Experiment 2

Objective:

To setup the interference fringes of the double slit variety using a single source and Fresnel's bi-prism and hence determine the wavelength of sodium light

Experimental setup:

Optical bench with mounts, sodium vapor lamp, Fresnel biprism, convex lens, slit, eyepiece with micrometer

Theory:

The biprism consists of a glass prism with two of its sides making an angle of about 180 degrees and other two being around 30 seconds. When its refracting edge is placed parallel to the slit, the incident light from the slit gets divided into two parts both of which appear to come from two virtual sources. Since the two sources are coherent, they can interfere to result in the interference fringes of alternate light and dark bands.

The fringe width β = Dλ/d where D is the distance between the slit and the eye-piece, d = distance between the two virtual sources and $\lambda =$ wavelength of the source. How to calculate 'd' is mentioned in the last step of the procedure.

Procedure:

1. It was made sure that the centre of the slit, centre of the biprism and the centre of the eye-piece were in a straight line at same height.
2. Sodium lamp was switched on and the slit width was set to narrow.
3. By the movement of the tangent screw, the biprism was rotated and brought parallel to the slit.
4. By the adjustments of the plane biprism and the mutual separation of slit, biprism and eye-piece, fringes were seen through the eye-piece

5. The fringe width was found by measuring the mean width of 20 consecutive fringes through the micrometer attached to the eye-piece. However, the micrometer also needs to be calibrated for the purpose.
6. The distance between the slit and eye-piece was also measured from the scale attached to the optical bench.
7. In order to calculate the distance between the virtual sources, a convex lens was inserted between the biprism and eye-piece. The lens was moved to the eye-piece until two sharp images of the slit were obtained. The distance between the images as found through micrometer and labeled d_1. Similarly, the lens was moved to the biprism and again the distance d_2 between the sharp images is found. The distance d is nothing but geometric mean of d_1 and d_2.

Observations and Calculations:

Calibration of micrometer:

Rotations of the micrometer screw	Displacement on the main scale (in mm)
4	2.5
8	5.0
12	7.5
16	10.0

So, 1 rotation of the screw is equivalent to 10/16 mm of displacement on the main scale.

S.No.	Initial reading on micrometer	Final reading on micrometer	Fringe width (in no. of rotations of micrometer screw)
1	0.17	0.32	0.15
2	0.32	0.47	0.15
3	0.47	0.63	0.16
4	0.63	0.84	0.21
5	0.84	0.97	0.13
6	0.97	1.15	0.18
7	1.15	1.29	0.14
8	1.29	1.42	0.13
9	1.42	1.6	0.18
10	1.60	1.71	0.11
11	1.71	1.8	0.09
12	1.80	2.02	0.22
13	2.02	2.16	0.14
14	2.16	2.31	0.15
15	2.31	2.43	0.12
16	2.43	2.57	0.14
17	2.57	2.71	0.14
18	2.71	2.89	0.18
19	2.89	3.04	0.15

Least count of micrometer = 2.5/400 mm (as 4 rotations of screw are equivalent to 2.5 mm and each rotation has 100 divisions)

The mean width = 2.87 rotations = 0.094 mm $\pm$ 0.00625mm

D = 74.0 cm $\pm$ 0.05 cm
'd_1' = 8.13 mm $\pm$ 0.00625mm
'd_2' = 2.90 mm $\pm$ 0.00625mm
d = $(d1\times d2)^{1/2}$ = 4.86 mm $\pm$ 0.00625mm

Wavelength of light = $d\beta/D$ = 617.3 nm $\pm$ 0.85% = 617.3 nm $\pm$ 5.2 nm

Precautions:

1. Biprism should be handled very carefully. It is expensive and fragile.
2. The surface of the lens, biprism and eyepiece should be cleaned with a clean tissue paper and should not be touched with fingers.
3. Micrometer should be moved only in one direction to avoid backlash error.