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EXPERIMENT-7

Determination of wavelength of sodium light by using By -Prism

Aim: To determine the wavelength of Sodium Light.

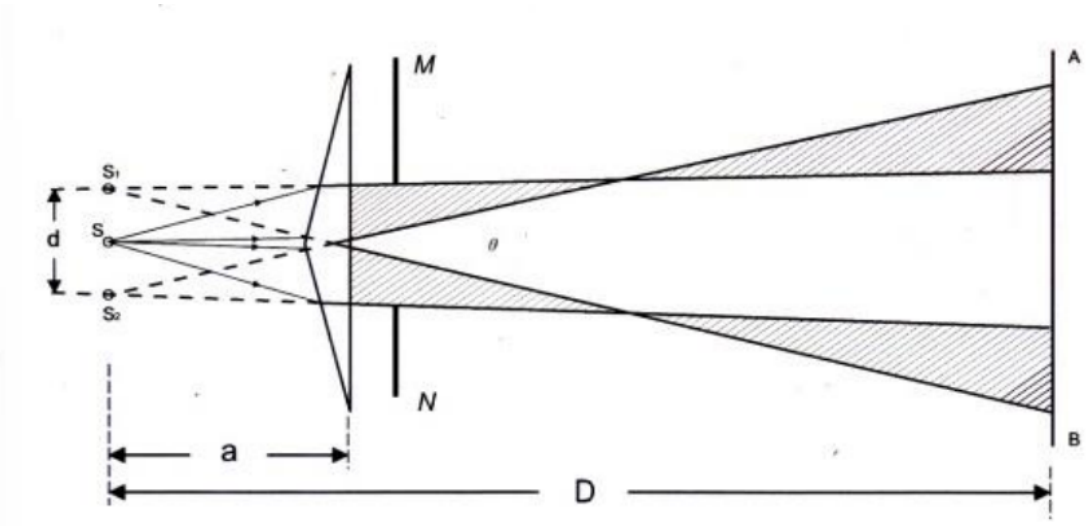
Apparatus: Sodium Vapour Lamp, Optical Rail, Adjustable slit, Bi-prism and Mount, Eye-piece with Micrometer reticule, Achromatic lens with Mount, Micrometer.

Theory: A prism with its angle slightly less than two right angles and two equal base angles is called a Fresnel Biprism. When a single source is placed facing opposite to the base of this prism, the rays emerging from the source get refracted and form a virtual image of two independent sources S1 and S2 equidistant to the main source. When this setup is placed in Infront of a slit and screen the light from the virtual sources produces an interference pattern on the screen. The screen contains continuous bright and dark fringes. The width of the dark or light fringes is given by β.

$$\beta = \frac{D\lambda}{d}$$

Where D is the distance between the slit and screen and d is the size of the single slit
To determine d , a convex lens having such a focal length that the distance between the slit and the focal plane of the eye-piece exceeds four times the focal length is interposed between the bi-prism and the eye- piece. The lens is adjusted so that for two of its positions the real images of the two virtual sources S1 and S2 are focused on the focal plane of the eye -piece. If d1 and d2 are the distances between the real images of S1 and S2 respectively for two positions of the lens,

$$d = \sqrt{d_1 d_2}$$



Observations:

Table-1: Measurement of fringe width:

Trial No	Micrometer Reading	Width for 20 fringes R(mm)	Fringe width - R/20 (mm)

	Initial	Final		
1	2.69	6.75	0.203	0.208
2	6.75	11.01	0.213	

Table-2: Determination of d

	Micrometer reading for the first bright fringe (A1)	Micrometer reading for the second bright fringe (A2)	Difference A1 – A2 (mm)
Lens at Position I	7.32	8.43	d1=1.11
Lens at Position II	5.33	12.41	d2=7.08

Calculation:

1. $d = \sqrt{d_1 d_2}$

$$d = \sqrt{1.11 \times 7.08} = 2.8032 \times 10^{-3} m$$

2. Wavelength

$$\beta = \frac{D\lambda}{d}$$

$$\lambda = \frac{(2.8032\times10^{-3}\times0.208\times10^{-3})}{100\times10^{-2}} = 583 \times 10^{-9} m$$

Error Analysis:

$$\lambda = \frac{\beta_2-\beta_1}{D_2-D_1} \times d$$

$$\beta = \frac{R}{n}, d = \sqrt{d_1 d_2}$$

$$\lambda = \frac{R_2-R_1}{n(D_2-D_1)} \times \sqrt{d_1 d_2}$$

$$ln\lambda = ln(R_2 - R_1) - ln(n) - ln(D_2 - D_1) + \frac{1}{2}ln(d_1) + \frac{1}{2}ln(d_2)$$

$$\frac{\Delta\lambda}{\lambda} = \frac{2\Delta R}{R_2-R_1} + \frac{2\Delta D}{D_2-D_1} + \frac{\Delta d}{d}$$

$$\Delta R = \Delta d = 2 \times Least\ count\ of\ micrometer = 0.02mm$$

$$\Delta D = 2 \times Least\ count\ of\ bench\ scale = 0.002m$$

$$\frac{\Delta\lambda}{\lambda} = \frac{2\times0.00002}{0.213-0.203} + \frac{2\times0.002}{10\times10^{-2}} + \frac{0.00002}{2.8032\times10^{-3}}$$

$$\frac{\Delta\lambda}{\lambda} = 0.004 + 0.004 + 0.00713 = 0.0151$$

Percentage error = 1.51%

$$\Delta\lambda = 8.82 \times 10^{-9} m$$

$$\lambda = (583 \pm 8.82) \times 10^{-9} m$$

Results:

1. The wavelength measured is $\lambda = (583 \pm 8.82) \times 10^{-9}$ m
2. The percentage error in wavelength measured is 1.51%

Precaution:

1. The setting of uprights at the same level is essential.
2. Crosswire should be fixed in the center of the fringe while taking observations for fringe width.
3. The slit should be vertical and narrow.
4. The micrometer screw should be rotated only in one direction to avoid backlash error.
5. The fringe width should be measured at a fairly large distance.
6. A convex lens of a shorter focal length should be used.
7. Motion of eyepiece should be perpendicular to the lengths of the bench.
8. Zero error must be noted in the measuring instruments.
9. To reduce statistical error in measurements, at least 3-5 readings must be taken.
10. Parallax and back-lash errors during measurement must be avoided.