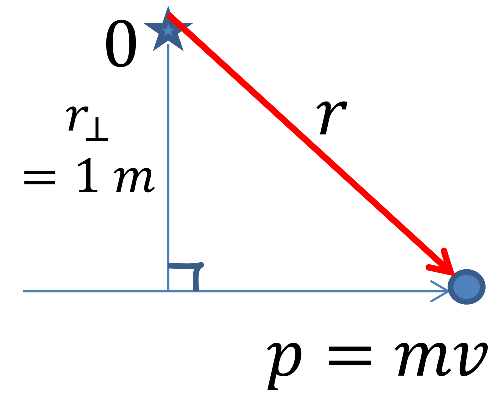
Inclass 21.1. Show that $\hat{L}_z \equiv x\hat{p}_y - y\hat{p}_x = \frac{\hbar}{i}\frac{\partial}{\partial\phi}$.

$$x = r sin\theta cos\phi$$
$$y = r sin\theta sin\phi$$
$$z = r cos\theta$$

$$\begin{pmatrix} \frac{\partial}{\partial x} \\ \frac{\partial}{\partial y} \\ \frac{\partial}{\partial z} \end{pmatrix} = \begin{pmatrix} sin\theta cos\phi & \frac{cos\theta cos\phi}{r} & \frac{-sin\phi}{r sin\theta} \\ sin\theta sin\phi & \frac{cos\theta sin\phi}{r} & \frac{cos\phi}{r sin\theta} \\ cos\theta & \frac{-sin\theta}{r} & 0 \end{pmatrix} \begin{pmatrix} \frac{\partial}{\partial r} \\ \frac{\partial}{\partial \theta} \\ \frac{\partial}{\partial \phi} \end{pmatrix}$$

Inclass 21.2. Show that $\hat{L}^2$ *and* $\hat{L}_z$ *commute, that is*: $\left[\hat{L}^2, \hat{L}_z\right] = 0.$

Inclass 21.3. (a) A bullet of mass 0.005 kg with a speed of 1000 m/s flying by 1 meter from me. Estimate the angular momentum quantum number $l$ for this system. Hint: approximate $|L| = \sqrt{l(l+1)}\hbar \approx l\hbar$. (b) What is the difference in angular momentum between adjacent states.



Inclass 21.4. Show that $\left[\hat{L}_x, \hat{L}_y\right] = i\hbar\hat{L}_z$

$\hat{L}_x = y\hat{p}_z - z\hat{p}_y$;  $\hat{L}_y = z\hat{p}_x - x\hat{p}_z$;  $\hat{L}_z = x\hat{p}_y - y\hat{p}_x$