STRUCTURE OF STANDING WAVES IN CHAOTIC DYNAMICAL SYSTEMS

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Project Description:
When a dynamical system exhibits simple, regular behavior due to a high level of symmetry (for example, the motion of a billiard ball on a rectangular or circular pool table without friction), the corresponding excitations or standing wave patterns (for example, the waves that can be excited on a rectangular or circular drumhead) are similarly simple. There is a direct correspondence between the billiard ball motion and the waves on the drum, known as classical—quantum correspondence, or ray—wave correspondence in optics. In dynamical systems that exhibit unstable, chaotic behavior (for example, motion on a pool table with an irregularly-shaped boundaries), the possible excitations (standing wave patterns on a drumhead with an unusual shape) are much more complex, but still bear imprints of the corresponding billiard-ball dynamics. This research involves a combination of theoretical work and computer simulations. It has possible application to multiple areas of physics such as atomic, nuclear, molecular, optical, microwave, and nanoscale physics.

Project Objectives:
The goal is to increase our understanding of how we can use information about billiard-ball bounces to make predictions about the statistical properties of drum oscillations. In particular, we want to extend our current understanding of this problem to a variety of distance scales, predicting wave patterns on scales much larger than or much smaller than a single wavelength. We also want to understand how existing theories can be extended to situations where the wavelength becomes comparable to the size of the drumhead, or where the irregularities are very strong.

Prerequisites or Experience Required:
Some familiarity with computer programming (any language) is very desirable. This research would be most appropriate for a student with a strong interest in theoretical science, applied mathematics, or numerical computation.