PHYSICS (OPTICS)
Unit-2

B.Sc (Sem-IV)
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TOPIC:- Hyperfine Structure of Spectral lines:-

Because of its bearing on the properties of atomic nuclei, the investigation of hyperfine structure with Fabry-Parot interferometer has become of considerable importance in modern research. Occasionally it is found that a line which appears sharp and single in an ordinary spectroscope, yields ring system consisting of two or more sets. These multiple ring systems arise from the fact that the line is actually a group of lines of wavelength very close together, differing by perhaps a few hundredths of an angstrom. If d is sufficient large these will be seperated, so that in each order m we obtain effectively a short spectrum very powerful resolved. Any given fringe of wavelength λ_1 is formed at such an angle that

$$2d\cos\theta_1 = m\lambda_1$$

$$\text{or} \quad m = \frac{2d\cos\theta}{\lambda_1} \qquad \text{——— (1)}$$

The next fringe farther out for this same wavelength has

$$2d\cos\theta_2 = (m-1)\lambda_1$$

Now let us suppose that λ_1 has a component line λ_2 which is very close to λ_1 so that we may write

$$\lambda_2 = \lambda_1 - \Delta\lambda$$

Let us also suppose that $\Delta\lambda$ is such that this component line λ_2 which ~~is very~~ falls

So that.

$$\lambda_2 = \lambda_1 - \Delta\lambda$$

Let us also suppose that $\Delta\lambda$ is such that this componen in order m, falls on the order (m-1) of λ_1, then

$$2d\cos\theta_2 = m(\lambda_1 - \Delta\lambda)$$

Equating the R.H.S. of equations (2) and (3), we get

$$(m-1)\lambda_1 = m(\lambda_1 - \Delta\lambda)$$

$$m\lambda_1 - \lambda_1 = m\lambda_1 - m\Delta\lambda$$

$$\lambda_1 = m\Delta\lambda$$

$$m = \frac{\lambda_1}{\Delta\lambda}$$

substituting the value of m from eqn. (4) in eq

we get,

$$\frac{2d\cos\theta_1}{\lambda_1} = \frac{\lambda_1}{\Delta\lambda}$$

or $$\Delta\lambda = \frac{\lambda_1^2}{2d\cos\theta_1} = \frac{\lambda_1^2}{2d}$$

if θ_1 is nearly zero.

This is the wavelength interval in a given order when the fringes of the same wavelength in the next higher order is reached. Thus we see that $\Delta\lambda$ is independent of m and hence constant. Knowing d and λ, the wavelength difference of components lines lying in this small range may be evaluated.
