INDIAN INSTITUTE OF TECHNOLOGY

PHYSICS DEPT.

NO. CLASS BATCH

NAME A. SRIYA

EXPT. No. 8 LABORATORY

DATE 26-10-23

58/60

FRESNEL'S Bi-PRISM

Aim: To obtain the wavelength of Na light using fresnels biprism

Apparatus: (i) Optical rail with uprights

(ii) Sodium lamp

(iii) Bi-prism

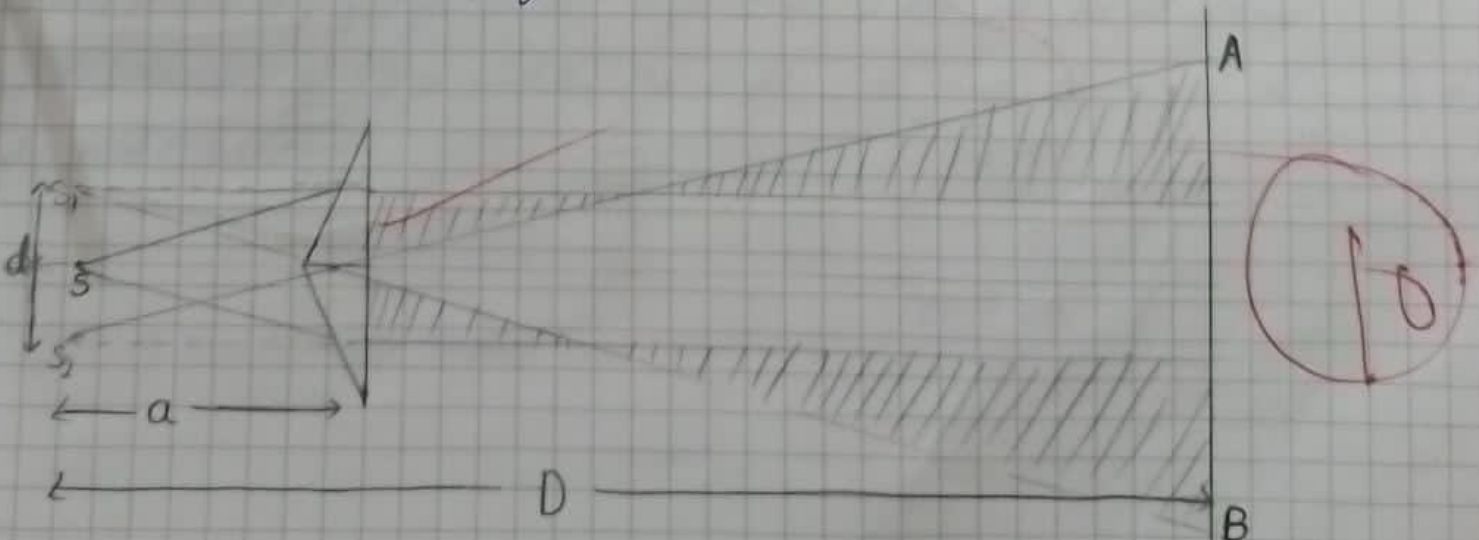
(iv) Convex lens

(v) Slit & micrometer-eyepiece

Theory:

1) The fresnels bi-prism has one angle slightly less than two right angles and two equal, small base angles act like 2 very thin prism placed base to base

2) When the rays from slit S illuminated by mono-chromatic light like Na light are incident on biprism, The emergent rays from 2 halves seems (appears) to diverge from 2 virtual sources S_1 & S_2.



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3) If the screen is placed in plane ⊥ to slits, emergent rays are in to overlap to form dark and bright fringes

4) If d (dis b/w S_1 & S_2); then relation is

$$x = \frac{\lambda D}{d} \quad \text{--- (1)}$$

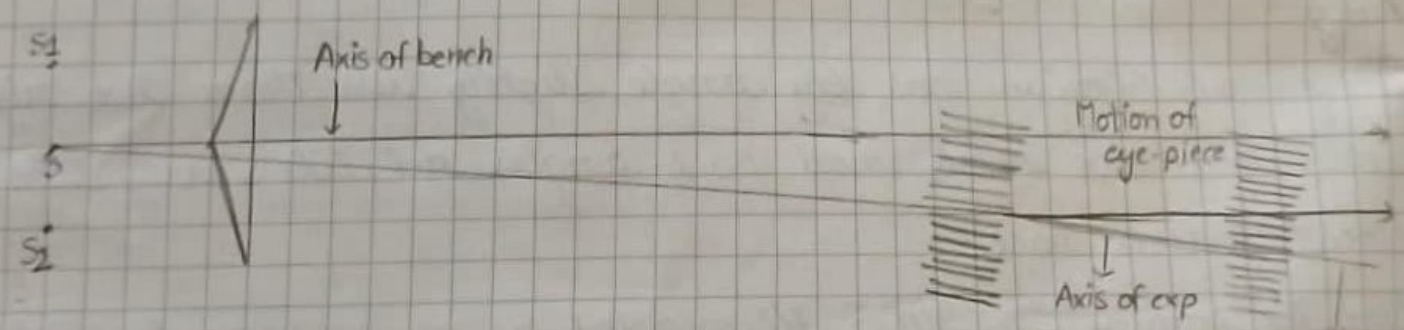
$$d = \frac{\lambda}{D}(x) \quad \text{--- (2)}$$

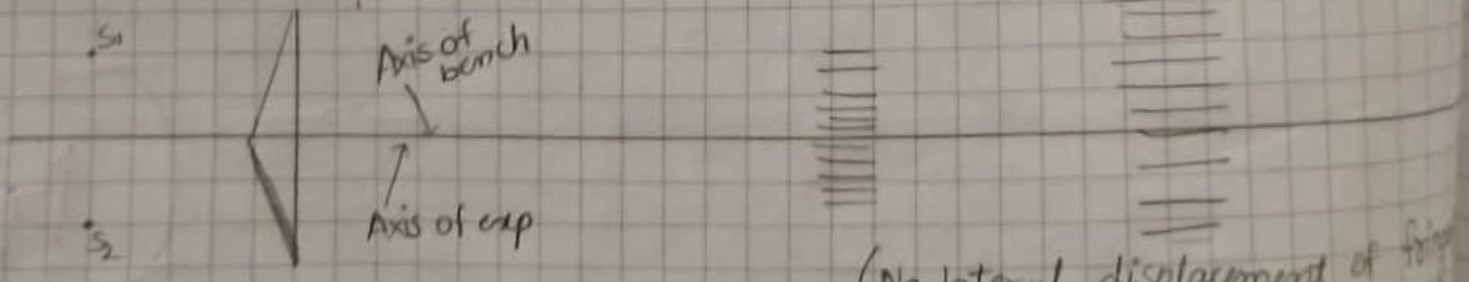
D - dis b/w slit & screen
λ - wavelength of light
x - fringe width

5) To determine d, convex lens is placed between slit and eyepiece with focal length less than one fourth of the distance b/w slit & ~~eye~~

6) lens is adjusted so that to obtain real images of the virtual sources S_1 & S_2 on the screen with d_1 & d_2 are their seperation in 2 positions $\Rightarrow$ $d = \sqrt{d_1 d_2}$ --- (3)

Removal of lateral shift





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Formulae used:

1) $d_{avg} = \frac{d_1 + d_2}{2}$

$\Delta d = \left| \frac{d_1 - d_2}{2} \right|$

2) Fractional error in x:

$\frac{\Delta x}{x} = \left| \frac{x' - x''}{2x} \right|$; x' & x'' are the slopes of x_n (vs) n graph

3) As $d = \frac{xd}{D}$

$\frac{\Delta d}{d} = \frac{\Delta x}{x} + \frac{\Delta d}{d}$ $\left(\left(\frac{\Delta D}{D}\right) \rightarrow \text{negligible}\right)$

Precautions:

1) d/s b/w slit and biprism & slit width should be kept constant
2) Move the eye-piece only backward - for adjusting lateral shift, move bi-prism laterally
3) During measurment of d_1 & d_2; Do not keep eyepiece at large distance from slit ($>> 4f$) that results in great error
4) While measuring fringe width, align cross wise at bright fringe.
5) While measuring fringe width, the cross-wise must be moved only in 1 dir to avoid backlash

Observations

* Distance between slit and eyepiece D = 1459mm - 459m

= 1000 mm = 100 cm

Least Count

Measurment of fringe width:

SNo of fringes	Main scale reading (1 mm)	Circular scale reading	Total reading xn (mm)
1)	14	30 ⇒ 0.30mm	14.30 mm
2	13.5	46 ⇒ 0.46mm	13.96
3	13.5	16 ⇒ 0.16mm	13.66
4	13	35 ⇒ 0.35 mm	13.35
5	13	5 ⇒ 0.05 mm	13.05
6	12.5	33 ⇒ 0.33 mm	12.83 mm
7	12.5	4 ⇒ 0.04 mm	12.54 mm
8	12	27 ⇒ 0.27 mm	12.27 mm
9	11.5	47 ⇒ 0.47 mm	11.97 mm
10	11.5	20 ⇒ 0.20 mm	11.70 mm

Measurment of dis b/w virtual sources d:

d_1 = ~~1152 mm~~ ~~1.50 mm~~ = (18.65 - 10.80) = 7.85 mm

d_2 = ~~750 mm~~ ~~2.49 mm~~ = 18.35 - 17.93 = 0.42 mm

$d = \sqrt{d_1 d_2}$ = ~~92.52 mm~~ 1.82 mm

for calculation of error, measuring d at diff eyepiece pstn

d_1' = ~~1161 mm~~ 20.03 - 13.71 = 6.32 mm

d_2' = ~~689 mm~~ 17.73 - 16.79 = 0.94 mm

$d' = \sqrt{d_1' d_2'}$ = ~~89.54 mm~~ 2.43 mm

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Calculations:

1) Fringe width x (from graph)

x' & x'' are max & min slopes of graph of the lines

$$x = \frac{x'+x''}{2} = \frac{0.3125 + 0.2800}{2} = 0.2962 \text{ mm}$$

$$\Delta x = \left|\frac{x''-x'}{2}\right| = \frac{0.3125 - 0.2800}{2} = 0.0162 \text{ mm}$$

2) Virtual source distance d:

$$d = \frac{d+d'}{2} = 2.125 \text{ mm}$$

$$\Delta d = \left|\frac{d'-d}{2}\right| = 0.305 \text{ mm}$$

3) wavelength λ: ; $\lambda = \frac{d(x)}{D}$

$$= \left(\frac{2.125}{1000}\right)(0.2962) \times 10^{-3} \text{ m} = 6.29425 \times 10^{-7} \text{ m}$$

$$= 629.425 \text{ nm}.$$

$$\frac{\Delta\lambda}{\lambda} = \frac{\Delta x}{x} + \frac{\Delta d}{d}$$

$$\therefore \left(\frac{0.0162}{0.2962} + \frac{0.305}{2.125}\right) = 0.05469 + 0.14353 = 0.198$$

$$\Delta\lambda = \left(\frac{\Delta\lambda}{\lambda}\right)(\lambda)$$

$$= (0.198)(629.425) \text{ nm}$$

$$= 124.76 \text{ nm}$$

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RESULT:

Using the fresnels biprism experiment, the wavelength of Na light comes out to be $\lambda = (\lambda \pm \Delta\lambda) = (629.425 \pm 124.76)$ nm.

Graph of x_n (vs) n.

Scale:
x-axis; 1 unit = 1
y-axis; 1 unit = 0.01

$|\text{max slope } x'| = \left|\frac{14.3 - 13.0}{6-1}\right| = 0.3125\text{mm}$

$|\text{min slope}| = |x''| = \left|\frac{13.66 - 11.7}{10-3}\right| = 0.280\text{mm}$

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