EXPERIMENT NO.: …….

Aim: - To determine the **fringe width of interference fringes** produced by monochromatic light using a Fresnel Biprism.

Practical Significance of the Experiment: -

Fresnel's Biprism is a device that is made by either joined 2 acute angled prism or by cutting glass sheet at specific angles. It is used to obtain 2 virtual point sources.

It is used to demonstrate wave nature of light. Also demonstrated the interference of the waves and they produce patterns.

Biprism is used in holography for 3D imaging. This experiment allows us to measure accurate wavelength of light.

It also has Applications in Optical Instrumentation and for this understanding interference is essential. Eg of optical instrument - Interferometers, etc... also it helps students to understand interference and wave behavior of light.

Relevant Program Outcomes

1. **Engineering Knowledge (PO1):** Applies the principles of wave optics, interference, coherence, and monochromatic light to determine fringe width.
2. **Problem Analysis (PO2):** Analyzes the interference pattern, identifies measurement errors, and interprets the relationship between wavelength, source separation, and fringe width.
3. **Modern Tool Usage (PO5):** Uses precision laboratory instruments such as the travelling microscope, optical bench, Fresnel's biprism, and monochromatic light source effectively.
4. **Ethics (PO8):** Maintains honesty in observations, records accurate data, and follows ethical laboratory practices.
5. **Individual and team work (PO9):** Performs the experiment individually or collaboratively while coordinating with laboratory partners.
6. **Communication (PO10):** Presents observations, calculations, graphs, and conclusions clearly in the laboratory record and viva examination.
7. **Life-Long Learning (PO12):** Develops experimental skills and conceptual understanding that support advanced studies in optics, photonics, laser technology, and optical engineering.

Relevant Course Outcomes:

Students will be able to find the wavelength of sodium light by using Fresnel's Biprism Experiment and also understand the wave nature of light and also the principles of interference and diffraction.

Practical Skills:

- **Optical Alignment and Instrument Handling:** Aligns the optical setup accurately and handles the Fresnel's biprism, travelling microscope, and other optical components with care.
- **Observation and Precision Measurement:** Observes interference fringes carefully and measures their positions accurately using a travelling microscope.
- **Data Recording, Analysis, and Calculation:** Records experimental data systematically, performs calculations, and determines the fringe width using the interference formula.
- **Problem-Solving and Error Analysis:** Identifies alignment or measurement errors, troubleshoots experimental issues, and improves the accuracy of results.
- **Scientific Reporting and Communication:** Presents observations, calculations, graphs, and conclusions clearly in the laboratory record and during viva examinations.
- **Critical Thinking and Interpretation:** Compares experimental results with theoretical values and interprets the significance of the obtained fringe pattern.
- **Laboratory Safety and Teamwork:** Follows safe laboratory practices, handles equipment responsibly, and collaborates effectively with team members during the experiment.

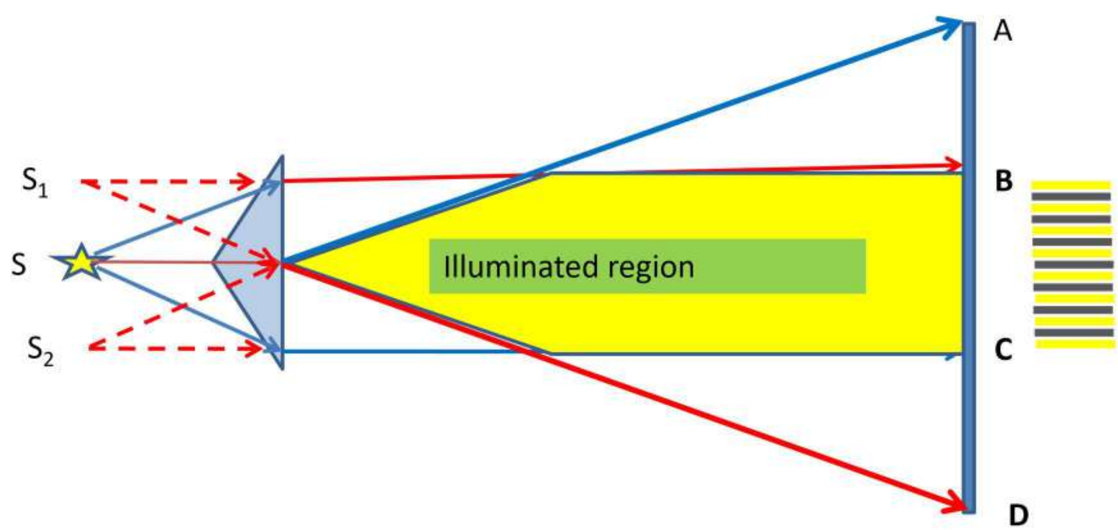
Relevant Effective Domain Related Outcomes:

- **Receiving: -** Demonstrate attentiveness to laboratory instructions, safety precautions, and the correct experimental procedure.
- **Responding: -** Actively participate in performing the experiment, recording observations, and discussing the experimental results.
- **Valuing: -** Appreciate the importance of accurate measurements, ethical data recording, and careful handling of laboratory equipment.

- **Organization (Partially Developed): -** Develop a positive attitude toward maintaining discipline, teamwork, and systematic laboratory practices during experimental work.

Theoretical Background:

This experiment is based on the principles of interference and formation of two coherent virtual sources. When a monochromatic light such as, sodium light passes through a narrow slit and then encounters a biprism, the prism effectively splits the light into two diverging beams that appear to originate from two virtual coherent sources. These two sources being coherent, interfere with each other to produce an alternating pattern of bright and dark fringes on a distant screen. The bright fringes result from constructive interference and dark fringes are result of destructive interference.



The separation between two fringes is called fringe width (β). It is related to wavelength, distance between slit and screen and distance between two slit is given by:

$\beta = (\lambda * D) / d$

Where: λ = wavelength
D = distance b/w slit and screen
d = distance b/w 2 virtual sources

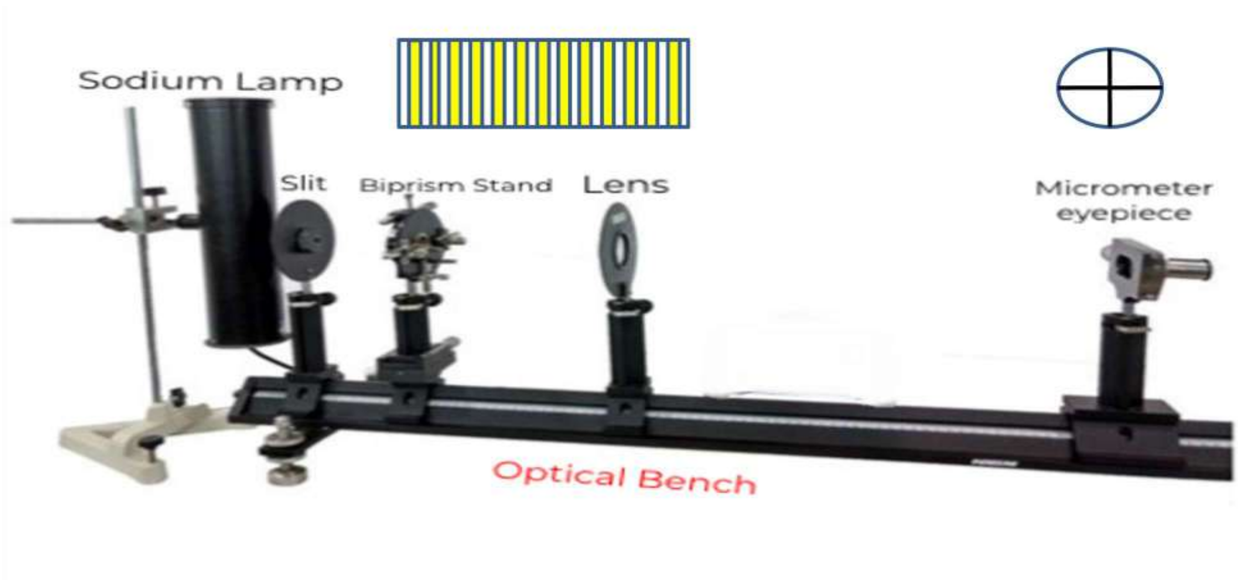
With this relation wavelength (λ) of sodium light can be determined. Here

$d = \sqrt{(d1 * d2)}$, where d1 = distance b/w images of slit at first position of lens; d2 = distance b/w images of slit at second position of lens.

Resources Required:

S. No.	Name of equipment	Specifications	Quantity	Remark
1.	Optical bench with uprights		1	
2.	Sodium lamp		1	
3.	Biprism		1	
4.	Convex lens		1	
5.	Slit		1	
6.	Micrometer eyepiece		1	

Experimental Set-up: -



Precautions:

1) Slits should be narrow and vertical as possible.

2) All uprights should be at same height.

3) Micrometer screw should be rotated in same direction in order to avoid backlash error.

4) The position of slit and biprism should not be changed through the focal length of convex lens while measuring d.

5) Lateral shift of fringes should be removed.

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

7) Motion of eyepiece should be perpendicular to length of the bench.

Procedure:

Measurement of fringe width (β)

i) Find out the least count of micrometer screw.

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

iii) The crosswire is moved on one side of fringes to avoid backlash error. Now fix the crosswire at center of the bright fringe of one side.

iv) Note down the position of the bright fringe from micrometer eyepiece.

v) The crosswire is now moved and fixed at center of second fringe. The micrometer readings are noted.

vi) Repeat this process by moving the cross wire upto the bright fringe of other side of spectrum.

vii) From these observations (β) fringe width can be calculated.

Measurement of D

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

Measurement of d

The distance d between the two virtual sources can be measured with the help of figure:

1. To obtain the value of d, the positions of slit and Biprism uprights are not disturbed.
2. A convex lens is introduced between Biprism and eyepiece and moved in between the two to obtain the second position to get two sharp images.
3. The lens is placed near to eyepiece and is moved towards biprism till two sharp images of slit are seen. The distance d1 is measured by micrometer eyepiece.
4. Lens is moved towards the biprism till two images are again seen. The distance between these two images is d2.
5. At least 2 sets of observations for d1 and d2 are taken.

Observation Table

1. Measurement of Fringe Width: -

No. of fringes	Micrometer reading (a) (mm)			No. of fringes	Micrometer reading (b) (mm)			Difference c = (a ~ b)	Mean of 10 fringes (c/10) (mm)	Calculated fringe width β (mm)
	m. s.	v. s.	Total (a)		m. s.	v. s.	Total (b)			
1				11						
2				12						
3				13						
4				14						
5				15						
6				16						
7				17						
8				18						
9				19						
10				20						

2. **Measurement of D: -**
   i) Position of the upright carrying slit (m) = ……...
   ii) Position of the upright carrying eyepiece (n) = ……….
   D = m – n = ………

3. **Measurement of d: -**

S. No.	Micrometer reading at 1st position of Lens						$d_1 =$ q - p	Micrometer reading at 2nd position of Lens						$d_2 =$ u - v	$d = \sqrt{d_1 d_2}$
	Image I Position			Image II Position				Image I Position			Image II Position				
	m.s.	v.s.	Total (p)	m.s.	v.s.	Total (q)		m.s.	v.s.	Total (u)	m.s.	v.s.	Total (v)		
1															
2															

Calculation: -

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

$\beta = \cdots nm$

Interpretation of Result: -

Result: -

The fringe width of sodium light is ……. **nm.**

Conclusions:

The experiment achieved its objective to find the wavelength of sodium light by using Fresnel's Biprism and also able to demonstrate the interference pattern.

The experiment illustrates destructive and constructive interference. It also demonstrates light's wave like behavior. Observer learns to align optics, measure data and analyze results.

However, there could be various sources of errors like uprights may not be at same level. There would be a backlash error. There might be imperfections in Biprism material. Inaccurate readings of ruler or micrometer.

Recommendations:

1- Familiarize yourself with wave optics and interference principles.

2- Use different wavelength light sources.

3- Use precise tools to measure. Focus the crosswires accurately.

4- Ensure to adjust the light source in centre properly.

5- Ensure proper cleaning of all instruments before use.