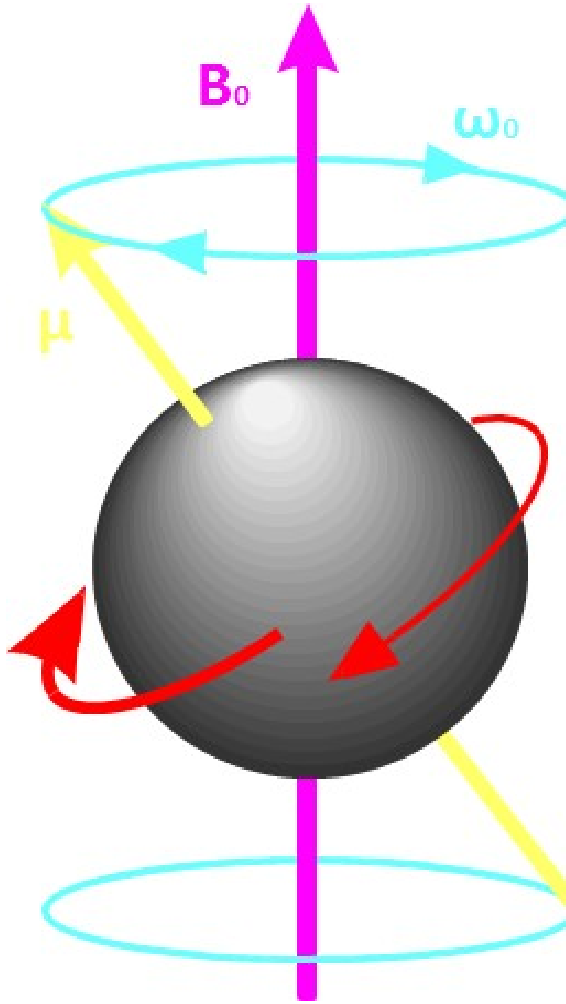
Atom placed in magnetic field

When an atom is placed in an external magnetic field (**B_0**) the electron orbit thus the electron magnetic Moment (**μ_l**) precess about the field direction as axis. This precession is called **Larmor Precession** and the frequency of the precession is called **Larmor Frequency** ($\frac{eB}{2m}$).



Energy of atom placed in magnetic field

<u>Potential energy of atom placed in an external magnetic field (B_0):</u>

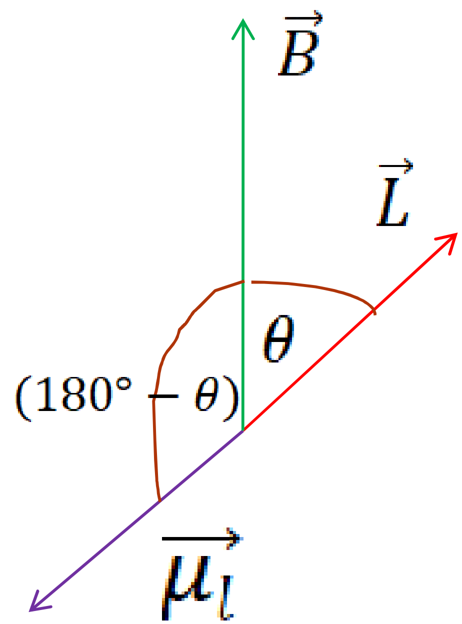
$$\epsilon_B = -\vec{\mu_l}.\vec{B} = \mu_l B\cos\theta$$

[angle between $\vec{\mu_l}$ *and* $\vec{B}$ *is* $(180° - \theta)$]

$$= \ell\mu_B B\frac{m_l}{\ell} = m_l\mu_B B$$

$$= m_l B\frac{e\hbar}{2m} = m_l\hbar\frac{eB}{2m}$$

$$= m_l\hbar\omega_L$$



Where $\omega_L = 2\pi f_L$ and f_L is the Larmor frequency

Total energy :

$$E_{nlm} = E_{nl} + \varepsilon_B = E_{nl} + m_l\hbar\omega_L$$

Quantization of Energy Level

$$E_{nlm} = E_{nl} + \varepsilon_B = E_{nl} + m_l \hbar \omega_L$$

Since the energy level is m_l dependent and hence for a given n & l energy level splits up into (2l+1) close sublevels depending on m_l

The freq. of the radiation:

$$\nu = E_{nlm} - E_{n'l'm'} = \frac{E_{nlm} - E_{n'l'm'}}{h} = \underbrace{\frac{E_{nl} - E_{n'l'}}{h}}_{\text{original freq of un-split spectral lines}} + \omega_L (m_l - m_l')$$

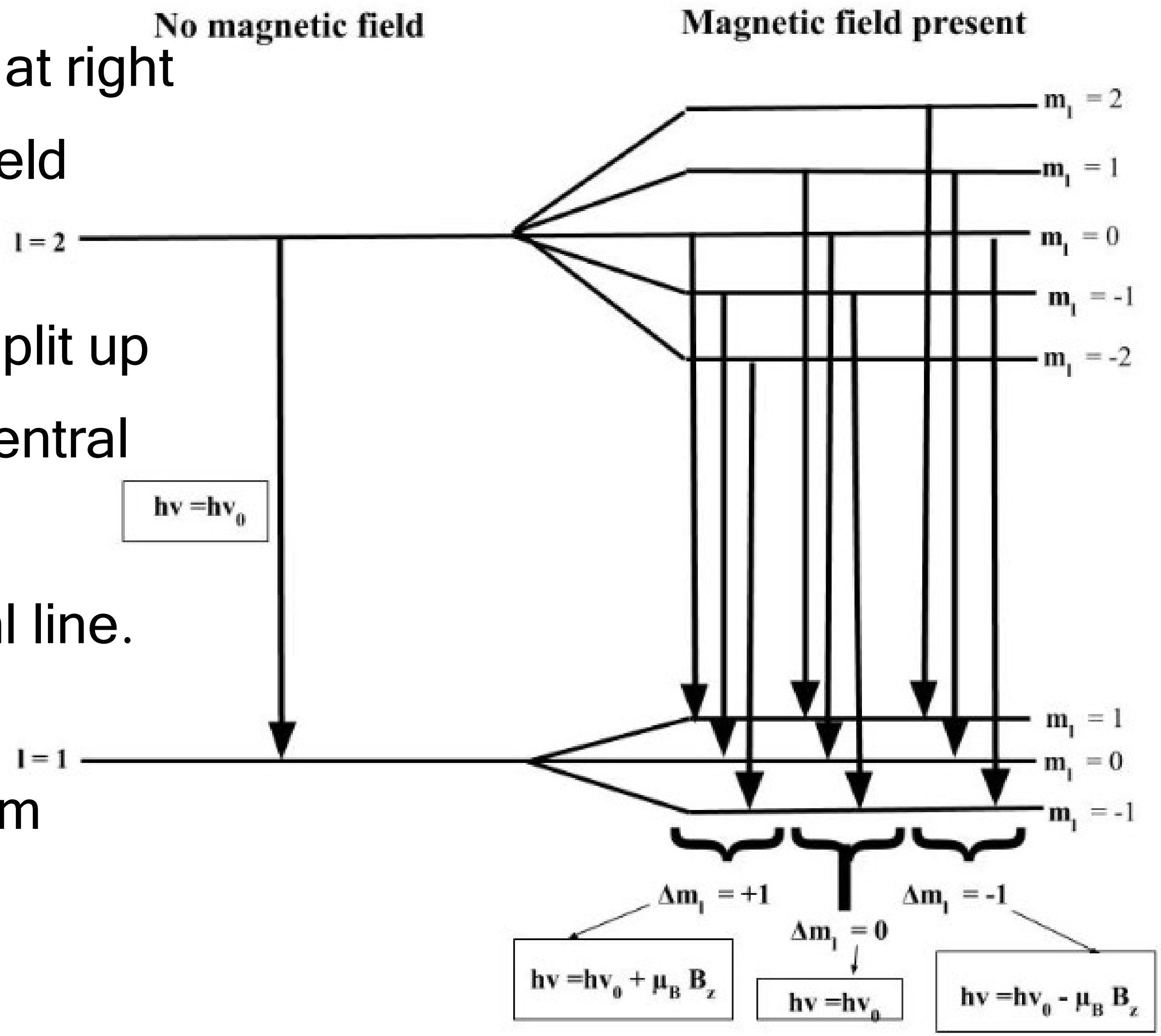
Component of spectral lines:

- $\nu_1 = \nu_o \; when \; \Delta m_l = 0$
- $\nu_2 = \nu_o + \omega_L \; when \; \Delta m_l = 1$
- $\nu_3 = \nu_o - \omega_L \; when \; \Delta m_l = -1$

$selection\ rule: \Delta m_l = 0, \pm 1$

Normal Zeeman Effect

When the light is viewed at right angles to the magnetic field direction a singlet spectral line is found to split up into 3 component. The central component has same freq. as the original line. The other 2 components are displaced equally from the central components



Spectroscopic Term Notation

- Energy levels of electrons of an atom are called Terms of the atom. The corresponding energies are called Term value .

For one electron atom energy terms correspond to L:

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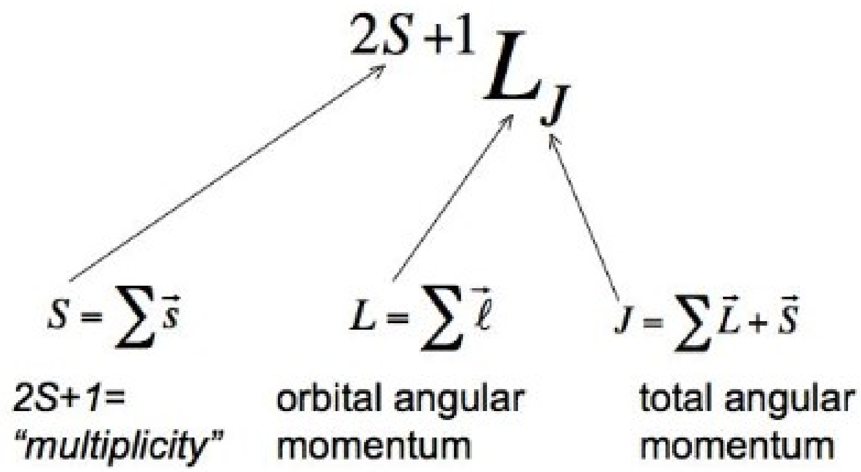
L=0	1	2	3	4
S	P	D	F	G

Spectroscopic Term Notation



l	s	j	Term	Full Notation
0	1/2	1/2	S	${}^2S_{\frac{1}{2}}$
1	1/2	3/2,1/2	P	${}^2P_{\frac{3}{2}}$, ${}^2P_{\frac{1}{2}}$
2	1/2	5/2,3/2	D	${}^2D_{\frac{5}{2}}$, ${}^2D_{\frac{3}{2}}$