Gyro Report

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Introduction

In rotational mechanics, there are phenomena analog to translational mechanics such as momentum of inertia, torque and angular velocity, acceleration and momentum. However, certain phenomena in rotational mechanics such as precession and nutation do not have such analogs and are thus inherently unintuitive. To explore these mechanics and to build the intuition, a mathematical derivation is required.

Precession

Precession is the motion where the spinning object rotations about a vertical axis, in addition to the rotation about its own axis.

In its inertial reference frame, the total torque of a spinning object is related to its angular momentum,

$$\vec{\tau} = \frac{d\vec{L}}{dt}. \tag{1}$$

However from a fixed reference frame, there must be a second term that accounts for the rotation of the inertial reference frame, i.e

$$\vec{\tau} = \frac{d\vec{L}}{dt} + \vec{\omega} \times \vec{L}. \tag{2}$$

This second term suggests that there is a torque that acts perpendicular to the angular momentum and velocity of the spiining object.

$$\vec{\tau}_p = \vec{\omega}_s \times \vec{L}_s. \tag{3}$$

Nutation

Nutation refers to the oscillating motion of a spinning object's own axis with respect to its original axis' position. Nutation occurs when a transient force acts on the spinning object in any direction perpendicular to its angular momentum. Hence,

$$\vec{\tau}_n = k_1\vec{F}_{applied} \times k_2\vec{L}_s. \tag{4}$$

Aim

Method

Results

Analysis

Discussion

Conclusion