Contributed Talk

Quantum Langevin Equation: An Approach to Dissipative Quantum Soft Impact Oscillator

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An impact oscillator is a system consisting of a mass-spring system with a wall in front of it. In the case of a soft impact oscillator, the wall is connected with another spring (stiffer than the previous one) as shown in Figure 5. In the classical forced

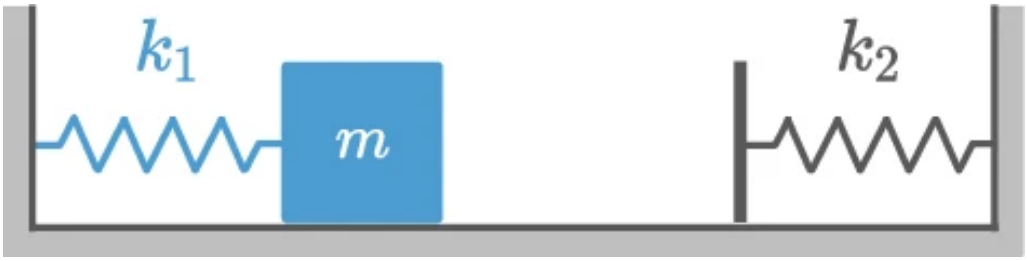

Figure 5: Schematic diagram of soft impact oscillator

impact system, collisions with the boundary result in sudden transitions to chaotic behavior, displaying multi-stability and chaotic attractors. We investigate the dynamical aspects of quantum chaos in a piecewise smooth system. Quantum chaos is often explored through a static lens, primarily focused on eigenvalue statistics of classically chaotic systems. In contrast, this study aims to investigate the dynamic aspects of quantum chaos within piecewise smooth systems, as already done without dissipation in [1].

Our work addresses the impact of dissipation on quantum dynamics, specifically with time-dependent forcing. We consider the quantum Langevin equation (following [2]) to tackle the challenges posed by infinite-dimensional quantum systems. We are studying the dynamics currently for $\hbar = 0.01$ for numerical stability issues.

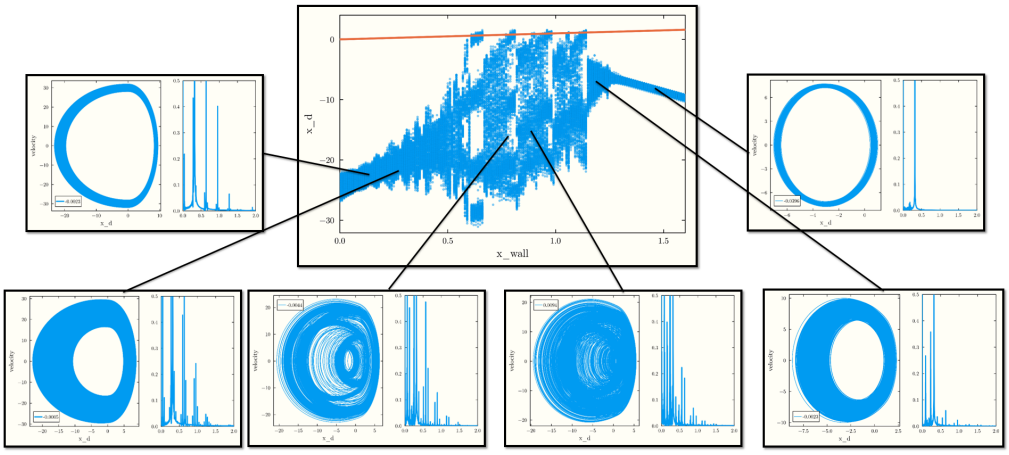

Figure 6: Trajectories for different wall positions for forcing amplitude $F = 10$

This paper reports some interesting bifurcation diagrams similar to classical ones in the quantum regime by varying the wall position as a parameter and analyzing the dynamics of these trajectories (see Figure 6).

References

[1] Arnab Acharya, Pratik Jeware, and Soumitro Banerjee. Objective collapse induced by a macroscopic object.

[2] Barik, Debashis, Bidhan Chandra Bag, Deb Shankar Ray. Numerical simulation of transmission coefficient using c-number Langevin equation. The Journal of Chemical Physics, 119(24):12973-12980, 2003.