UE4030300 FRESNEL BIPRISM

EXPERIMENT PROCEDURE

- **Use a Fresnel biprism to create two virtual coherent sources of light from a single point light source.**
- **Observation of the interference between the two split beams from the virtual light sources.**
- **Determine the wavelength of light from an He-Ne laser from the separation between interference bands.**

OBJECTIVE

Generating interference between two beams using a Fresnel biprism

SUMMARY

Refraction of a divergent light beam by means of a biprism separates the beam into two parts which, since they are coherent, will interfere with one another. The wavelength of the light used in the experiment can be determined using the separation of the virtual light sources and the distance between adjacent interference bands.

REQUIRED APPARATUS

Quantity	Description	Number
1	Fresnel Biprism	1008652
1	Prism Table on Stem	1003019
1	He-Ne Laser	1003165
1	Achromatic Objective 10x / 0.25	1005408
1	Convex Lens on Stem f =+200 mm	1003025
3	Optical Rider D, 90/50	1002635
1	Optical Precision Bench D, 50 cm	1002630
1	Projection Screen	1000608
1	Barrel Foot, 1000 g	1002834
1	Pocket Measuring Tape, 2 m	1002603

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UE4030300

BASIC PRINCIPLES

In one of his experiments on interference, *August Jean Fresnel* used a biprism to induce interference between two beams. He split a diverging beam of light into two parts by using the biprism to refract them. This resulted in two split beams which acted as if they were from two coherent sources and which therefore interfered with each other. By observing on a screen, he was able to see a series of peaks in the light intensity with a constant distance between them.

Whether a peak occurs in the intensity or not depends on the difference Δ in the path travelled by each of the split beams. If the light source is a long distance L from the screen, the following is true to a good approximation:

(1) $$\Delta = A \cdot \frac{x}{L} \ .$$

Here, x refers to the coordinate of the point observed on the screen which is perpendicular to the axis of symmetry. A is the distance between the two virtual light sources, which is yet to be determined Peaks in intensity occur at the precise points where the difference in the path travelled is a multiple of the wavelength λ:

(2) $$\Delta_n = n \cdot \lambda \text{, where } n = 0, 1, 2, \ldots$$

A comparison between (1) and (2) shows that the peaks will be at the following coordinates:

(3) $$x_n = n \cdot D$$

They should also be at a constant distance D apart. The following relationship is also true:

(4) $$\lambda = A \cdot \frac{D}{L} \ .$$

Equation (4) can be seen as an expression for determining the wavelength λ of the light being used. It is always applicable for interference between two beams.

Nevertheless, it is still to be established how the distance between the two virtual sources A can be measured. This can be assisted by a simple optical set-up, in which in image of both sources is obtained on the screen with the help of a converging lens so that the distance B between the images of the two sources can be measured (see Fig. 2). The following then applies:

(5) $$A = B \cdot \frac{a}{b}$$

a: Object distance, b: Image distance.

NOTE

Instead of a biprism, a Fresnel mirror (1002649) can also be used to generate the two virtual light sources. The corresponding list of accessories can be found under the entry for UE4030320.

EVALUATION

In this experiment a laser is used as the source of the light. Its beam is spread out by a lens. The position of the light source is not precisely known, therefore the object distance a is not known either. It therefore needs to be calculated from the focal length f of the lens and the easily measured image distance b using the law for the formation of images:

The following therefore applies: $\frac{1}{f} = \frac{1}{a} + \frac{1}{b}$

The distances D and L can be measured directly. This means that all the variables for determining the wavelength using equation (3) are now known.

$$A = a \cdot \frac{B}{b} = \frac{f \cdot B}{b - f}$$

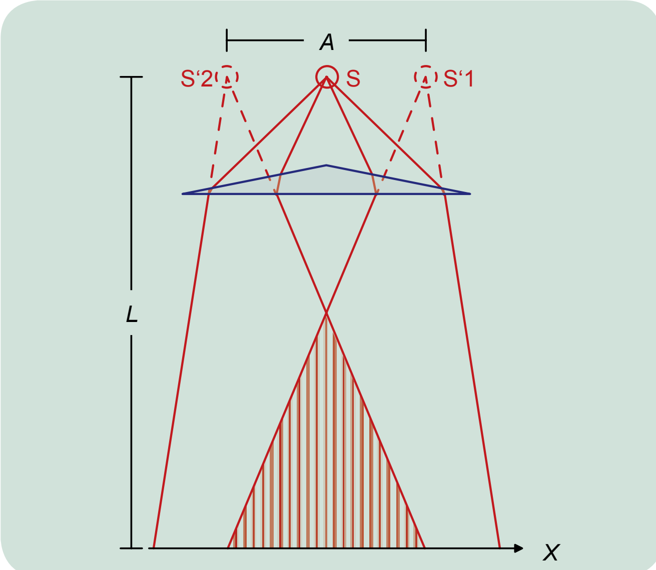

Fig. 1 : Schematic diagram of light passing through a biprism

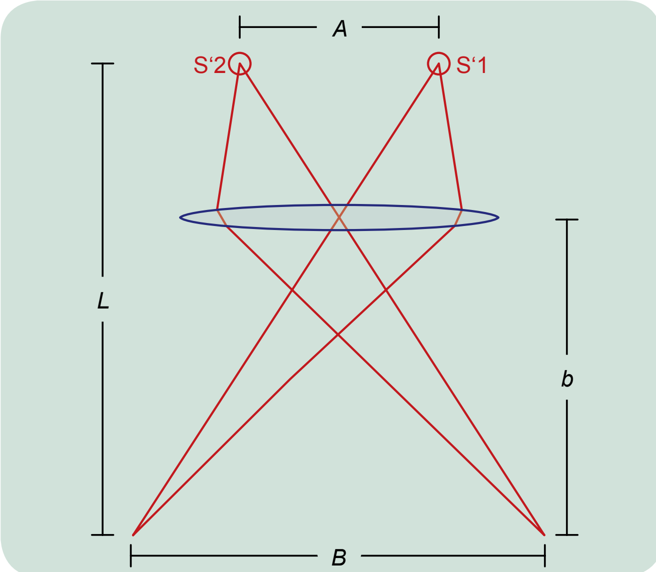

Fig. 2: Ray diagram for obtaining an image of the two virtual sources on the screen