Athletic Twisting Robot Experiment
(Acrylic Stick Experiment)

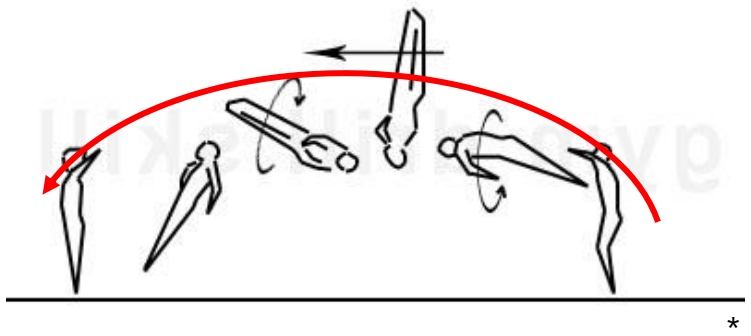
Shingo Nishimoto

School of Engineering

College of Engineering, Computing, & Cybernetics

The Australian National University

Gymnastics twist motion

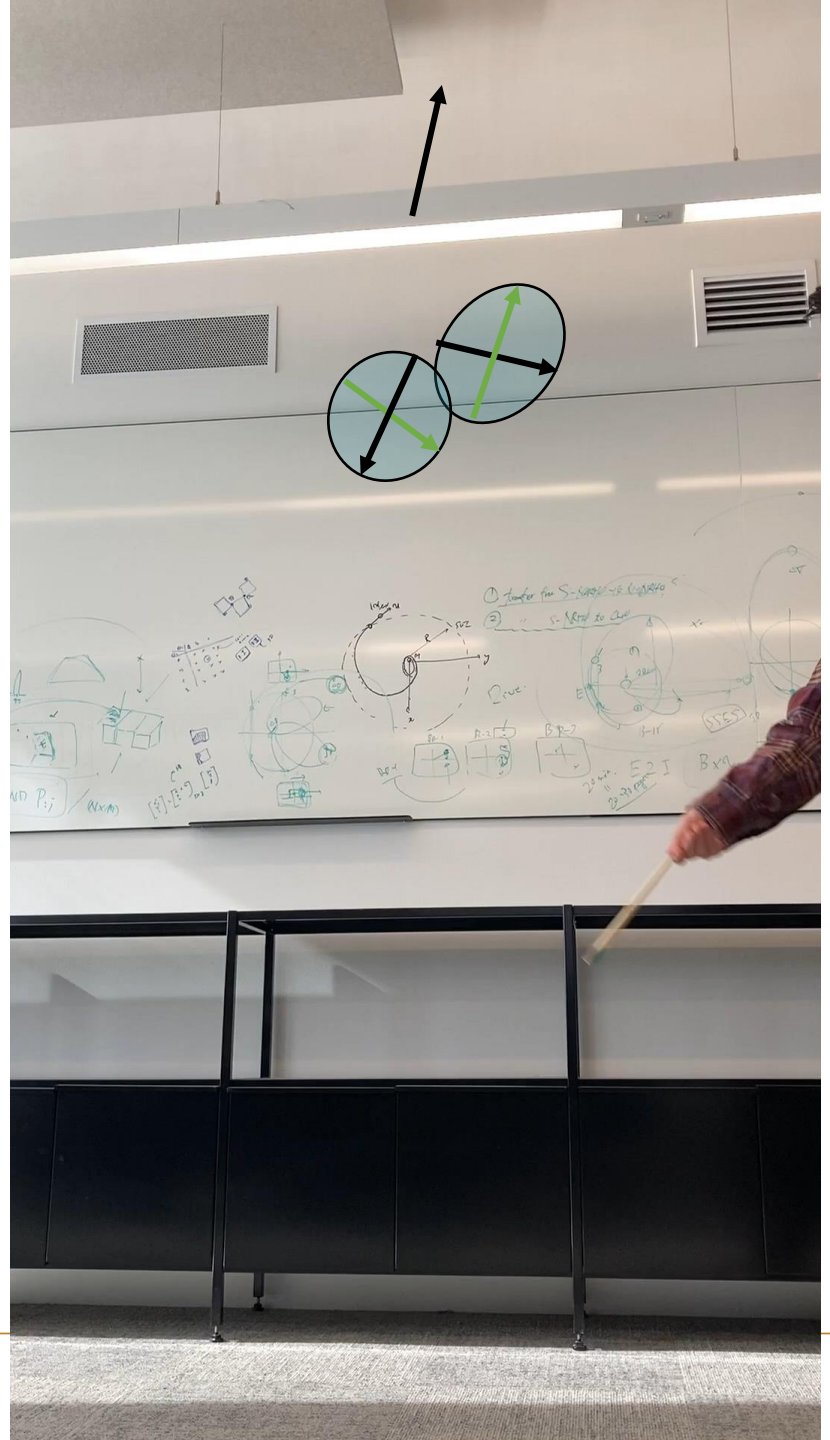


*

With no twist torque by kicking floor.
Twist source is in a big revolution (red) (angular momentum).
Body deformation extracts twist motion around body axis.

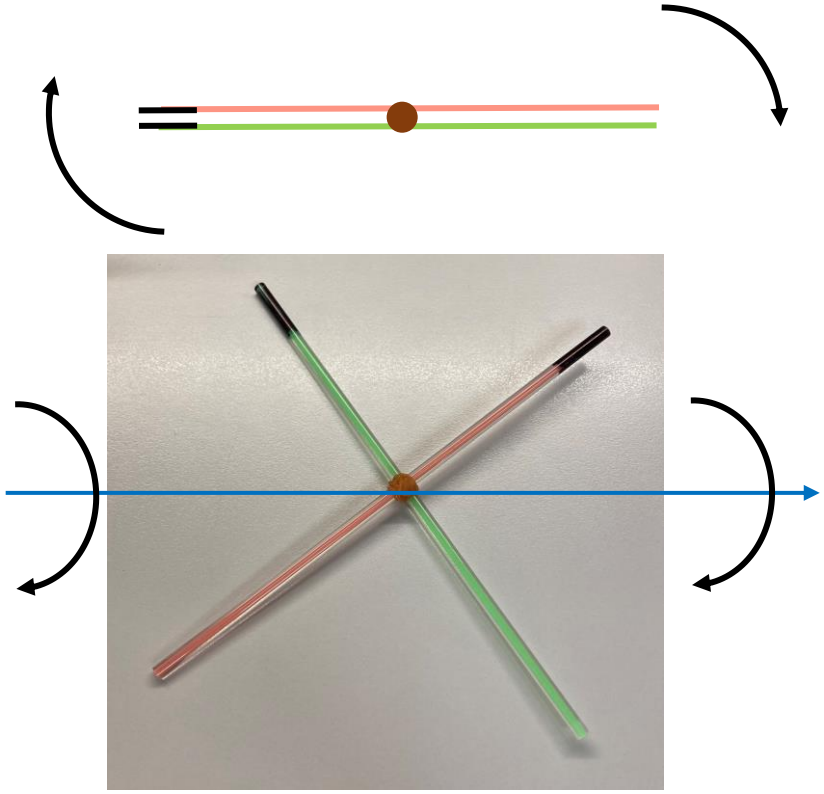
Expected results in ISS

- Sticks stay **longer time at the same place**, which enables us to observe the motion longer and better.
- Comparison of experiment A and B will show the different results (**with/without twist motion**).

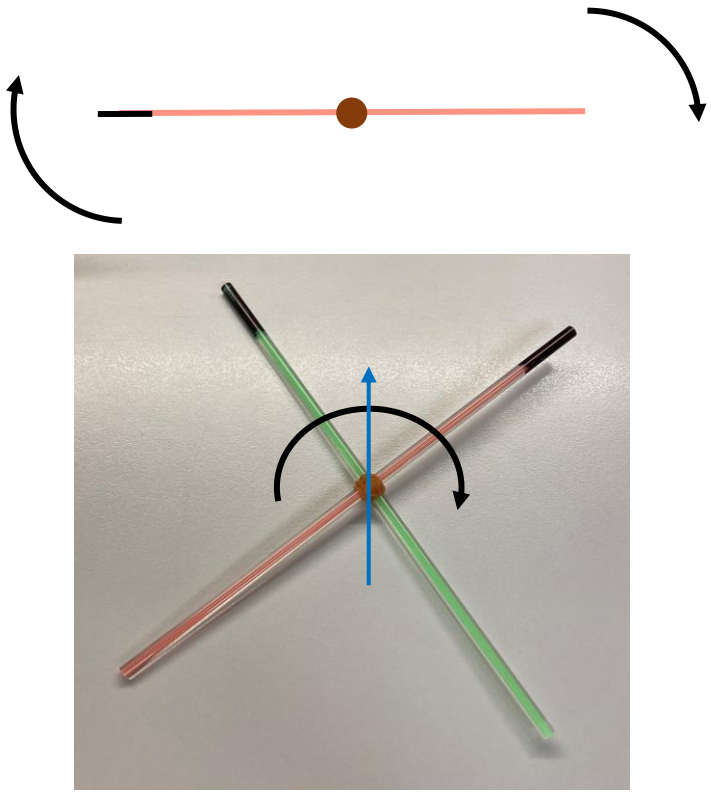


*: http://www.gymdrills4profs.com/gymnastics-events/skill-drills-floor/gymnastics-floor-front-full.php

Experiment A



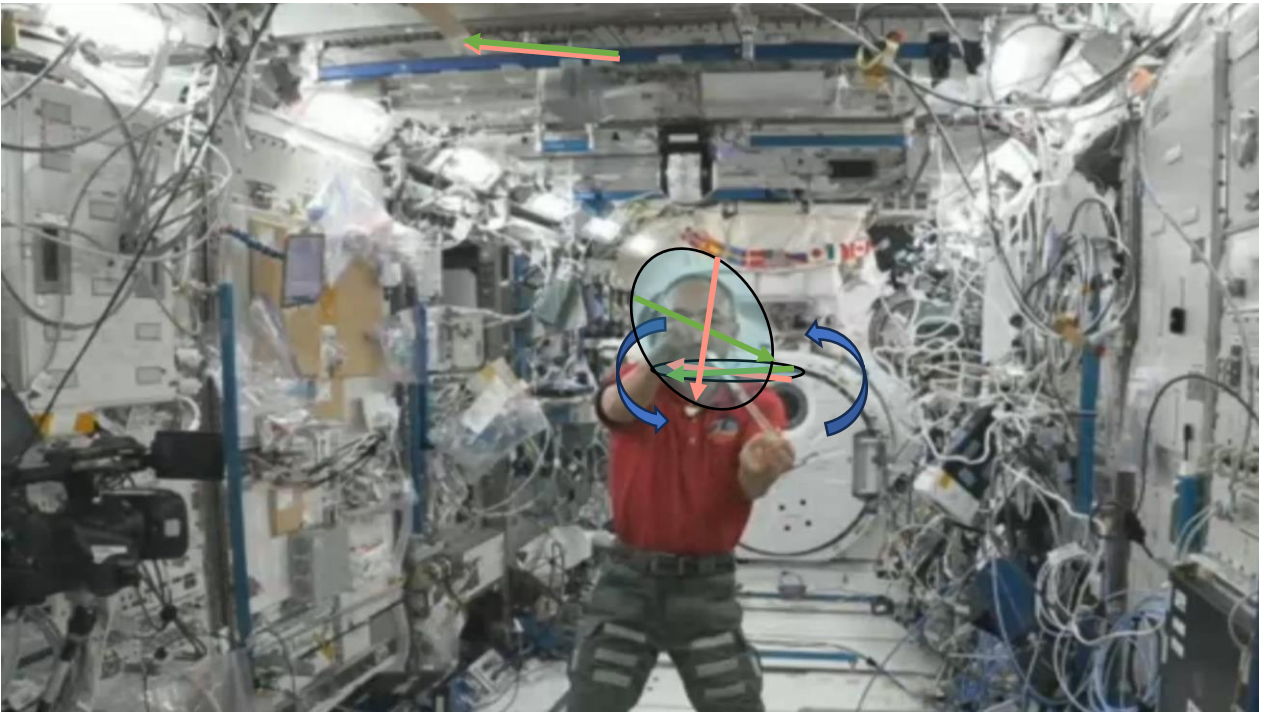
Experiment B



- When the blue rotation axis **lies in the body-cross plane** (the plane that looks like the letter X) through deformation, **twist motion appears**. (Experiment A)
- When the blue rotation axis remains **normal to body-cross plane** through deformation, **nothing happens**. (Experiment B)

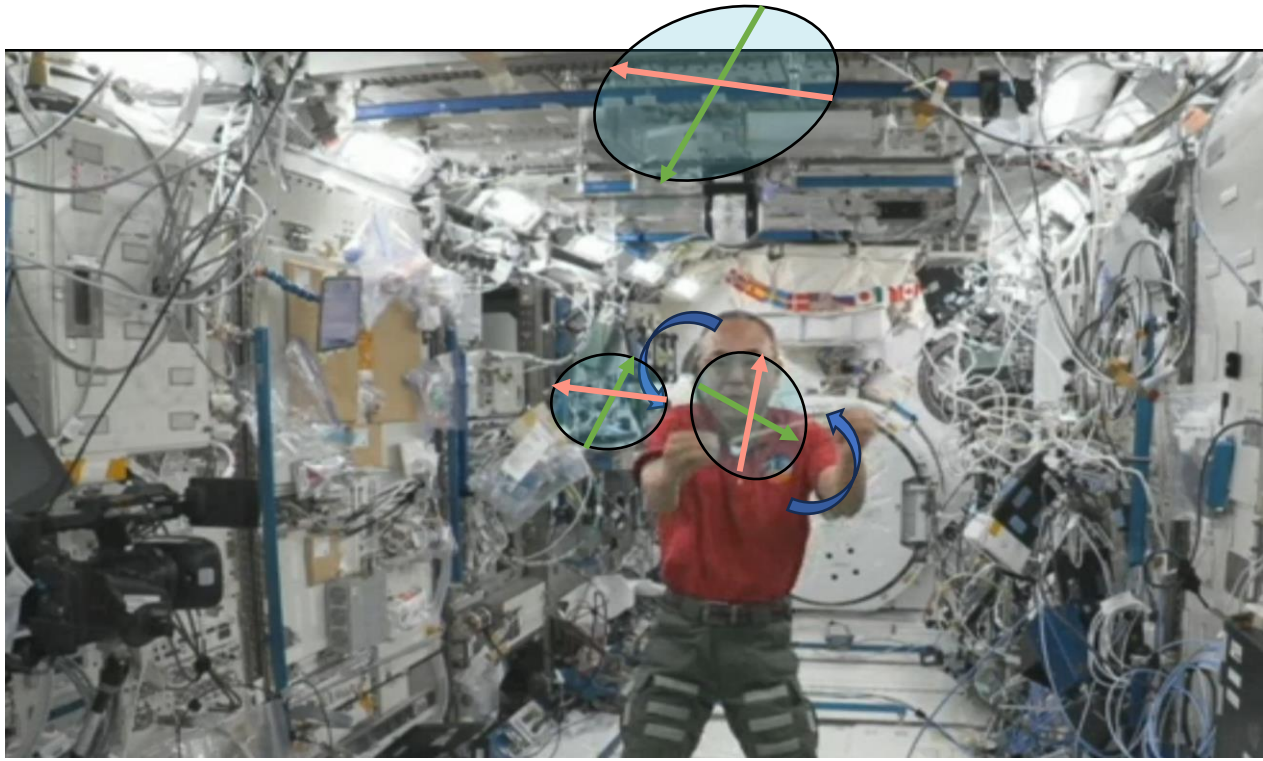
Experiment A

- Once sticks are deployed, **the rotation axis remains in the body-cross plane**.
- A twist motion appears (The body-cross plane is rotating, so looks like both **a line and X**.)



Experiment B

- Once sticks are deployed, **the rotation axis becomes orthogonal to the body-cross plane**.
- The body-cross plane continues to face the camera, so **always looks like X**.



Summary

Results

- **We could see the twist motion for longer than on the ground and different motions between experiment A and B,** although it was not perfect.
- It was hard to see the twist motion easily in real-time due to the fast rotation speed (shown video is in $0.1 \times$ original speed).
- The unintended translation motion was acting. Even though it was small, **sticks moved fast due to the microgravity**.

Lessons Learned

- Hard to perform it in a microgravity environment, the better releasing way should be considered.
- **The one of sticks should be shorter than the other**, which makes them similar to the human body and arms.

Acknowledgement

I appreciate all who supported me throughout this experiment.