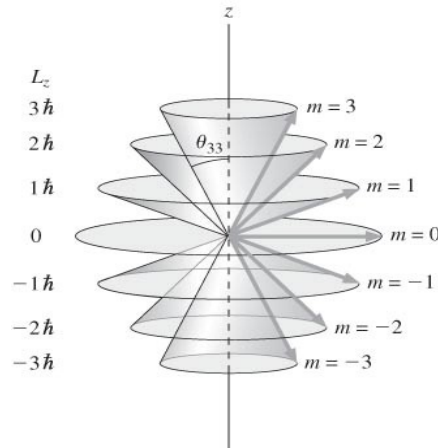Quiz #11d

[10 pts] Consider a hydrogen atom in an orbital anglular momentum state of l=3.

a. [5 pts] What is the minimum angle between L and the z-axis?

b. [5 pts] What is the maximum angle between L and the z-axis?

For $l=3$ the total angular momentum is $L=\sqrt{(l(l+1))}\,\hbar=\sqrt{(3(3+1))}\,\hbar=\sqrt{(12)}\,\hbar$
the z-component of the angular momentum given by,
$L\cos\theta=L_z=m\hbar$

where m is an integer varying from -3 to $+3$ hence there are 7 possibilities as illustrated by the diagram.

a) Therefore the minimum angle between the L and the z axis is given by

$\theta=\cos^{-1}(m\hbar/\sqrt{12}\,\hbar)$ the minimum value being for maximum value of $m=3$ which gives $\theta_{min}=\cos^{-1}(3/\sqrt{12})=30^0$

b) The maximum value of theta is given by $(|m|)_{min}=0$, therefore $\theta_{max}=90^0$