ABSTRACT

Planar dynamics of a particle, a spherical ball, and a dimer on an elastic surface carrying a harmonic traveling wave is studied. The particle-surface interaction in the case of a particle is assumed to be inelastic both normally and tangentially, and the surface is assumed to provide a kinematic boundary condition to the particle. In this setting, we search for periodic hopping solutions of the particle. The results point to a rich variety of possible particle trajectories which include periodic and chaotic motions. Interestingly, coexisting distinct multi-period attractors are observed over a frequency band. In the case of a mutually non-interacting multi-particle system, we observe ballistic and diffusive transport in inter-leaved frequency bands. The results from an analytical treatment of the hopping problem coincide with the results of the classical bouncing ball problem extended to three-dimensional configuration space. The particle is subjected to bi-directional momentum bound to arrest practically unyielding impact conditions. The particle, in general exhibits a mix of sticking and sliding modes of motion besides hopping. In the case of finite-sized bodies, the interaction with the surface is considered to be through Coulomb friction as opposed to the coefficient of tangential restitution in the case of particles. The problem of the planar impact of a rigid body with frictional interaction is solved using Routh's impact process diagram. The ball is found to exhibit rolling with or without slip besides hopping mode of motion, giving rise to frequency-dependent current resulting in primary and secondary resonance points with transversal zero crossings. The double impact in the dimer is modeled using the impulse correlation ratio derived for a dimer on a compliant foundation. The dimer is observed to admit periodic drift and jump-drift modes leading to chaos via period-doubling and bifurcation route. A range of simple to complex periodic behavior with coexisting stable orbits are noted in the dimer.

Keywords: vibration induced transport, particle hopping, stability, bifurcation, drift velocity, impulse correlation ratio, coexisting periodic attractor, double impact, rolling, sticking, sliding.