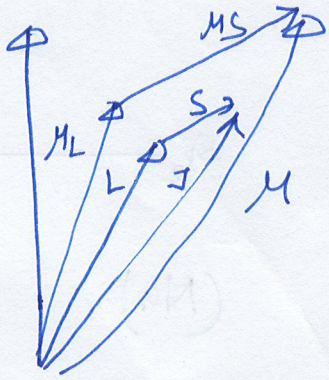
Anomalous Zeeman Effect:-

The anomalous Zeeman effect occurs when the spin of either the initial or the final states, or both, is nonzero.

$$J = L + S$$

Whereas the total magnetic moment is

$$\mu = -g_e \mu_B \frac{L}{\hbar} - g_s \mu_B \frac{S}{\hbar}$$



$g_e = 1$ and $g_s = 2$

$$\boxed{\mu = -\frac{\mu_B}{\hbar}(\vec{L} + 2\vec{S})} \quad --(1)$$

Each energy level is split into $2j+1$ levels, corresponding to the possible values of m_j. For the usual laboratory magnetic fields, which are weak compared with the internal magnetic field associated with spin-orbit effect.

Here upper and lower states are split by different amounts. The level splitting, that is, the energy shift relative to the position of the no-field energy level, can be written as

$$\boxed{\Delta E = g m_j \left(\frac{e\hbar B}{2me}\right) = g m_j \mu_B B} \quad --(2)$$

Where g, called the Lande g factor, is given by

$$g = 1 + \frac{j(j+1) + s(s+1) - l(l+1)}{2j(j+1)}$$

for $s = 0$, $j = l$ and $g = 1$. → gives normal zeeman effect.

Ex. The splitting of sodium doublet levels.

$2P_{1/2}$, $2P_{3/2}$ and $2S_{1/2}$

$\Delta m_j = \pm 1, 0$ (selection rule)

$2P_{1/2} \rightarrow 2S_{1/2}$ → 4 tramition lines.

$2P_{3/2} \rightarrow 2S_{1/2}$ → 6 " "

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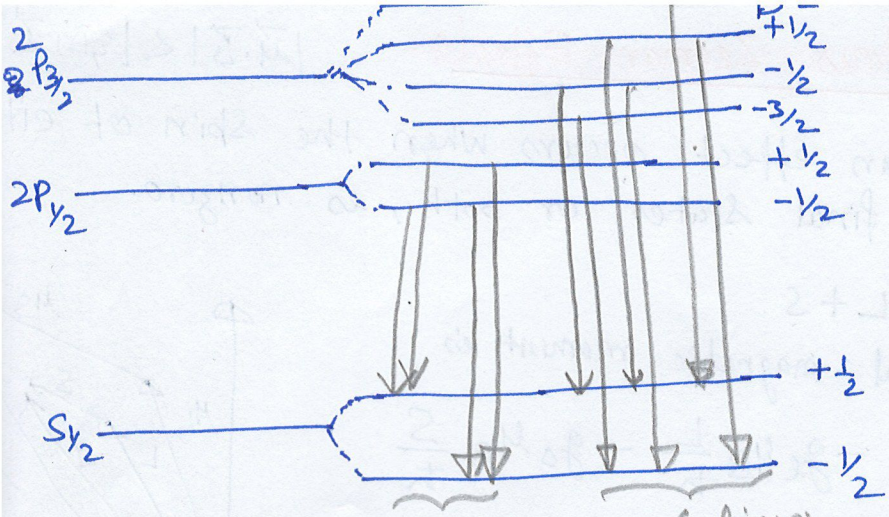

(Na)

Selection Rule

$\Delta m_j = \pm 1, 0$

$J = 0 \not\Leftrightarrow J = 0$

$M_J = 0 \not\Leftrightarrow M_J = 0$

(N) The term 'anomalous' originates from the fact that the total magnetic moment $\mu = \mu_L + \mu_S$ is not antiparallel (and therefore not collinear) to the total angular momentum $\vec{J} = \vec{L} + \vec{S}$. This is because the gyromagnetic ratio having a value $\neq 1$.

(N)

- one electron atom, in the presence of a weak magnetic field.
- When electronic transitions occur in single or multi-electron atoms in the presence of a weak magnetic field.

e.g. $^2P_{3/2}$ & $^2P_{1/2}$ ↓ we observe many more lines and the effect is called anomalous Zeeman effect.