. Coherent States

III. Applications of Random Matrix Theory

1. Spectra of compound nuclei
2. Anderson localization
3. $S-$matrix fluctuations
4. Universal conductance fluctuations
5. Random surfaces and quantum gravity

IV. Quantum Chaos

1. Semiclassical quantization
2. Semiclassical sum rules
3. The Bohigas-Giannoni-Schmit conjecture
4. Perron-Frobenius operator
5. The Riemann ζ function

V. QCD

1. Symmetries of the QCD Partition Function
2. Lattice QCD
3. The QCD Dirac spectrum
4. The low energy limit of QCD and the chiral Lagrangian
5. Partially quenched chiral perturbation theory
6. Connection between QCD and Random Matrix Theory
7. QCD at nonzero temperature and finite density

VI. Non-Hermiticity

1. Problems of Non-Hermiticity in QCD
2. Non-Hermitean Random matrix theory
3. Directed chaos
4. Dissipative systems

The time spend on each of the topics depends on their significance and on the interest of the students. Additional suggestions are welcome
Looking forward to see you during the first meeting!