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In Zeeman effect

Paschen Back effect :- Due to spin and orbital motion of $\bar{e}$ the external M.F is weak as compared to internal field in. When strength of M.F is increased the sep. b/w Zeeman components increase until they become greater than separation b/w multiplet fine structure component. Therefore anomalous Zeeman effect changes over to like a normal Zeeman pattern. This phenomena is called Paschen Back effect.

When external field B becomes stronger as compared with internal field, the magnetic coupling b/w $\vec{J}$ and $\vec{B}$ exceeds that between $\vec{L}$ and $\vec{S}$ and precession of J about B becomes faster than $\vec{L}$ & $\vec{S}$ about J. Under these condition the coupling b/w $\vec{L}$ and $\vec{S}$ is partially broken down and $\vec{J}$ is no longer mixed in magnitude. As field B is further increase $\vec{L}$ and $\vec{S}$ start precessing independly about B with quantised component (L_z and S_z) along field direction. The magnitude of these components are $M_L \frac{h}{2\pi}$ and $M_S \frac{h}{2\pi}$ resp.

$M_L = L, L-1, \ldots -L$

$M_S = S, S-1, \ldots -S$

By Larmour theorem

$$W_L = \frac{eB}{2mc}, \quad W_S = \frac{2e}{2mc} B$$

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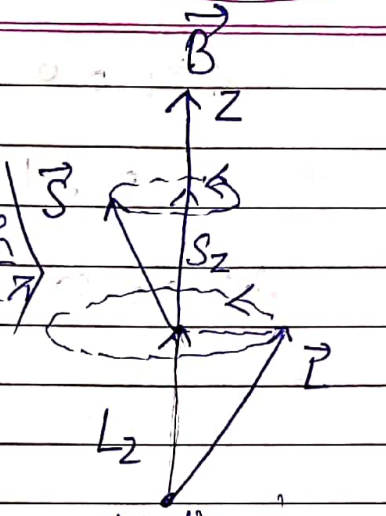
$$\Delta E_L = \omega_L L_z = \frac{eB}{2mc} \cdot M_L \frac{h}{2\pi}$$

$$\Delta E_S = \omega_S S_z = \frac{2eB}{2mc} M_S \frac{h}{2\pi}$$



Motion in P.B. Effect

$$\Delta E = \Delta E_L + \Delta E_S$$

$$= (M_L + 2M_S)\frac{eh}{4\pi mc}B$$

Shifts in wave number unit

$$-\Delta T = \frac{\Delta E}{hc} = (M_L + 2M_S)\frac{eB}{4\pi mc^2}$$

$$= (M_L + 2M_S)L'$$

Each field free level is split into $(2L+1)(2S+1)$ magnetic levels.

Consider the transistion $2p \to 2s$ in strong M.F. This is responsible for D_1 and D_2 line of sodium.

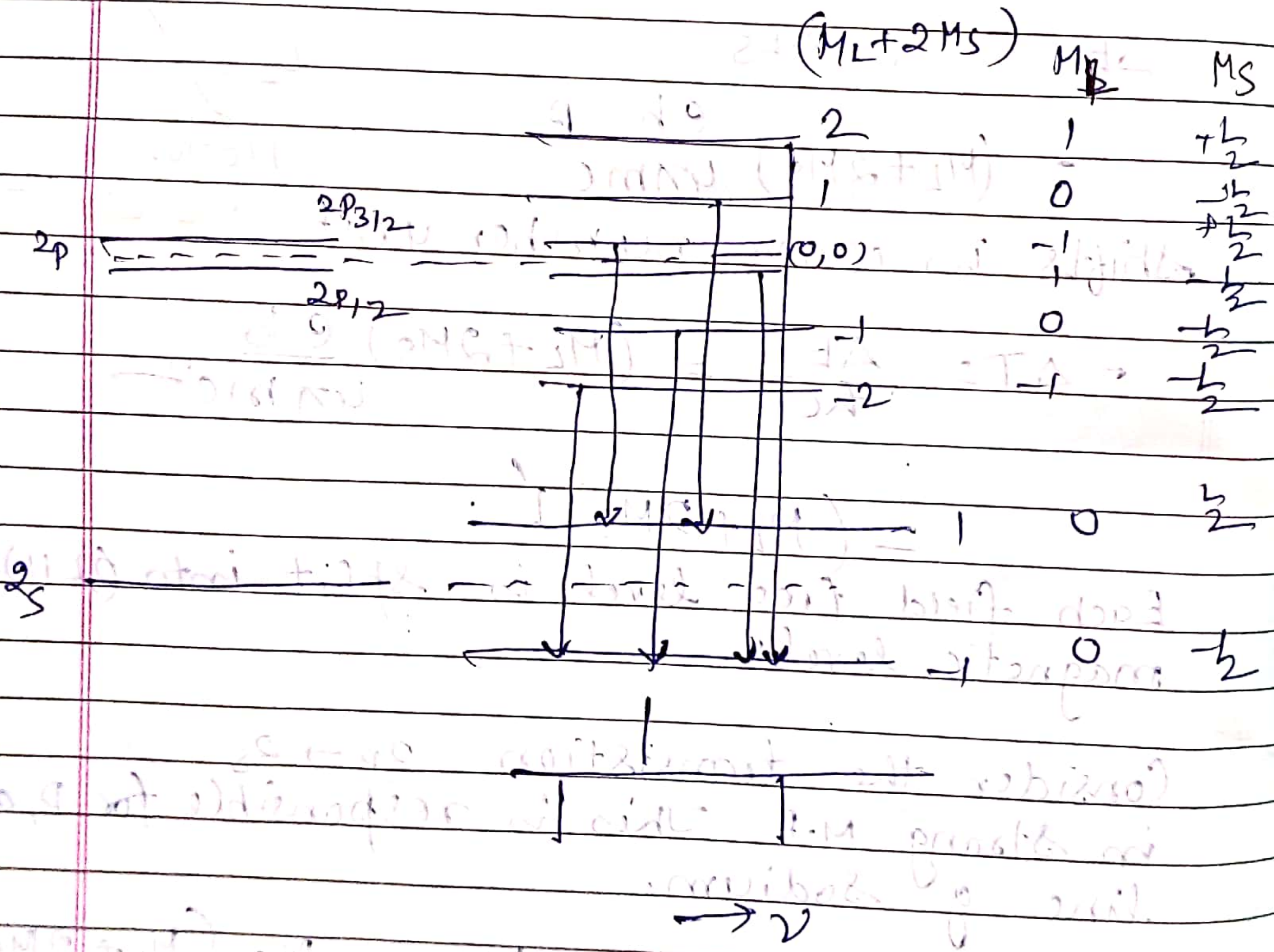
Term	No. of strong field levels	M_L	M_S	$(M_L + 2M_S)$
2p, $L=1, S=\frac{1}{2}$	6	1	$\frac{1}{2}, -\frac{1}{2}$	2, 0
		0	$\frac{1}{2}, -\frac{1}{2}$	1, −1
		−1	"	0, −2
2s, $L=0, S=\frac{1}{2}$	2	0	"	1, −1

Scanned by CamScanner

$\Delta M_L = 0$ Component polarise ∥ to field

$= \pm 1$ $\perp^r$ ''

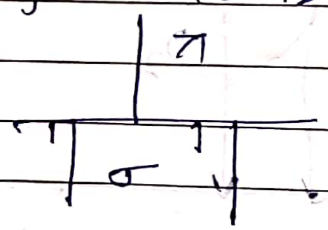
$\Delta M_S = 0$



Spin orbit Correction:- In practice the residual spin orbit coupling changes the relative energies of the components of different terms. This can be allowed for by adding a small coupling term $a M_L M_S$ in the expression for magnetic interaction energy which now becomes

$$-\Delta T = (M_L + 2M_S) L' + a M_L M_S$$

Each of two σ components of normal triplet splits into narrow doublet, triplet according to original field free transition was a doublet, triplet. In the present field free transition $2p \to 2s$, each σ component splits into a doublet with separation just 2/3 that of field free doublet



The P.B effect has experimentally been obs. for very low multiplets only such as Li doublet having field free separation of $\cdot 34\, cm^{-1}$. The reason is that the effect occurs when magnetic splitting exceeds the fine structure splitting for field 43000 Gauss..