DEPARTMENT OF PHYSICS

MAR THOMA COLLEGE FOR WOMEN, PERUMBAVOOR

SPECTROMETER – DISPERSIVE POWER OF PRISM

A spectrometer is an instrument used to measure the properties of light, such as its intensity and wavelength distribution. It works by dispersing light into its constituent colours or wavelengths and then measuring the intensity of each component. The dispersive power of a prism is a measure of how effectively it separates different wavelengths of light

Aim

To determine the dispersive power of the material of the given prism for different pairs of spectral lines.

Apparatus

Spectrometer, prism, mercury vapour lamp, magnifying glass, reading lamp and spirit level.

Theory

When a white light is passed through a prism, it splits into its constituent colours. This phenomenon is called dispersion. To measure the ability of the material to separate the various components of the incident light we introduce a term called dispersive power (w). Dispersive power of two colours is measured as the angular dispersion to the mean deviation. Angular dispersion is the difference in angles of deviation of different colours. If d_v, is the deviation of violet colour and d is the deviation of green colour, the angular dispersion = $d_v - d_g$.

Using the formula for deviation, d = (μ - 1) A

$$d_v = (\mu_v - 1) A \text{ and } d_g = (\mu_g - 1) A$$

$$\therefore d_v - d_g = (\mu v - \mu g) A$$

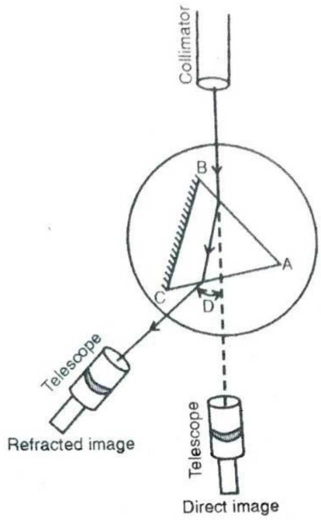
The mean deviation of violet and green is

$$d = \frac{(dv + dg)}{2} = \frac{(\mu v - 1) A + (\mu g - 1) A}{2}$$

$$= (\mu - 1) A, \text{ where } \frac{(\mu v + \mu g)}{2} = \mu$$

Using the definition of dispersive power,

$$\omega_{vg} = \frac{Angular\ dispersion}{Mean\ deviation}$$



$$\omega_g = \frac{dv - dg}{\frac{(dv + dg)}{2}} = \frac{(\mu v - \mu g)}{(\mu - 1)}, \quad \mu = \frac{(\mu v + \mu g)}{2}$$

Similarly, the dispersive power for the blue and yellow colour is

$$\omega_{by} = \frac{\mu b - \mu y}{\mu - 1}, \text{ where } \mu = \frac{\mu b + \mu y}{2}$$

The refractive indices of the prism for different colours may be calculated using the formula.

$$\mu = \frac{sin\frac{A+D}{2}}{sin\frac{A}{2}}$$

where A is the angle of the prism and D is the angle of minimum deviation for the particular colour.

Procedure

The preliminary adjustments of the spectrometer are made and the angle of the prism A is determined.

<u>To find the angle of minimum deviation D for different colours.</u>

The prism is mounted on the prism table with the base towards the clamp. The vernier table is unclamped and rotated so that the base BC of the prism is nearly parallel to the collimator. The light from the collimator falls on the face AB and gets refracted through the face AC. The refracted rays always bend towards the base of the prism. The vernier table is then clamped. The telescope is rotated to get the refracted image of the slit illuminated by mercury vapour lamp. The refractive image consists of spectral lines of different colours. The slit is made narrow. The telescope is adjusted so that the violet line is in the field of view. Looking through the telescope, the prism table alone rotated slowly so that the image (violet) moves towards the position of the direct ray.

The rotation of the prism table decreases the angle of deviation of violet line. When the rotation of the prism table continues, at a particular position violet line becomes stationary and there is no further decrease in the angle of deviation. On further rotation of the prism table makes the violet line move in the reverse direction. The position of the violet line at which it starts moving in the reverse direction is called the position of minimum deviation of violet. When the violet line becomes stationary, the rotation of the prism table is stopped. The tangential screw of the telescope is adjusted so that the vertical cross wire coincides with the violet line. Take the corresponding readings on the verniers I and II (main scale reading and vernier scale coincidence). Repeat the experiment for the colours blue, green, and yellow. The prism is then removed. The telescope is brought in line with the collimator so the direct image of the slit is seen. Clamp the telescope, by adjusting the tangential screw image is made to coincide with the vertical cross wire. The reading of (main scale and vernier scale coincidence) both the verniers (I and II) are noted.

The difference in reading of the vernier I corresponding to violet line and vernier I corresponding to direct image gives the angle of minimum deviation for violet colour. Similarly find it for vernier II. The average of the two gives the angle of minimum deviation of violet colour. The same is repeated for all colours. Then the refractive indices of the prism for different colours may be calculated by using the formula.

$$\mu = \frac{\sin\frac{A+D}{2}}{\sin\frac{A}{2}}$$

After calculating μ_v, μ_g, μ_b and μ_y we can evaluate the dispersive power for violet – green and blue – yellow using, for small angled prism:

$$\omega_{vg} = \frac{(\mu v - \mu g)}{(\mu - 1)}, \ \mu = \frac{(\mu v + \mu g)}{2}$$

$$\text{and } \omega_{by} = \frac{\mu b - \mu y}{\mu - 1}, \ \mu = \frac{\mu b + \mu y}{2}$$

Observations and tabulations

Value of one main scale division (1 M.S.D) = ... degree

= ....minute

Number of divisions on the vernier, n = ………..

Least count (L.C) $= \frac{Value\ of\ 1\ M.S.D}{n}$ =.............minute

To find A

Reading of	Vernier I			Vernier II		
	M.S.R.	V.S.R.	Total reading	M.S.R.	V.S.R.	Total reading
Image reflected from face AB (a)						
Image reflected from face AC (b)						
Difference between a and b 2A	—	—		—	—	

Mean 2A =…………

Angle of prism A = …………………

Colour of the spectrum	Vernier	Refracted image X_1			Direct image X_2			Deviation D $= X_1 \sim X_2$	Mean deviation $D = \frac{D_1 + D_2}{2}$	Refractive index $\mu = \frac{\sin \frac{A+D}{2}}{\sin A/2}$
		M.S.R.	V.S.R.	Total X_1	M.S.R.	V.S.R.	Total X_2			
Violet	Ver I							D_1 = ……..	D_v = ……..	μ_v = ……..
	Ver II							D_2 = ……..		
Blue	Ver I							D_1 = ……..	D_B = ……..	μ_B = ……..
	Ver II							D_2 = ……..		
Green	Ver I							D_1 = ……..	D_g = ……..	μ_g = ……..
	Ver II							D_2 = ……..		
Yellow	Ver I							D_1 = ……..	D_y = ……..	μ_y = ……..
	Ver II							D_2 = ……..		

Dispersive power $\omega_{vg} = \frac{(\mu v - \mu g)}{(\mu - 1)}$, where $\mu = \frac{(\mu v + \mu g)}{2}$

Dispersive power $\omega_{by} = \frac{\mu b - \mu g}{\mu - 1}$, where $\mu = \frac{\mu b + \mu g}{2}$

Result

1. Dispersive power of the material of the prism
    a) For violet - green = …………..
    b) For blue - yellow = …………..

References

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