Ergodicity and quantum correlations in irrational polygonal billiards

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The present work consists of a numerical study of the dynamics of irrational polygonal billiards. Specifically triangular and symmetrical shapes. Our contribution reinforces the hypothesis that these systems can be strongly mixing, although never demonstrably chaotic [1]. The absolute value of the position correlation function $\mathrm{Cor}_x(t)$ decays like $\sim t^{-\sigma}$. Fast ($\sigma \simeq 1$) and slow ($0 < \sigma < 1$) decays are observed, thus indicating that the irrational polygons do not share a unique ergodic dynamics, which, instead, may vary smoothly between the opposite limits of strong mixing ($\sigma = 1$) and regular behaviors ($\sigma = 0$) [2]. Spectral statistical properties of the quantized counterparts are computed from hundreds of thousands eigenvalues numerically calculated for each billiard. Gaussian Orthogonal (Unitary) Ensemble spectral fluctuations are observed when $\sigma \simeq 1$ for singlets (doublets) states. Intermediate statistics are found otherwise. For $0 < \sigma < 1$, formulas for intermediate quantum statistics have been derived for the doublets [2]. We also discuss the role of rotational C_n symmetries on the polygonal boundaries [3]. For odd, small values of n, the exponent $\sigma \simeq 1$ is found. On the other hand, $\sigma < 1$ (weakly mixing cases) for small, even values of n. Intermediate n values present $\sigma \simeq 1$ independently of parity. For larger values of symmetry parameter n, the biparametric family tends to be a circular billiard (integrable case). For such values of n, we identified even less ergodic behavior at the pace at which n increases and σ decreases [3].

References

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