

# Behaviors of the magnus effect in zero-gravity

Presentation of Wrap-up Session





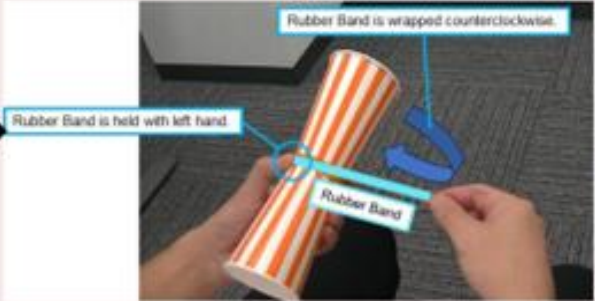





Asian Try Zero-G 2023 Call for Proposal 2024/06/09

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# Category A : Simple Physics Experiments 5

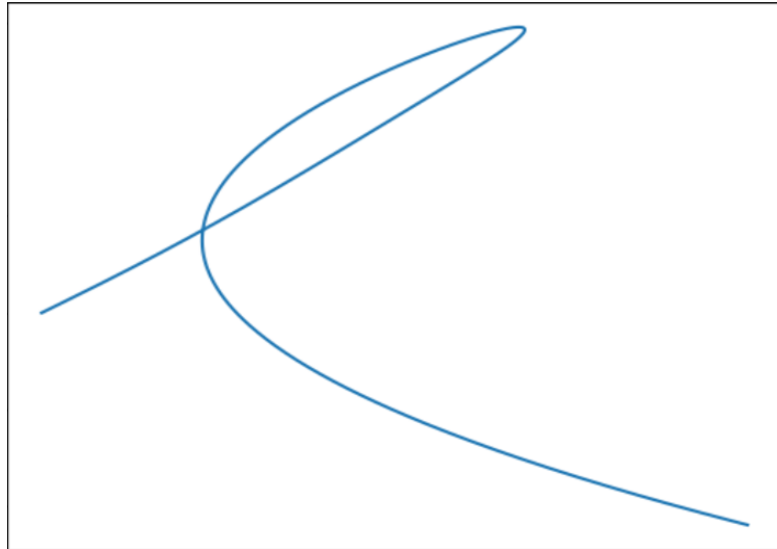


Experiment Title (Proposer's Country/Region)	MAGNUS GLIDER EXPERIMENTS (Taiwan, Singapore)			
Description	Goal of this experiment is to observe the trajectory of Magnus Glider in microgravity.			
Items/Configuration	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Cup (Magnus Glider) (1)</p> </div> <div style="text-align: center;">  <p>Rubber Band (1)</p> </div> <div style="font-size: 2em; margin: 0 10px;">→</div> <div style="text-align: center;">  <p>Rubber Band is held with left hand</p> <p>Rubber Band is wrapped counterclockwise.</p> </div> <div style="text-align: center;">  <p>Rubber Band extends under Cup</p> <p>Cup</p> </div> </div>			
Run#	<p style="text-align: center;">1</p>  <p>Number of Turns of Rubber Band: 2 Direction: Horizontal</p>	<p style="text-align: center;">2</p>  <p>Number of Turns of Rubber Band: 4 Direction: Horizontal</p>	<p style="text-align: center;">3</p>  <p>Number of Turns of Rubber Band: 2 Direction: Downward</p>	<p style="text-align: center;">4</p>  <p>Number of Turns of Rubber Band: 4 Direction: Downward</p>

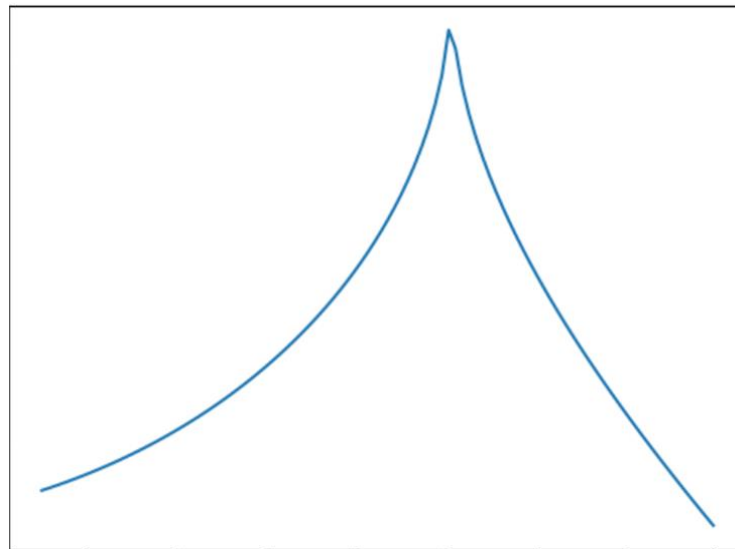
# Three Types of Experiment Hypothesis on the Ground



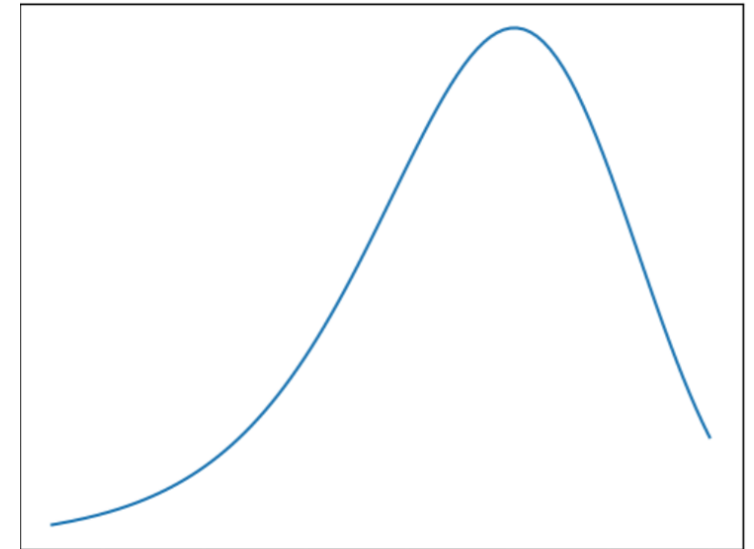
Twirling Motion



Peak Motion



Curve Motion



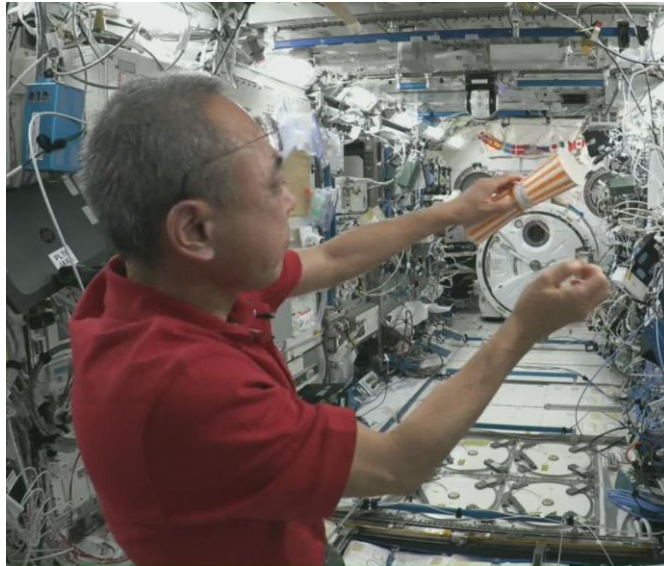
$$Re = \frac{2RV}{v} \text{ and } S_p = \frac{\omega R}{V}$$

$$m \frac{dv_y}{dt} = \left[ -\frac{1}{2} C_D \rho S \right] V_y |V_y| - \rho V_y (2\pi r^2 \omega)$$
$$m \frac{dv_x}{dt} = \left[ -\frac{1}{2} C_D \rho S \right] V_y |V_y| - mg + \rho V_x (2\pi r^2 \omega)$$

◆ Reynold's Number and Spin Number

◆ Resultant Differential Equations

# Experiment Procedure on International Space Station



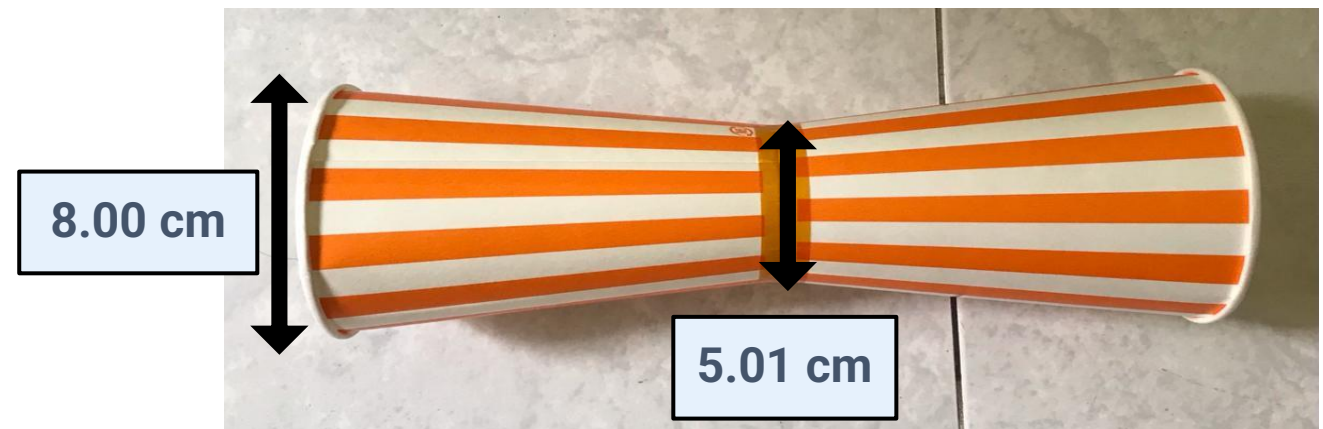
**Wrapped the Rubber Band**



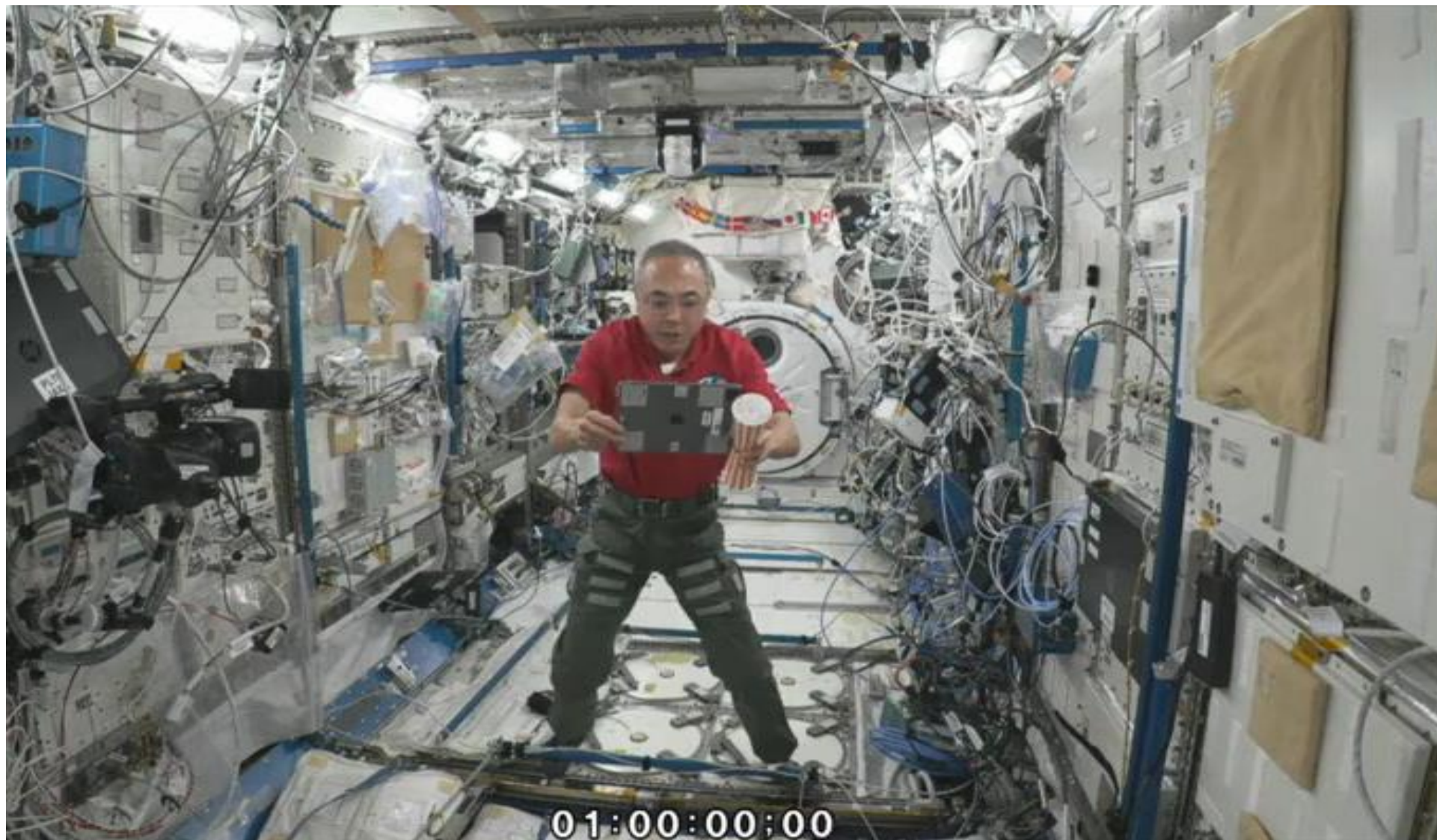
**Rubber Band extends under Cup**



**Release the Magnus Glider**



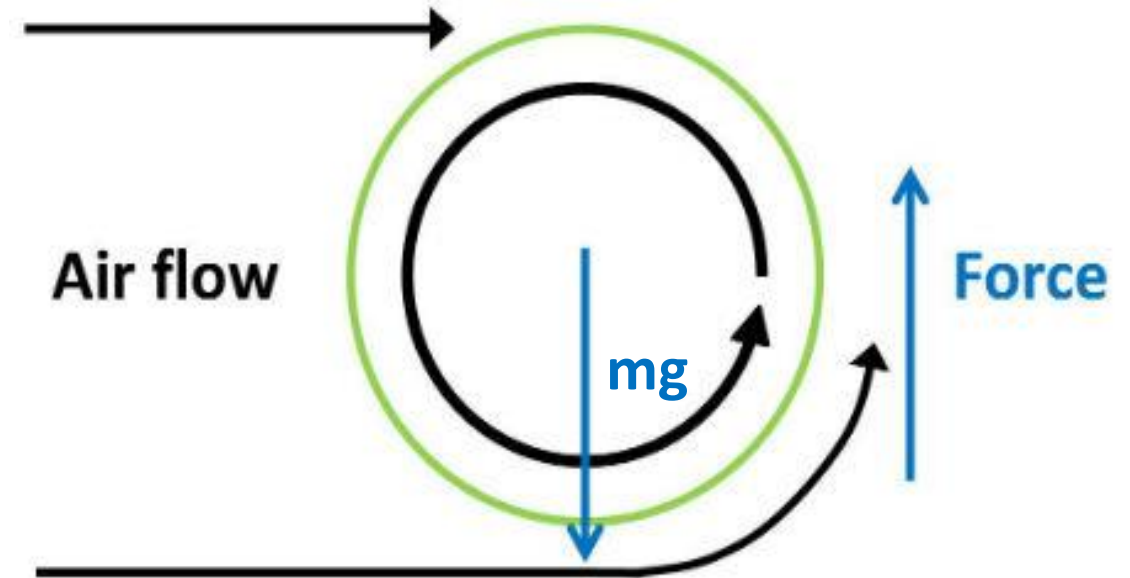
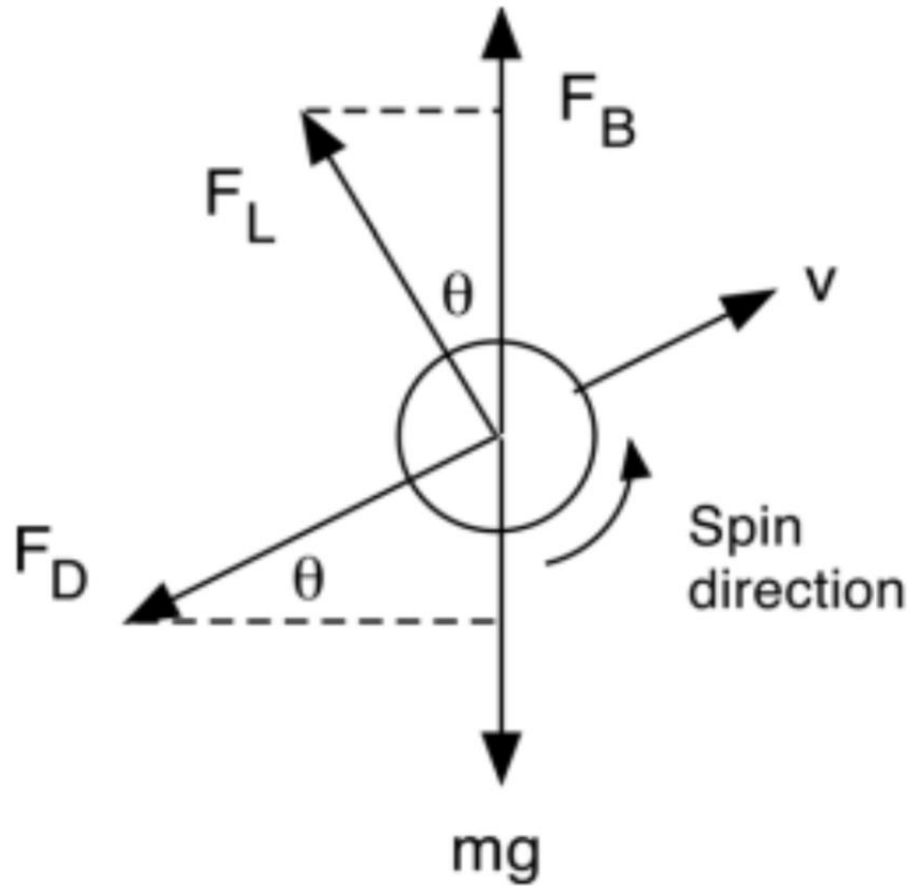
# Experiment Video on Kibo (Japanese Experiment Module)



# Magnus glider stay in stationary motion without gravity



# Schematic diagram of Magnus glider without gravity



Magnus Force ( $F_B$ ) > Gravity ( $mg$ )

◆ Force Component Diagram

◆ Force of Magnus effect established



# References (Research Paper offer by Singapore partner)





**HAL**  
open science

**The physics of Magnus gliders**  
Nicolas Plihon, Gauthier Legrand, Francis Pagaud, Arsène Chemin, Jérémy Ferrand, Nicolas Taberlet

► To cite this version:

Nicolas Plihon, Gauthier Legrand, Francis Pagaud, Arsène Chemin, Jérémy Ferrand, et al.. The physics of Magnus gliders. *American Journal of Physics*, 2021, 89 (9), pp.843-850. 10.1119/10.0004981. hal-03326471

HAL Id: hal-03326471  
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Submitted on 26 Aug 2021

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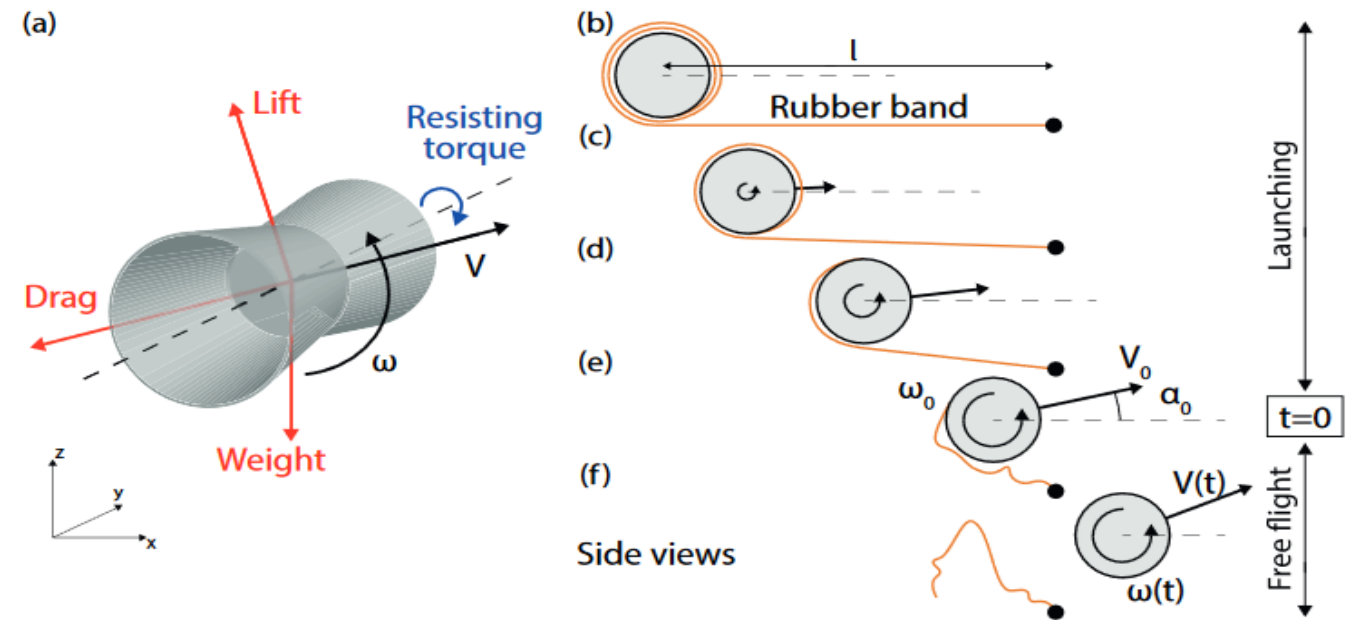


FIG. 2. (a) Sketch of the Magnus glider showing the forces acting during free flight. (b)-(f) Time sequence showing the launching protocol using a rubber band. The black point represents a fixed point.

## ◆ Analytical solution for trajectory of Magnus glider's flight

# Q&A Session

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All on board photos and videos courtesy by JAXA.

