The Relation between Rotation and The Distance a Bouncy Ball can travel

Ryota Oka Kosuke Tanaka Toma Tanigawa

【Purpose】

To examine how rotation of the bouncy ball influences distance it travels.

【Research Method】

First, we estimated how long the ball travels without spinning.

Next, we compared the estimate with the results of following experiment.

【Experiment Method】

<Equipment>

Chair, rail, ball, string, tape, measure, camera, ruler, garbage can, gummed tape, felt-tip pen and foam polystyrene.

1. Make a device as you can see.
2. Roll the ball on the rail and launch it horizontally. Then, take photos of the situation where the ball bounces two times.
3. Change the height of the rail and roll the ball again. Do it 9 times.
4. Measure the distance the ball moved, angular velocity of the ball and height the ball jumped.
5. Compare with the estimate.

【Estimate】

- The height the ball jumps = h
- Repulsion coefficient = e
- The distance between the rail and the first point the ball bounced = ℓ_1
- The distance between the rail and the second point the ball bounced = ℓ_2
- The height of the highest point the ball reached after the first bounding. = h'

(The value of "e" was "0.920", for we measured it.)

Table1: Estimate (without spin)

Height Launched	From 10cm	From 15cm	From 20cm
h'	37.2cm	37.2cm	37.2cm
ℓ_1	32.9cm	41.9cm	47.9cm
ℓ_2	60.6cm	77.1cm	88.1cm

【Experiment Result】

Table2: Result

Height Launched	10cm	15cm	20cm
h'	36.6cm	36.1cm	36.0cm
ℓ_1	32.7cm	41.7cm	46.0cm
ℓ_2	54.3cm	74.3cm	84.0cm
Velocity①	1.08m/s	1.36m/s	1.61m/s
Velocity②	0.993m/s	1.37m/s	1.55m/s
The Angle of incidence①	22.5π/s	29.8π/s	33.9π/s
The Angle of incidence②	20.2π/s	27.1π/s	29.7π/s
Rotational speed at the surface①	1.10m/s	1.45m/s	1.65m/s
Rotational speed at the surface②	0.984m/s	1.32m/s	1.45m/s

【Consideration】

We couldn't see how the rotation effect on the distance because estimate and result are almost the same (①).

The angle of incidence, reflection and the angle of impulse are these;

Table3: The Angle of incidence, reflection and impulse

	10cm	15cm	20cm
Incidence	20.2°	24.9°	61.2°
Reflection	69.7°	62.8°	59.7°
Impulse	89.1°	90.1°	88.4°

So, the ball didn't get the impulse to horizontal direction (②). Therefore, horizontal velocity before bouncing and after it was almost the same. So ①.

And the reason of ② is, we think, because the horizontal velocity and rotational speed was almost the same.

However, from these, we got the supposition that

The difference between the horizontal velocity and rotational speed of the ball has an effect on the distance the ball moves.