<u>Experiment No.2</u>

Object: To find the wavelength of Sodium light by Fresnel's biprism experiment.

Apparatus used: Optical bench with uprights, sodium lamp, biprism, convex lens, slit and micrometer eye piece are already fitted on the optical bench.

Formula used: The wavelength λ of the sodium light is given by the formula in case of biprism experiment.

$$\lambda = \beta\, 2d / D$$

Where β = fringe width,
2d = distance between the two virtual sources,
D = distance between the slit and screen.
Again $2d = \sqrt{(d_1 d_2)}$
Where d_1 = distance between the two images formed by the convex lens in one position.
d_2 = distance between the two images formed by the convex lens in the second position.

Description of the Apparatus:
Two coherent sources, from a single source, to produce interference pattern are obtained with the help of a Bi-prism. A bi-prism may be regarded as made up of two prisms of very small refracting angles placed base to base. In actual practice a single glass plate is suitably grinded and polished to give a single prism of obtuse angle 170^{0} leaving remaining two acute angles of 30' each.
The optical bench used in the experiment consists of a heavy cast iron base supported on four leveling screws. There is a graduated scale along its one arm. Te bench is provided with four uprights which can be clamped anywhere and the position can be read by means of Vernier attached to it. Each of the uprights is subjected to the following motions:

i) Motion along bench
ii) Transverse motion
iii) Rotation about the axis of the up[right.
iv) With the help of the tangent screw, the slit and bi-prism can be rotated in their own vertical planes.

The bench arrangement is shown in the fig.

Action of Bi-prism:
The action of the Bi-prism is shown in the fig.
Monochromatic light source S falls on two points of the prism and is bent towards the base. Due to the division of wavefront, the refracted light appears to come from S_1 and S_2. The waves from two sources unite and give interference pattern. The fringed are hyperbolic, but due to high eccentricity they appear to be straight lines in the focal plane of eyepiece.

Procedure:
Adjustments:

i) Level the bed of optical bench with the help of spirit level and leveling screws.
ii) The slit, Bi-prism and eye-piece are adjusted at the same height. The slit and the cross wire of eye piece are made vertical.
iii) The micrometer eye piece is focused on cross wires.
iv) With an opening provided to cover the monochromatic source, the light is allowed to incident on the slit and the bench is so adjusted that light comes straight along its lengths. This adjustment is made to avoid the loss of light intensity for the interference pattern.
v) Place the bi-prism upright near the slit and move the eye piece sideways. See the two images of the slit through Bi-prism; if they are not seen, move the upright of Bi prism right angle to the bench till they are obtained. Make the two images parallel by rotating bi-prism in its own plane.

vi) Bring the eye piece near to the bi prism and give it a rotation at right angle of the bench to obtain a patch of light. As a matter of fact, the interference fringes are obtained in this patch provided that the edge of the prism is parallel to the slit

vii) To make the edge of the Bi prism parallel to the slit, the bi prism is rotated with the help of tangent screw till a clear interference pattern is obtained. These fringes can be easily seen even with the naked eye.

viii) The line joining the centre oft the slit and the edge of the Bi prism should be parallel to the bed of the bench. If this is not so, there will be a lateral shift and the removal is most important. This is shown in the fig.

(a) In order to adjust the system for no lateral shift, the eyepiece is slowly moved away from Bi-prism; the fringes will move to the right or left but base screw provided with Bi-prism, is moved at right angle to the bench in such a direction so that bridge in such a direction as to bring the fringes back to their original position.

(b) Next move the eye piece towards the bi-prism; the fringe system will move towards right or left but this time, they are brought to their original position by moving the screw of eye piece.

On using the above process repeatedly, the lateral shift is removed.

Measurements:

(A) Measurement of fringe width (β):

i) Find out the least count of the micrometer screw.

ii) Place the micrometer screw at such a distance from bi prism where fringes are distinct, bright and widely spaced, say 120 cms.

iii) The cross wire is moved on one side of the fringes to avoid backlash error. Now the cross wire is fixed at the centre of a bright fringe.

iv) The crosswire is now moved and fixed at the centre of every second fringe. The micrometer readings are noted. From these observations β can be calculated.

(B) Measurement of D:

The distance between the slit and eyepiece uprights is noted. This distance gives D.The value of D is corrected for the bench error.

(C) Measurement of 2d:

The distance 2d between the two virtual sources can be measured with the help of fig.

i) To obtain the value of 2d, the positions of slit and Bi-prism uprights are not disturbed.

ii) A convex lens is introduced between Bi-prism and eye-piece and moved in between to obtain the second position where again two sharp and focused images are obtained. The distance between two images is noted. In the first position the distance is noted by d_1

iii) The lens is again moved towards the eye-piece to obtain the second position where again two sharp and focused images are obtained. The distance in this case is denoted by d_2. Knowing d_1 and d_2 , 2d can be calculated by using the formula:

$$2d = \sqrt{(d_1 d_2)}$$

Result: Wavelength of sodium light $\lambda = {}^0A$

Standard value of $\lambda = ..{}^0A$

% Error = …%

Precautions and Sources of Error:

i) The setting of uprights at the same level is essential.

ii) The slit should be vertical and narrow.

iii) Fringe shift should be removed.

iv) Bench error should be taken into account.

v) Crosswire should be fixed in the center of the fringe while taking observations for fringe width.

vi) The micrometer screw should be rotated only in one direction to avoid backlash error.

vii) The fringe width should be measured at a fairly large distance.
viii) Convex lens of shorter focal length should be used (f = 25 cms. approx)
ix) Motion of eyepiece should be perpendicular to the lengths of the bench.

VIVA VOCE

1 What do you mean by interference of light?
2 Is there any loss of energy in the interference phenomenon?
3 What are the different types of interference?
4 What are interference fringes?
5 What is a Bi-prism?
6 Why are the refracting angles of the two prisms made so small?
7 What is the purpose of the Bi-prism?
8 What is the effect of changing the distance between the slit and bi-prism on the fringe – width?
9 How o you measure 2d?
10 How will you locate zero order fringes in Bi-prism experiment?
11 How can you measure the thickness of mica sheet?
12 Are the bi-prism fringes perfectly straight?
13 What is the construction of sodium lamp?

Observations:

Pitch of the screw = ….cm
No. of divisions on the micrometer screw = ….cm
L.C of micrometer screw = ….cm

(1) Table for fringe width β:

No. of fringes	Micrometer reading (a)			No. of fringes	Micrometer reading (b)			Diff. for 20 fringes a-b	Mean for 20 fringes	Fringe width B= [Mean/20]
	M.S	V.S	Total cms.		M.S	V.S	Total cms.			
1	…	…	…	21	…	…	…	…		
3	…	…	…	23	…	…	…	…		
5	…	…	…	25	…	…	…	…		
7	….	…	….	27	….	….	….	….		
9	…	…	…	29	…	…	…	…		
11	..	…	..	31	..	..	..	..	…..	……
13	…	…	…	33	…	…	…	…		
15	…	…	…	35	…	…	…	…		
17	….	…	….	37	….	….	….	….		
19	…	…	…	39	…	…	…	…		

(2) Measurement of D:

Position of upright carrying slit = ….cms
Position of upright carrying the eyepiece = ….cms
Observed value of D = ….cms
Value of D for bench error = ….cms.

Measurement of 2d:

S.No.	Micrometer Reading						$2d = \sqrt{(d_1 d_2)}$	Mean 2d
	I st position of the lens			2 nd position of the lens				
	I image	II image	.d_1	I image	II image	.d_2		
1	…	…	…	…	…	…	…	…
2	…	…	…	…	…	…	…	…
3	…	…	…	…	…	…	…	…

Calculations:

$$.\lambda = \beta.2d/D = \ldots {}^0A$$

Figure 1

Figure 2

Figure 3

Figure 4