TORNADO SPHERE

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ARTICLE INFO

Winner of Bronze Medal , ICYS 2019, Malaysia

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Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI

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ABSTRACT

In this research we are going to investigate a phenomenon which two joined steel balls together are spinning at incredibly high frequency. Their first spinning is by hand and then blowing on them through a tube, e.g. a drinking straw. There are relevant parameters such as , ball diameter, velocity of blowing and surface friction.

(This is a short explanation)

1 Introduction

Hurricane balls are a simple spinning toy formed of two steel balls welded together. When spun by hand on a smooth surface with little friction, the spin rate can be significantly increased by blowing on the edge of one of the balls through a tube (e.g. a straw). The movement of hurricane balls has three steps: 1.rising 2.speeding 3.steady, that in steady-state situation, the double-sphere rolls without slipping during its motion. Also one of the balls separates from the table so it has an angle with horizontal axis [1].

2 Theory and Methods

To calculate the angel, we need to calculate the potential and kinetic energy, and then with lagrangian approach we'll find θ (angle) according to angular velocity [2].

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}}\right) - \left(\frac{\partial L}{\partial \theta}\right) = \frac{\partial L}{\partial \theta} = 0$$

$$\theta = 90 \rightarrow I_3\ddot{\theta} = 2mgr - I_1\dot{\psi}\dot{\phi}$$

$$\ddot{\theta} > 0 \rightarrow 2mgr > I_1\dot{\psi}\dot{\phi}$$

$$\rightarrow \dot{\psi}\dot{\phi} > \frac{2mgr}{I_1}$$

3 Experiment

We used two ball bearings and joined them together (with glue) (Fig. 1), so we had constructed double-spheres of different sizes. The distance between two ball bearings was other parameter which we used three and four balls between our main balls to have different distances. Then we recorded their motion using a camera, 240 frames per second. At last we analyzed our videos using video analysis program tracker , then by blowing in a tube we got the time, θ and number of frames around the axis of the rotation with tracker until the end of the video (when θ is zero) (Fig.2)

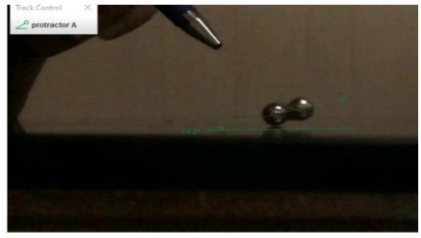

Fig.1: Blowing with a tube to see rolling of the hurricane ball

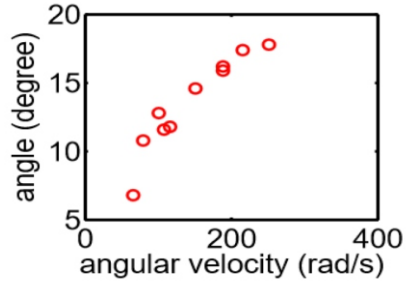

Fig. 2: The angle from the surface according to the angular velocity (d=1cm)

4 Results and Discussion

At last as a general result, we found:

- As the angular velocity increases, the angle (θ) increases with horizon.
- There is a minimum angular velocity that if (***ω***)is less than that, the phenomenon doesn't occur.
- We have maximum θ too.

References

[1] Brett J. , Mertens, P D, Jackson, D P (2015), " Hurricane Balls: A Rigid-Body-Motion ". Project for Undergraduates.

[2] Walker,J, Halliday & resnick(9th edition).