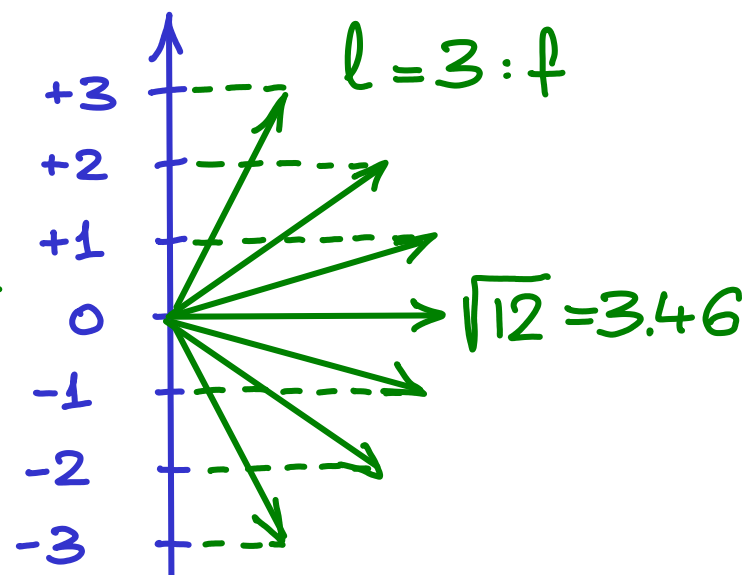
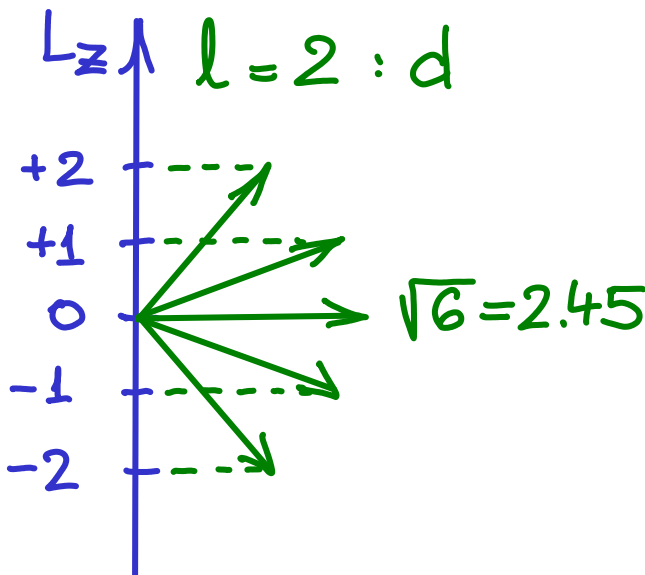
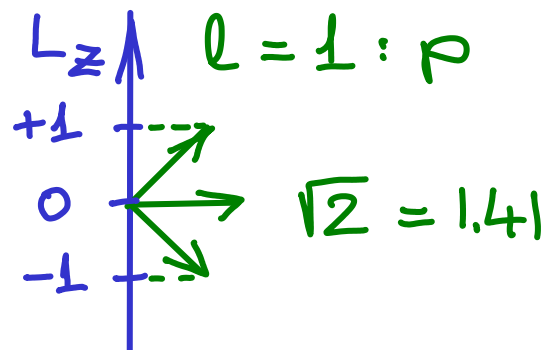
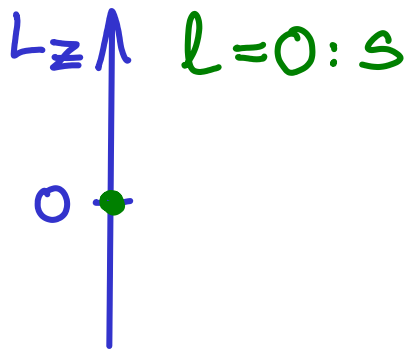


Orbital angular momentum

$$L = \sqrt{l(l+1)} \cdot \hbar ; 0 \leq l \leq (n-1)$$

$$L_z = m_l \cdot \hbar ; -l \leq m_l \leq l \quad (2l+1) \text{ values}$$



Bohr condition: $L = n \cdot \hbar$

According to Bohr: $L = \hbar$ when $n=1$.

According to Schrödinger: $L=0$

when $n=1$ or when $l=0$ in higher states. But how can you have $L=0$ in a spherically symmetric s state?

Spin

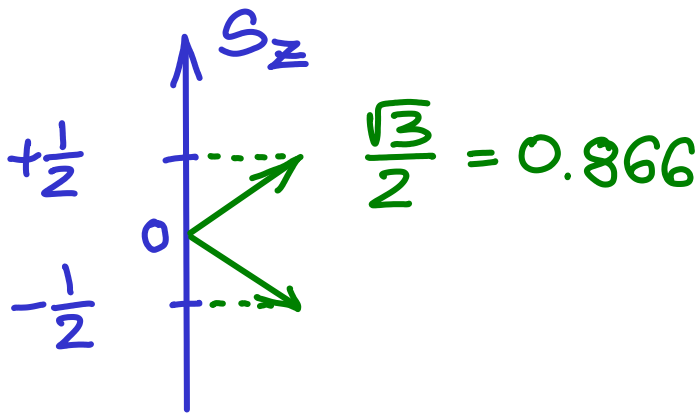
(Intrinsic angular momentum)

Pauli, Stern-Gerlach

Goudsmit-Uhlenbeck, Dirac

$$s = \frac{1}{2} \quad S = \sqrt{s(s+1)} \cdot \hbar = \frac{\sqrt{3}}{2} \hbar$$

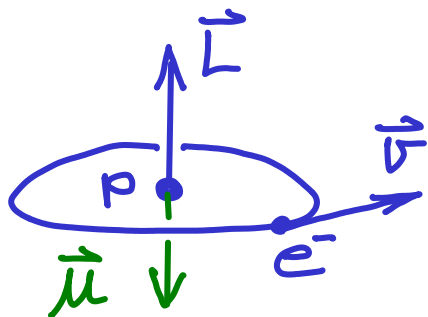
$$m_s = +\frac{1}{2} \text{ and } -\frac{1}{2}$$



In general, $m_s = -s, -s+1, \dots, s$

E.g. for $s = \frac{3}{2}$, $m_s = -\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}, \frac{3}{2}$

Magnetic moment



L : orbital angular momentum

$\vec{\mu}$: magnetic moment ($\vec{m}$)

L is due to orbiting mass : $L = \vec{r} \times \vec{p}$
 $\vec{\mu}$ is due to orbiting charge

$$\mu = I \cdot A = \frac{q}{T} \cdot \pi r^2 = \frac{-e}{\frac{2\pi r}{v}} \cdot \pi r^2 = \frac{(-e)rv}{2}$$

$$\mu = - \frac{ermv}{2m} = - \frac{erp}{2m} = - \frac{e}{2m} \cdot L$$

$$\boxed{\vec{\mu} = - \frac{e}{2m} \vec{L}}$$

$$\frac{\vec{\mu}}{e} = - \frac{1}{2} \frac{\vec{L}}{m}$$

$$L = \sqrt{l(l+1)} \cdot \hbar$$

$$L_z = m_l \cdot \hbar$$

$$-l \leq m_l \leq l$$

$$\rightarrow \mu_z = - \frac{e}{2m} L_z$$

$$\mu_z = - \frac{e}{2m} \cdot m_l \hbar$$

$$\boxed{\mu_z = - \frac{e\hbar}{2m} \cdot m_l = -\mu_B \cdot m_l}$$

$$\mu_B = \frac{e\hbar}{2m} : \text{Bohr magneton}$$

Magnetic moment 2.

$$\mu_z = -\frac{e\hbar}{2m} \cdot m_l = -\mu_B \cdot m_l$$

$$\vec{\mu} = -\frac{e}{2m} \vec{L} = -\frac{e\hbar}{2m\hbar} \cdot \vec{L} = -\frac{\mu_B}{\hbar} \vec{L}$$

$$\vec{\mu}_l = -\frac{\mu_B}{\hbar} \cdot \vec{L} = -g_l \frac{\mu_B}{\hbar} \cdot \vec{L} ; g_l = 1$$

$$\vec{\mu}_s = -g_s \frac{\mu_B}{\hbar} \cdot \vec{S} ; g_s = 2 \text{ (P.A.M. Dirac)}$$

g_l and g_s : gyromagnetic ratios

for angular momentum and spin:

how much magnetic moment an orbiting (l) or a spinning (s) charge can produce.

$$g_s = 2.002,319,304,361, \overset{82}{\underset{\pm 26}{}}$$

Polykarp Kusch (Nobel, 1955)

Richard Feynman (Nobel, 1965)