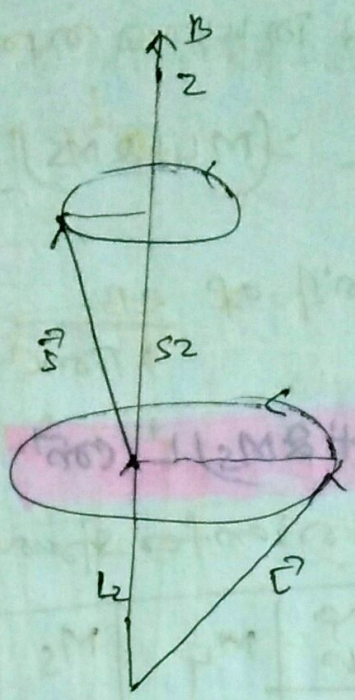
B.Sc-III, Paper-VII, Group-A

Paschen Back effect:-

In the zeeman effect the external Magnetic Field is weak as compared with the internal fields due to the spin and orbital motions of the valance electron. When the strength of the external Field is increased, the separations b/w zeeman components increase until they become greater than the separation b/w multiplet fine structure components. The anamalous zeeman pattern then changes over to like a normal zeeman pattern. This phenomenon is known as paschen back effect.



When the external field B becomes stronger as compared with the internal fields, the magnetic coupling b/w $\vec{J}$ and B exceeds that b/w $\vec{L}$ & $\vec{S}$ and the precession of $\vec{J}$ about B becomes faster than that of $\vec{L}$ & $\vec{S}$ about $\vec{J}$ under these conditions the coupling b/w $\vec{L}$ & $\vec{S}$ is partially broken down and $\vec{J}$ is no longer fixed in Magnitude.

$M_L = +L, \ldots -L$

$M_S : +S, \ldots -S$

$\omega_L = \frac{e}{2mc} B.$

$\omega_S = 2 \cdot \frac{e}{2mc} B.$

$\Delta E_L = \omega_L L_z = \frac{e}{2mc} B M_L \frac{h}{2\pi}$

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

The sum of these two interaction energies is the main energy shift ΔE from the unperturbed energy level is

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

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

The shift in wave number is

$$-\Delta T = \frac{\Delta E}{hc} = (M_L + 2M_S)\frac{eB}{4\pi mc} \text{ cm}^{-1}$$

or in Lorentz unit of $\frac{eB}{4\pi mc^2}$

$$-\Delta T = (M_L + 2M_S)L' \text{ cm}^{-1}$$

This is the expression for strong field interaction

Term	No. of strong field levels $(2L+1)(2S+1)$	M_L	M_S	Shift in Lorentz unit $M_L + 2M_S$
^2P $S = 1/2, L = 1$	$3 \times 2 = 6$	1	$\frac{1}{2}, -\frac{1}{2}$	2, 0
		0	$\frac{1}{2}, -\frac{1}{2}$	1, −1
		−1	$\frac{1}{2}, -\frac{1}{2}$	0, −2
^2S $L = 0, S = 1/2$	$1 \times 2 = 2$	0	$\frac{1}{2}, -\frac{1}{2}$	1, −1