Physical Mathematics Seminar

Bouncing droplets as a damped-driven system

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ABSTRACT:

Damped-driven systems are ubiquitous in science, however the damping and driving mechanisms are often quite convoluted. This talk presents a fluidic droplet on a vertically vibrating fluid bath as a damped-driven system. Fortunately, the damping and driving in the present system are relatively segregated. By separating the two mechanisms, we show that the droplet exhibits similar bifurcations present in other more complex damped-driven systems. In this investigation we study a fluidic droplet in an annular cavity with the fluid bath forced above the Faraday wave threshold. We model the droplet as a kinematic point particle in air and as inelastic collisions during impact with the bath. In both experiments and the model the droplet is observed to chaotically change velocity with a Gaussian distribution leading to diffusion-like behavior. In addition, the forcing above the Faraday wave threshold on the fluid bath simplifies the wave dynamics to that of a standing wave, which allows us to explicitly segregate the damping and driving mechanisms. The energy gain comes from the kinematics of the droplet between impacts, and the energy loss comes from the hydrodynamic damping at impact. We show that this energy gain-loss formulation exhibits dynamical behavior canonical to a wide range of damped-driven systems. The bifurcations and route to chaos present in the droplet system reveals analogies with other well-studied systems from optics, detonation, and electronics. This also hints at analogies with many more systems that have yet to be analyzed in detail, and paves a framework with which other systems can be analyzed.

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