Technische Universität Dresden
Fakultät Physik, Institut für Theoretische Physik
Prof. Dr. R. Ketzmerick

Chaos and Quantum Chaos

Summer term 2021

Homework - Quantum Chaos (2 out of 3 required)

H4 Random Matrix (Due: Monday 21.06.2021, 10:00)

Set up a GOE random matrix for $N = 500$ (or larger) with variance $\frac{1}{2N}$ on the diagonal.

a) Determine the density of states and compare to the Wigner semicircle law.
Hint: eigenvalues should be in the interval $[-1, 1]$ *with few exceptions.*

b) Unfold the spectrum with the analytic prediction for the average density of states
Hint: ignore eigenvalues outside the interval $[-1, 1]$.

c) Determine the nearest-neighbor level-spacing distribution $P(s)$ for the unfolded spectrum and compare to the Wigner surmise.

Hand in the resulting figures for a) and c).
Hint: You get more convincing comparisons when averaging over several matrices or for larger N.

H5 Quantum Kicked Rotor: Eigenstates (Due: Monday 12.07.2021, 10:00)

Determine the eigenstates of the time-evolution operator for the kicked rotor on the torus for $K = 2.5$. Compare their Husimi-representation with classical phase-space structures. Choose a small effective Planck's constant, e.g. $h = \frac{4\pi^2}{500}$ or smaller.

Hand in Husimi-representations of 4 interesting eigenstates (with classical phase-space structures plotted on top) and your program (any programming language).

H6 Quantum Kicked Rotor: Time evolution (Due: Monday 12.07.2021, 10:00)

Analogous to H5 consider the time evolution of a wave packet.

Hand in Husimi-representations of three wave packets after 10 iterations (with classical phase-space structures plotted on top), where the initial wave packet is a coherent state started in i) the chaotic sea, ii) the main regular island, and iii) the period 4 island and your program (any programming language).