

Interaction of a bouncing ball with a sinusoidally vibrating table

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Exploring all its ramifications, this presentation gives an overview of the simple yet fundamental bouncing ball problem, which consists of a ball bouncing vertically on a sinusoidally vibrating table under the action of gravity. The dynamics is modeled on the basis of a discrete map of difference equations, which numerically solved fully reveals a rich variety of nonlinear behaviors, encompassing irregular non-periodic orbits, subharmonic and chaotic motions, chattering mechanisms, and also unbounded non-periodic orbits. For periodic motions, the corresponding conditions for stability and bifurcation are determined from analytical considerations of a reduced map. Through numerical examples, it is shown that a slight change in the initial conditions makes the ball motion switch from periodic to chaotic orbits bounded by a velocity strip $v = \pm \Gamma / (1 - \epsilon)$, where Γ is the non-dimensionalized shaking acceleration and ϵ the coefficient of restitution which quantifies the amount of energy lost in the ball-table collision. Moreover, a detailed numerical discussion of the excitation of the unstable 1-periodic mode and the ensuing transition to its stable counterpart mode is also given.