Physics 111 Section 1
Problem Set 14
November 2, 2016

Rotational Motion: Spinning Top

Help:

i Comparing components of angular momentum in the space frame and body frame. More vegetables.

10.49 Starting from Equation (10.100) for $\vec{L}$, verify that L_z is correctly given by Equations (10.102) and (10.103).

$$\vec{L} = (-\lambda_1 \dot{\phi} \sin\theta)\vec{e}_1' + \lambda_1 \dot{\theta} \vec{e}_2' + \lambda_3(\dot{\psi} + \dot{\phi}\cos\theta)\vec{e}_3 \tag{10.100}$$

$$\begin{aligned} L_z &= \lambda_1 \dot{\phi} \sin^2\theta + \lambda_3(\dot{\psi} + \dot{\phi}\cos\theta)\cos\theta && (10.102) \\ &= \lambda_1 \dot{\phi} \sin^2\theta + L_3 \cos\theta && (10.103) \end{aligned}$$

ii Chandler wobble for a symmetric top.

10.52 Consider the rapid steady precession of a symmetric top predicted in connection with (10.112).

(a) Show that in this motion the angular momentum $\vec{L}$ must be very close to the vertical. [*Hint*: Use (10.100) to write down the horizontal component L_{nor} of $\vec{L}$. Show that if $\dot{\phi}$ is given by the right side of (10.112), L_{nor} is exactly zero.]

(b) Use this result to show that the rate of precession Ω given in (10.112) agrees with the free precession rate Ω_s found in section 10.06.