## Space Quantization:-

When an atom is placed in an external Magnetic Field $\vec{B}$, the electron orbit processes about the Field direction as axis.

If the Magnetic field $\vec{B}$ is along the z axis the component of $\vec{I}$ parallel to the field direction is

$$I_z = |\vec{I}| \cos\theta$$

Where $\theta$ is the angle b/w $\vec{I}$ and the z axis

In quantum Mechanically, the magnitude of the angular momentum and its z-component are quantized according to the relations

$$\boxed{|\vec{I}| = \sqrt{l(l+1)}\ \frac{h}{2\pi}}$$

and $$\boxed{I_z = m_l \frac{h}{2\pi}}$$

$l \to$ orbital q. no

$m_l \to$ Magnetic Q. No.

thus $$\boxed{\cos\theta = \frac{I_z}{|\vec{I}|} = \frac{m_l}{\sqrt{l(l+1)}}}$$

Since there are $(2l+1)$ possible values of $m_l$ $(0, \pm1, \pm2 \,\text{---}\, \pm l)$ and angle $\theta$ can assume $(2l+1)$ discrete values. "The angular momentum vector $\vec{l}$ can have $(2l+1)$ discrete orientations with respect to the Magnetic Field. This quantization of the orientation of atoms in space is known as 'space quantization'.

The space quantization of the orbital angular momentum vector corresponding to $l=2$ or $|\vec{l}| = \sqrt{6}\; h/2\pi$

for $l=2$ :→

$m_l = 0, \pm1, \pm2$

$l_z = 0, \pm \frac{h}{2\pi}, \pm\frac{2h}{2\pi}$

$\cos\theta = \frac{m_l}{\sqrt{l(l+1)}} = 0, \pm\frac{1}{\sqrt{6}}, \pm\frac{2}{\sqrt{6}}$

$= \frac{2}{\sqrt{6}}, \frac{1}{\sqrt{6}}, 0, -\frac{1}{\sqrt{6}}, -\frac{2}{\sqrt{6}}$

$= 0.8165, 0.4082, 0, -0.4082, -0.8165$

$\theta \simeq 30^\circ, 66^\circ, 90^\circ, \cancel{-30^\circ}\; 114^\circ, \cancel{-66^\circ}\; 145^\circ$