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Quantum Chaos and Complexity in Triangular Billiard Systems

In light of recent advancements made towards quantifying quantum chaos in dynamical systems, and motivated by the search for viable definitions of complexity in quantum field theory and holography, we revisit pseudo-integrable quantum billiards and examine the recently proposed measure of Krylov state complexity known as spread complexity. In particular, we investigate the growth of Krylov state complexity in the system of triangular billiard systems with both rational and irrational angles, which we take to be the boundary of two-dimensional infinite potential boxes. While classically, these billiards exhibit zero Lyapunov exponent, quantum mechanically they display exponential growth of out-of-time-order-correlations (OTOC) and Krylov complexity. We further investigate higher moments of Krylov state complexity as well as new universality classes among them. Normally, the level spacing statistics follow Gaussian orthogonal ensemble statistics, but deviations caused by scarring and superscarring mechanisms occur. We check the effect of these mechanisms on the growth of complexity and quantum chaos in such billiards in general. We find general results regarding effects of symmetry and topology in the dynamics of chaotic billird systems. This work has future directions of using new quantum chaos quantifiers to establish a quantum mechanical ergodic hierarchy.

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