Experiment #: 08

Experiment Title: Fresnel's biprism

Objectives:

1. To determine of the wavelength of light by interference with Fresnel’s biprism.
2. Fresnel biprism is used to divide the wavefront of a monochromatic, coherent beam of light producing an interference pattern. The wavelength of the light is determined.

Theory:

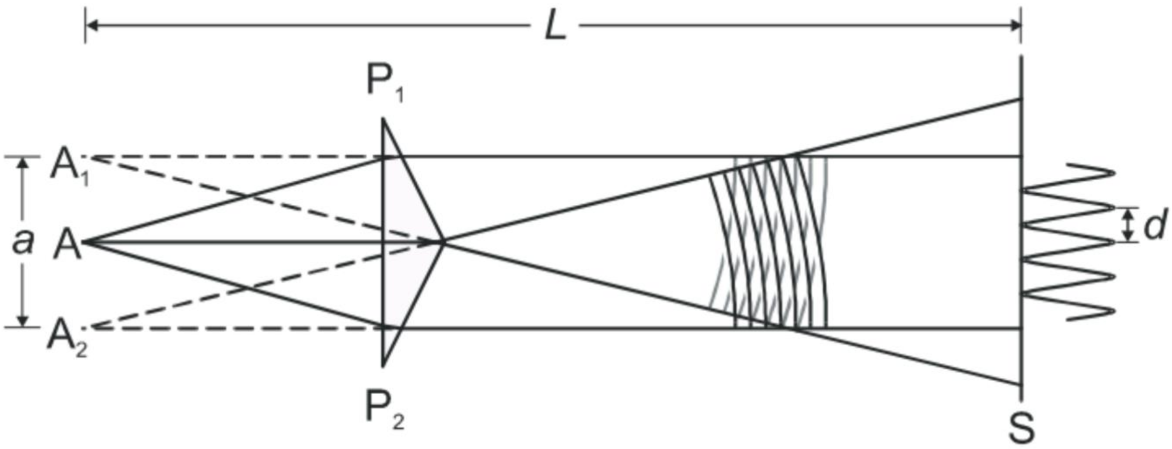

Fig 1. Schematic representation of the beam path at Fresnels biprism:

A: Light source (He-Ne laser).

A_1 and A_2: Virtual light sources.

S: Screen/wall.

a: Distance between the two virtual light sources.

d: Distance between two neighbouring intensity maxima or minima. P_1 and P_2: Prism halves.

L: Separation between laser and screen/wall.

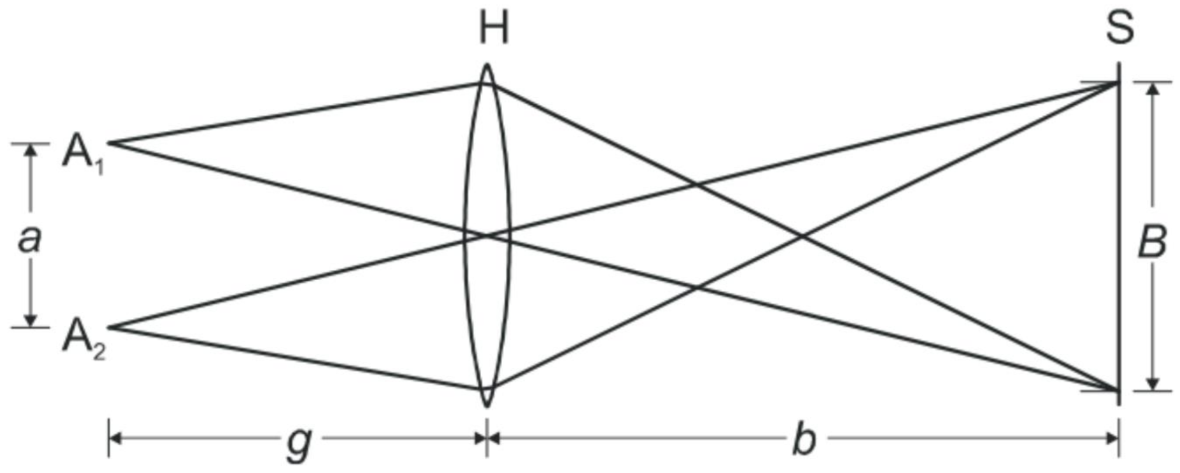

Fig 2. Schematic representation of the image of the two virtual light sources:

H: Imaging lens H.

A_1 and A_2: Virtual light sources.

S: Screen/wall.

a: Distance between the two virtual light sources.

B: Distance between the image of two virtual light sources on the screen. g: Distance between the virtual sources and the lens H (object distance). b: Distance between the lens H and the screen S.

Precautions

1. Laser light is dangerous and can potentially cause visual impairment. Never look directly into any laser beam. Prolonged exposure will cause flash-blindness, after images and glare which will reduce or cause complete loss of visibility in the central field of vision.
2. Optical systems are sensitive and are often fine-tuned. Be very careful with the equipment, as a slight nudge might damage the equipment.
3. Stray light can obscure the images seen on the screen. Preform the experiment in pitch-black darkness.

List of Equipment:

Apparatus

• Fresnel biprism.

• Lenses (f = 20 mm and 300 mm). • Lens mounts.

• Swinging arm and slide mounts.

• Optical bench.

• Laser, He-Ne 1.0 mW, 220 V AC. • Measuring tape, 200 cm.

Circuit Diagram:

Procedure:

Part 1: Interference Pattern (Fig. 1):

In front of you, the He-Ne laser is mounted at the 2 cm mark.

Mount the lens (f = 20 mm) at the 23.3 cm mark. This lens spreads the laser beam slightly (widens it).

Mount the biprism at the 45 cm mark, with its tip facing the laser. Use your finger to determine where the biprism's tip is.

You should be able to see an interference pattern on the wall.

Using a vernier scale, measure the separation D between five maxima/minima. Repeat step 5 three times, measuring D_1, D_2 and D_3.

Measure the distance L between the laser and the screen/wall.

Part 2: Virtual Source Separation (Fig. 2):

Mount the lens (f = 300 mm) at ≈ 60 cm mark. You should be able to see two separate light points.

Using a vernier scale, find the distance B between the two light points. Measure the distance b between the lens H and the screen S.

7 Evaluation

1. Calculate the separation d between two successive maxima/minima:

$d_n = \frac{D_n}{5}$

Where n = 1, 2 and 3.

2. Find the average d_{avg} of d_n.

3. Calculate the distance g between the virtual sources and the lens H (object dis- tance) using the imaging equation:

$g = \frac{fb}{b-f}$

Where f = 300 mm.

Calculate the distance a between the virtual light sources:

$a = \frac{Bg}{b}$

Find the wavelength λ using:

$l = \frac{d_{avg}a}{L}$

Calculate the error percentage.

Postlab Questions

What is meant by the virtual source in Fresnels Biprism experiment? Using the experimental sketch above, explain how such a source arises.

You can find the value of g using an equation other than the imaging equation. Write the expression of that equation, explaining how you obtained it.

Data Collection:

Calculation:

Result: