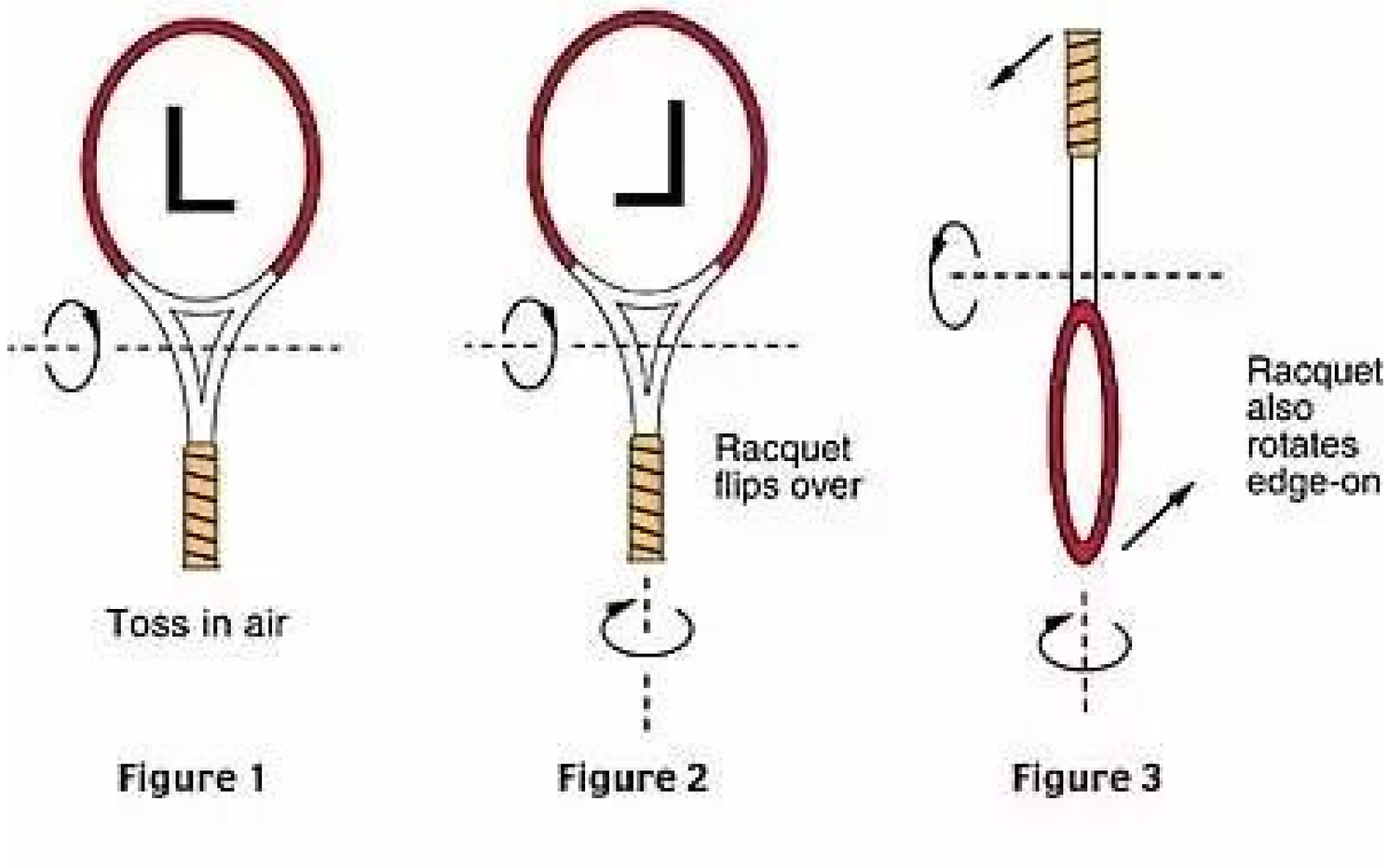
The Tennis Racquet Theorem

MA 203
Numerical Methods

Introduction

There lies a mystery, something that defies the most fundamental laws of physics. An object, when rotated in space, ***undisturbed***, about a particular axis shows strange behaviour, Whereas, about a different axis, it's normal.

The answer is:
"Tennis Racquet Theorem"



https://www.quora.com/What-is-Tennis-racket-theorem-Djanibekov-effect

Equations

Tennis racquet theorem can be understood using Euler's equations , as listed below.

$$I1\ \dot{\omega}1 = -(I3 - I2)\ \omega3\ \omega2$$
$$I2\ \dot{\omega}2 = -(I1 - I3)\ \omega1\ \omega3$$
$$I3\ \dot{\omega}3 = -(I2 - I1)\ \omega2\ \omega1$$

***Assume I1<I2<I3.**

Unstable Rotation about I2:

When rotating about I2

$$I1\ \dot{\omega}1 = -(I3 - I2)\ \omega3\ \omega2$$
$$I3\ \dot{\omega}3 = -(I2 - I1)\ \omega2\ \omega1$$

$$\ddot{\omega}21 = (\text{positive quantity})\ \omega1$$

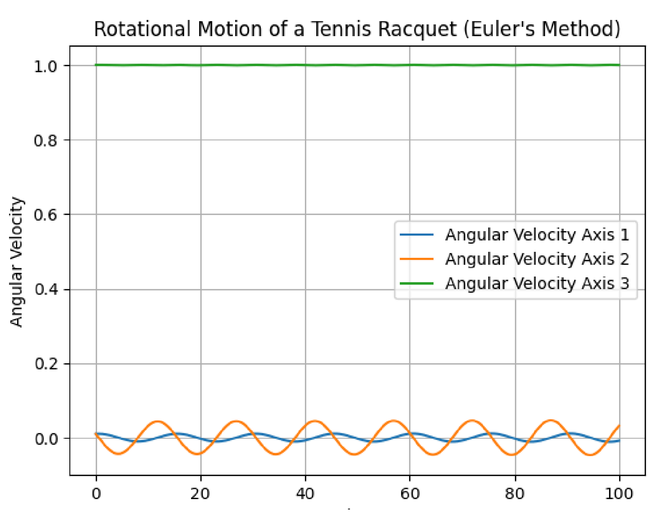
This means that ω1 is not opposed, it will **increase**. Even a small disturbance about the other axis can make the object "flip".

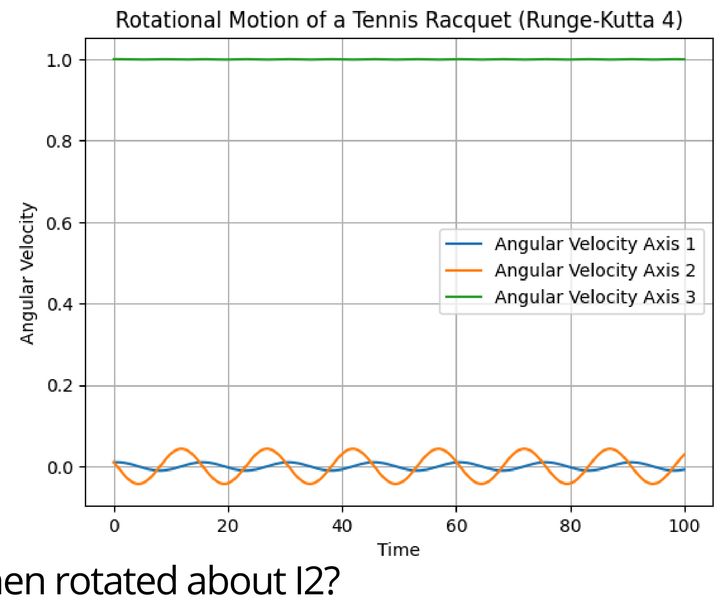
Methods Used

1. Euler's Method
2. R-k Methods

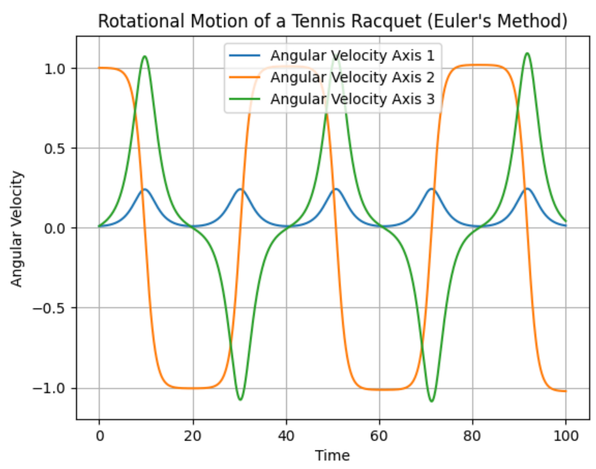
Results

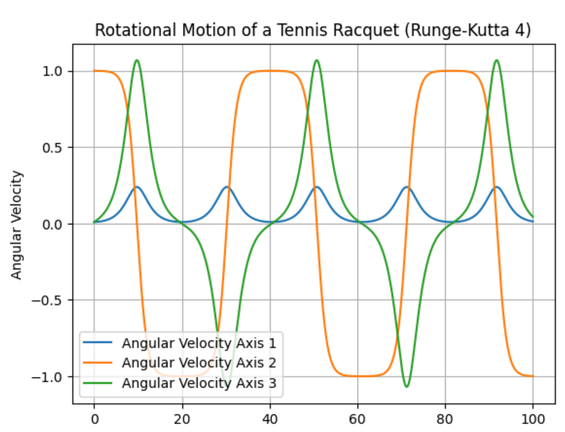
The following results were obtained when we rotated the object about I3.





But, what happens when rotated about I2?





Object will Flip!