B.Sc Physics (Hons), Part II

Dr Satyadeo Narayan Singh

S.B. College, Ara

Q What do you mean by dispersions? Give brief Information.

Ans In brief the variation of refractive index of a medium with wavelength is called dispersion. In mathematical form, it is expressed as $\frac{d\mu}{d\lambda}$. In general refractive index (μ) decreases with wavelength. This effect is called normal dispersion. But over small wavelength ranges, there is often increase of refractive index due to an increased absorption of the radiation passing through the medium. This effect is called as anomalous dispersion.

Main characteristics of normal Dispersion:-

(a) The refractive index decreases as wavelength increases

(b) The rate of increase with wavelength, i.e $\frac{d\mu}{d\lambda}$ is greater shorter wavelength. We have to say that dispersion increase as the wavelength decreases.

Cauchy's Equation:→

This equation explains the normal dispersion. Cauchy's emperical equation expresses refractive index as a function of wavelength as

$$\mu = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4} \quad \text{------} \quad (1)$$

Here, A, B, C are called cauchy's constant, depend on the medium and decreasing sharply in magnitude as we proceed to the higher order terms. In some cases the variation of refractive index with λ may be represented with sufficient accuracy by the first two terms of the power series.

i.e $$\mu = A + \frac{B}{\lambda^2} \quad \text{------} \quad (2)$$

As A and B are positive, it follows that the refractive index μ decreases as λ increases, i.e μ is maximum for violet end and least at the red end of the visible region of the spectrum.

on diffrentiating eqn (2)

$$\frac{d\mu}{d\lambda} = \frac{2B}{\lambda^2} = -\frac{AB}{\lambda^2}$$

This shows that for a chose approximation the despersion varies inversely as the cube of wave length. The (-ve) sign indicates that the slope of dispersion curve is (-ve) and the magnitude of slope, i.e depression decreases as λ increases.

Hartmann's formulae:-

when the wavelength range is not too large the normal dispersion may be explained by Hartmann's emperical formula.

$$\mu = \mu_n + \frac{b}{\lambda - \lambda_n} \quad \text{------} \quad (3)$$

Sellmeir's formula:-

The first dispersion formula of general ~~polarisation~~ application was given by Sellmekr in 1871; on the basis of the elastic solid theory of light, his history gives

$$\mu = i + \frac{A\lambda^2}{\lambda^2 - \lambda_0^2} = n^2$$

Here A = constant

Dispersion of Gases:-

The adequate theory of despersion baset on e.m. theory was given by H.A. Lorentz. Lorentz assumed

(a) when an e.m. wave passes through a medium, the atomic (or molecular) dipoles are created in the medium due to relative displacement of electrons and nuclei of neutral atoms due to electric field

(b) These atomic dipoles execute force vibrations under the action of oscillatory electric fied of the passing wave.

(c) The molecule of gases so apart that the interaction between them can be neglected. The magnetic field on electron on account of its motion may be neglected.

(d) The electrons are bound to the nucleus by a linear restoring force proportional to the displacement from equilibrium position.