

The Relationship Between a Rotated Sphere and Internal Fluid

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1. Motivation

Previous research showed that when a fluid-filled sphere with BB pellets inside is rotated and then stopped, the pellet begins to move chaotically and accelerates. We became interested in this phenomenon.



figure1 Photo of previous research

2. Purpose

To clarify the mechanism of the movement observed in previous research.

Chaos state ... No pattern movement.

3. Experiment I

【Purpose】

To observe the movement of the fluid in more detail.

【Hypothesis】

Similar movement could be observed with spangles or glitter, which consist of many particles and are easy to spread throughout the fluid.

【Methods】

- use the same device as in previous research
- make a small hole with an awl and put BB pellets, glitter and spangles
- fill the sphere with water by using syringe
- fix the sphere to the device and rotate for 35 seconds

【Results】

When BB pellets was used, the chaos state continued for 1.23 seconds on average, while with glitter for 0.76 seconds. In the experiment with spangles, we couldn't observe a chaos state.

【Discussion】

Spangles stacked on the surface. That's why chaos status couldn't be observed. Glitter spread throughout the sphere, so it is better to catch its movement.

A spiral movement (figure2) was observed so we consider that it has something to do with the movement. The fluid started to rotate on surface side (figure3). the movement gradually spread (figure4) after the rotation stopped, and the speed gradually slowed by friction (figure5).

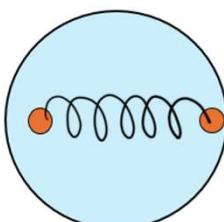


figure2

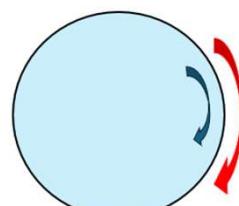


figure3

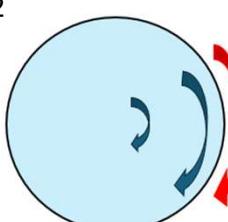


figure4

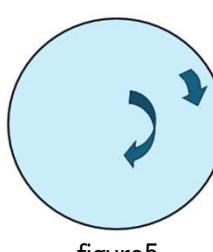


figure5

4. Experiment II

【Motivation】

We wondered what would happen if friction increased due to higher viscosity.

【Hypothesis】

If we increase the viscosity, the duration will become shorter.

【Method】

Water and thickening powder were mixed to make four types of fluid (0.50%, 0.10%, 0.25%, 0.050%)(g/ml) After this, all other procedures were the same as Experiment I .

【Result】

Chart1 Result of Experiment II

0.50%	It behaved like a solid and nothing happened after the plastic sphere stopped.
0.10%	While the plastic sphere was spinning, it moved like water, but when it stopped spinning, it slowed down.
0.050%	As with water, chaotic states and re-acceleration were observed.
0.0% (water)	Chaotic states and re-acceleration were observed.

※0.25% was the same as 0.10%

【Discussion】

We think 0.050% was too small, the situation was similar to water, so chaotic state was observed.

In the other experiment, the viscosity was too high and different from water. We consider that friction prevents the fluid from keeping a chaos state.

5. Future Directions

In Experiment I using BB pellets, when the sphere was rotated for a longer time, the chaos state became shorter. When it was rotated enough, it accelerated immediately after the rotation stopped, without a chaos state. So, we are going to change the rotation duration and observe its movement and whether a chaotic state occurs or not.

6. Reference

Hikonehigashi High School, physics B group, 2023