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Time 01 pm

MPHYCC10-18

Transition from weak to strong field:→

In a weak field a level with given number J split into $(2J+1)$ levels. J can have only two values $J = L+\frac{1}{2}$ and $J = L-\frac{1}{2}$ so that a level split into

$$\left\{2\left(L+\tfrac{1}{2}\right)+1\right\} + 2\left\{\left(L-\tfrac{1}{2}\right)+1\right\} = 4L+2 \quad \text{(1)}$$

In a strong field L alone has $2L+1$ orientations & S has $(2S+1)$, together

$$(2L+1)(2S+1) = 4L+2 \qquad \because S = \tfrac{1}{2}$$

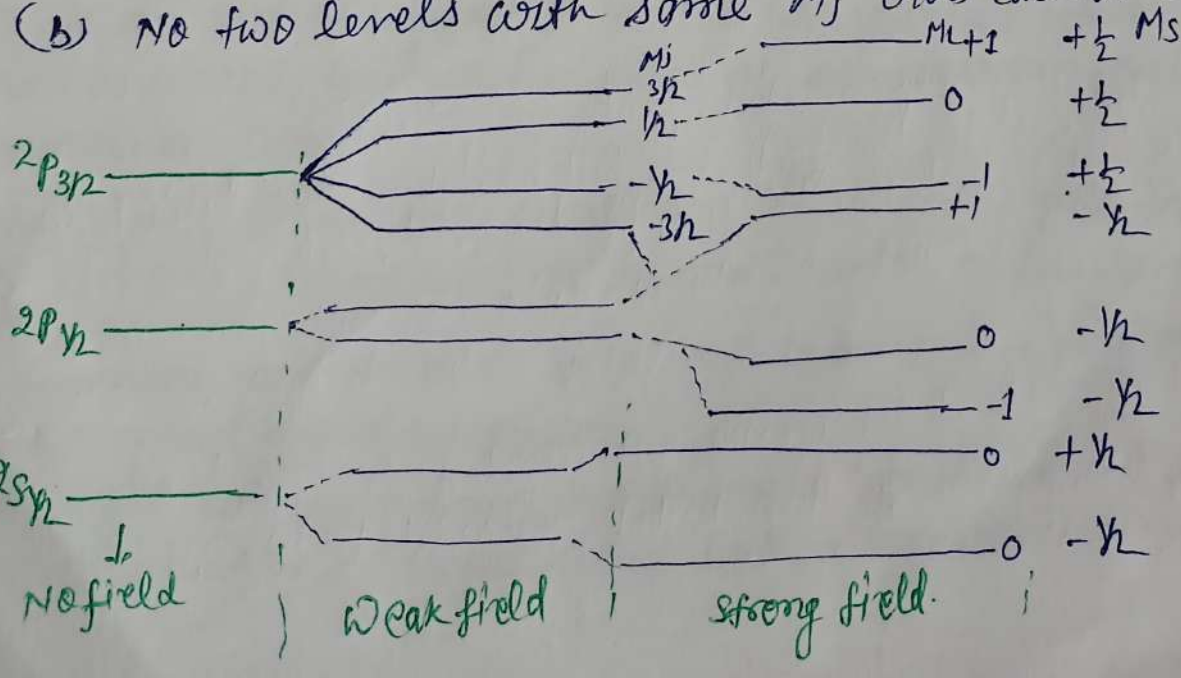
similar to the levels in the weak field.

In a weak field each of the magnetic level is characterized by the quantum numbers j & M_j. whereas in the strong magnetic field M_L & M_S are treated as characteristic quantum numbers.

(a) First rule of transition for the levels with J & M_J goes over to particular M_L & M_S when the field is increased

$$M_J = M_L + M_S$$

(b) No two levels with same M_j cross each other.



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Numericals based on zeeman effects

(a) $^1F_3 - {}^1D_2$ — show the zeeman pattern

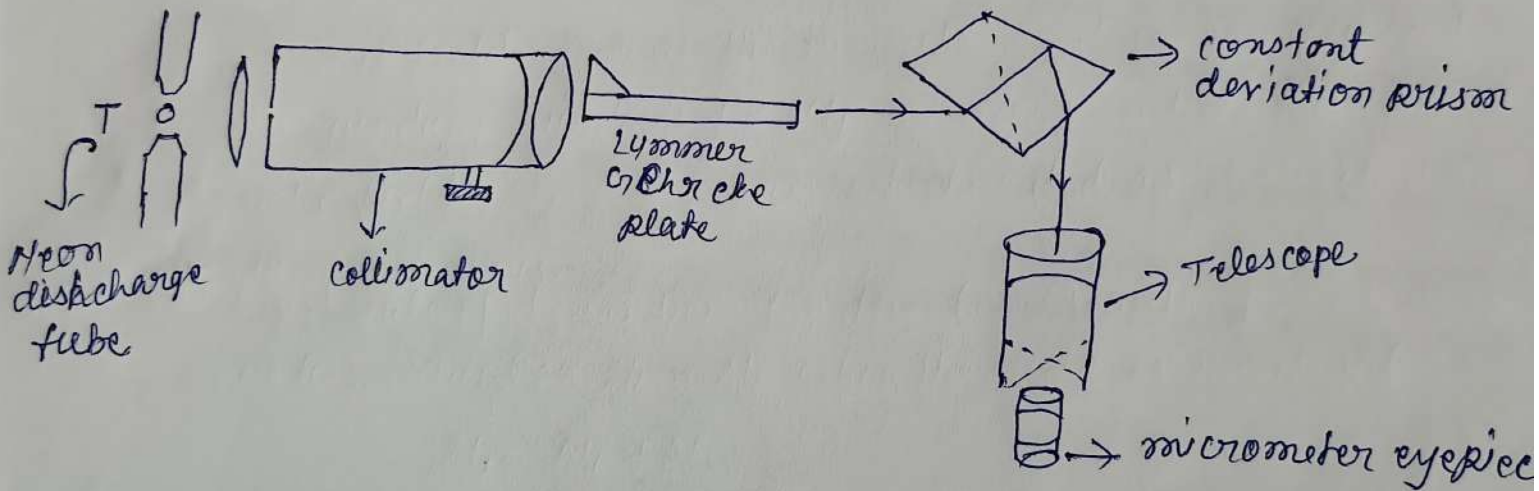
(b) $^2D_{3/2} - {}^1P_{1/2}$ — show the zeeman pattern.

(c) Calculate the zeeman pattern arising from the transition

$^3D_3 - {}^3P_2$

(d) Calculate the value of Lande 'g' factor for the given term value $^2P_{1/2}$

Experimental set up to study zeeman effect :→



T is a neon discharge tube (line source) which capillary part is placed between the poles of an electromagnet & C is condensing lens.

The light from the capillary part of the tube is condensed by C (lens) on the slit of the collimator of the spectrometer.

A Lummer-Gehrcke plate is placed between the collimator and the constant deviation prism.

The light emerging from the prism $\perp^r$ to its initial direction & is received by telescope fitted with a micrometer eyepiece.

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MPHYCC 30—18

Procedure for adjustment :→

In the beginning current is off in the electromagnet. Condensing lens C, L-G plate and micrometer eyepiece is removed
Slit of the collimator is kept widely open.
On looking through the telescope, the pole pieces & the neon tube are adjusted so that the pole pieces appear central in the field of view & neon tube symmetrical between pole pieces.
Now the condensing lens C is placed between the electromagnet and slit of the collimator in such away that its aperture is fully illuminated and image covers the whole field of view.
Micrometer eyepiece is kept at position & focused on the crosswire. Looking through it bright spectrum of neon light is seen.
L-G plate mounted on the stand. Now looking through the eye piece each spectral line shows a few orders. It is adjusted with the help of screw to obtain sharp and bright fringe system shown in fig (a).

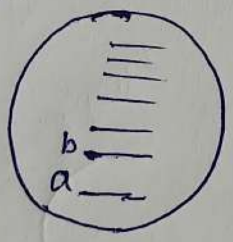

fig (a)

The singlet yellow line ($\lambda = 5852 Å$) of the spectrum is identified & setting the crosswire on a few successive order the reading of micrometer is taken.

Now the current in the electromagnet is switched on to give a field of 4000 Gauss. Each order (e.g. a & b) splitted into three components one is undisplaced & two are symmetrically displaced

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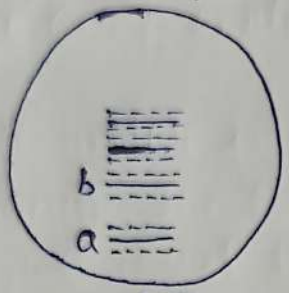
Time: 03pm

MPHYCE10 – 18

on either side fig (a) in presence of external applied magnetic field converted into fig (b) as show below. Now the readings of these symmetrical components are taken using micrometer scale.



fig(b).

The measurement can be repeated for different fields like at 7000 Gauss, 10000 Gauss and also for the singlet red line $\lambda = 6266\text{Å}$ of the neon spectrum.

By this way we can measure $\frac{e}{m}$ ratio of electron through the Zeeman pattern.