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THE DRIFT PHENOMENA OF A RIGID BODY COLLIDING AGAINST AN OSCILLATED PLANE

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ABSTRACT

Strongly shaken rods in a oscillated plate exhibited surprising self-organization, such as the swarming and swirling motion. The underlying physical mechanism leading to the large-scale collective behavior is the noneccentric frictional collisions between the rods and the vibrated plate. Obviously better understanding the mechanism of the frictional collision of a rigid body is crucial to discover the connection between the microscopic origins and the macroscopic phenomena. In this paper, we focus on studying a simple system with frictional collision presented by S. Dorbolo [1], in which a rod connected with two steel spheres colliding against with a oscillated plate.

Depending on the geometry and the incident velocity of the body, three different modes of persistent motion of the rod are observed in Dorbolo's experiments when the rod hits the oscillated plate: the flutter (F) mode and the the jump (J) mode as well as the drift (D) mode. In particular, the rod in D-mode will experience complex collisions including individual and double collisions with friction that may take variety of tangential motions (slide, slip stick, and slip reversal). In order to reproduce the experimental phenomena, this paper will base on the method presented in [2] to deal with the complex impact problems. The feature of the method is that the evolution of energy during impacts is mapped into the impulsive-velocity level by stretching the time scale into the impulsive scale, such that multi-impact processes can be described as a set of differential equations with respect to a normal impulse. The local energy loss will be confined by an energetic constraint defined by the Stronge's energetic coefficient.

For the bouncing dimer experimentally investigated in [1], we find that the stick motion and the double impacts occurring at the contact points are the crucial factors of influencing the global behavior of the dimer. The drift motion of the dimer with a direction either positive or the negative depends on the tangential velocity at the left contact point. If $Ar \leq 5$, the double impacts will make the direction of the tangential velocity changes from negative to positive, while the single impact or slip in this case, will make its value change from positive to negative. Since the integration with the time for the positive tangential velocity will be greater than the one of the tangential velocity with negative value, so the positive drift motion will occur in the case of the $Ar \leq 5$. However, with the increase of A_r, the critical value of the friction coefficient μ_s^* for the occurrence of the stick motion during double impacts will decrease. If this value is less than the static friction coefficient at contacts, stick motion will occur during

double impacts, such that the tangential velocity at contact point can not pass through zero point. This will make the left tip of the dimer move only along a unilateral direction. So the negative drift motion will occur.

In conclusion, this talk will present a reasonable illustration for the phenomenon of the drift motion occurring at the dimer. Moreover, an approximated formula for the mean drift velocity of dimer will also be presented, that seems to well agree with the experimental results.

REFERENCES

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