Quantum Mechanics of a rotating Billiard

Nandan Jha\textsuperscript{a}, Sudhir R. Jain\textsuperscript{b}

\textsuperscript{a} High Pressure and Synchrotron Physics Division, Bhabha Atomic Research Centre, Trombay, Mumbai-400085

\textsuperscript{b} Nuclear Physics Division, Bhabha Atomic Research Centre, Trombay, Mumbai-400085
corresponding author: nandanj@barc.gov.in

Integrability of a square billiard is spontaneously broken as it rotates about its centre [1]. The system becomes quasi-integrable where the invariant tori are broken with respect to a certain parameter, $\lambda = 2E/\omega^2$ where $E$ is the energy of the particle inside the billiard and $\omega$ is the angular frequency of rotation of billiard. We study the system classically and quantum mechanically in view of obtaining a correspondence in the two descriptions. In a finite set of levels, the spectral statistics shows a transition from Poisson to Wigner distribution as the system turns chaotic with increase in $\lambda$. At the same time, it is also observed that a very long sequence of energy levels will have Poisson-distributed fluctuations. The amplitude distribution of the eigenfunctions also corroborates a region where transition from order to chaos is observed. In all, we have treated the system comprehensively and believe that the results found have significant applications to the physics of rotating nuclei and clusters.

Figure 1: Poincare surface section of phase space for $\lambda = 10^4, \lambda = 10^3$, $\lambda = 10^2$ and $\lambda = 2 \times 10^1$

Figure 2: Level spacing distribution for $\omega=5$, 500 and 2000. The distribution changes from Poisson to Wigner as $\omega$ increases.