## *Interference at Fresnel's biprism with an He-Ne laser*

Experiment Objective: to study the two-beam interference effect.

Tasks:

- to acquire skills of the optical scheme "Fresnel biprism" adjustment and observe an interference pattern;
- to observe a change in the width of the interference fringes depends on the distance between the source and the biprism;
- to determine the distance between the coherent sources;
- to determine the light wavelength of monochromatic source.

Optical elements and apparatus:

- ✓ He-Ne laser (1);
- ✓ Fresnel biprism (3);
- ✓ lens in frame, f = +5 mm (2);
- ✓ lens in frame, f = +200 mm (7);
- ✓ precision optical bench (5);
- ✓ optics riders (6);
- ✓ translucent screen (4);
- ✓ measuring ruler or steel tape measure.

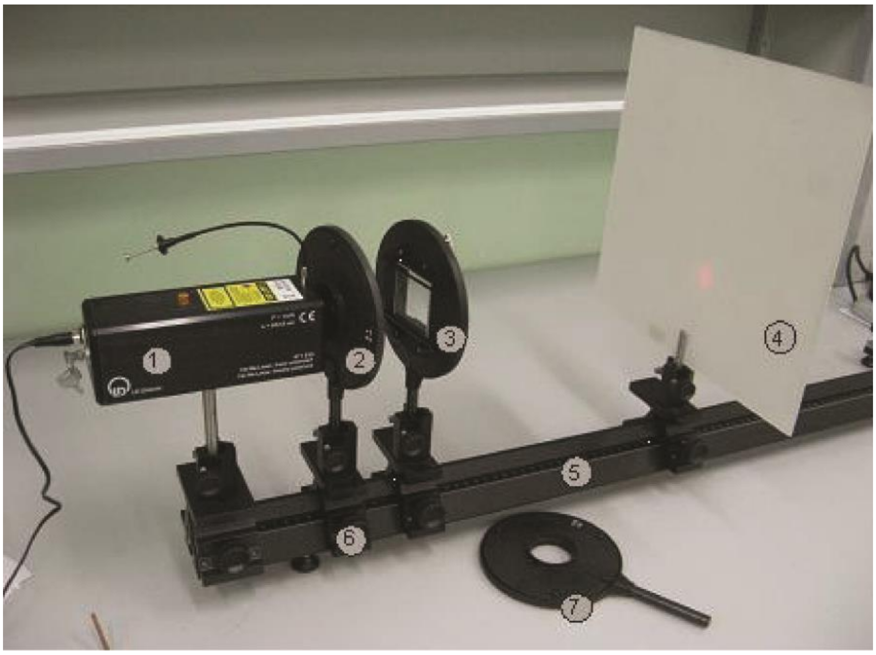


Fig.1. Experimental setup for observing interference phenomena created by means of Fresnel's biprism.

Coherent waves in the optical scheme with Fresnel's biprism are created by dividing the wavefront.

The plane wave from the laser 1 is focused by the short-focus lens (2) in a point "A" (see Figure 1 and the scheme in Figure 2) and then turns into a divergent beam of light. Part of the wave front hits the screen through the top half of the double prism, and the other part of the wave through the bottom one. As a result, two imaginary coherent sources “A1” and “A2” are appear (see Fig. 2). At the crossing region of divergent beams the interference occurs. It can be observed on the screen as a alternating light and dark bands.

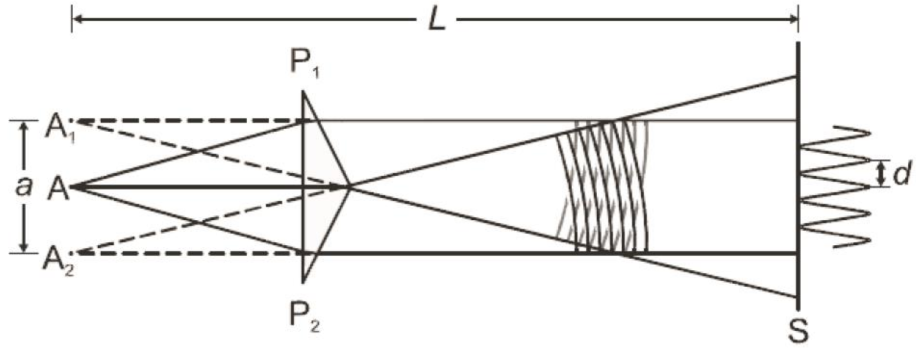


Fig.2. Schematic representation of the beam path at Fresnel’s biprism.

The distance between two intensity maxima (or minima) *d* is:

$$d = \frac{\lambda}{\varphi} = \frac{\lambda L}{a}, \qquad (1)$$

where *a* - distance between the two virtual light sources; *L*: distance between the plane of the light sources and the plane of observation; *λ* – wavelength (see Fig. 2).

The distance *a* between the two virtual light sources $S'_1$ and $S'_2$ is determined by means of a simple optical setup:

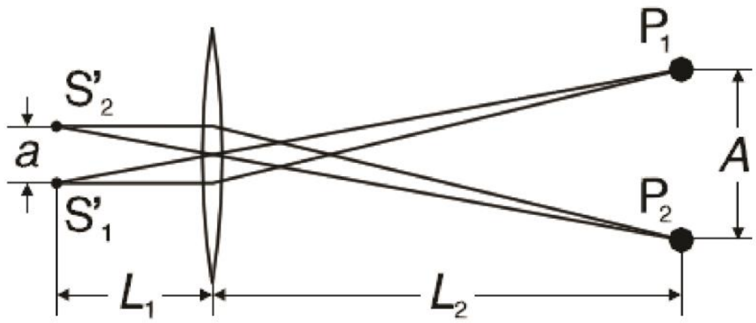


Fig.3. Determining the distance *a* between the virtual light sources.

For the image of the $P_1$ and $P_2$ sources on the remote screen obtained with the lens the distances *a*, *A*, $L_1$ and $L_2$ are related as:

$$\frac{a}{A} = \frac{L_1}{L_2},$$

where the required distance is:

$$a = A\frac{L_1}{L_2} \qquad (2)$$

Procedure:

*Exercise 1. Adjustment of the "Fresnel biprism" optical scheme and observe an interference pattern.*

The entire setup is illustrated in Figure 1.

1. Mount the He-Ne laser (1) to the left edge of the optical bench. Direct the laser beam along the optical bench towards the screen. Measure the height of the beam on the optical bench (call it $Z$).
2. Place the spherical lens with the focal length f = +5 mm at a distance of approx. 12 cm in front of the laser. (the distances are measured from the riders left edges which are fixed the elements). First light beam is focused in the vicinity lens, creating source A (Fig. 2), and then becomes divergent. Readjust the height of the spherical lens so that the diverging beam center was located at a height $Z$.
3. Fix the Fresnel biprism on the optical bench at a distance of approx. 7 cm from the spherical lens. Rib biprism must be in the middle of the light beam.
4. Set up the screen (4) at the right edge of the optical bench.
5. The interference fringes appear in the centre of the screen. Observe the change in the width of the interference fringes by moving the biprism along the optical bench.

*Exercise 2. The distance determination between the coherent sources.*

1. Set up the biprism at 7 cm from the lens and get an interference pattern on the screen.
2. Remove the screen and place the spherical lens with the focal length f = +200 mm on the optical bench (see Fig.1).
3. Moving the lens along the optical bench, get an image of two points on the remote for 1.5 - 2 m screen (this is the image of two coherent sources).
4. Measure the distance $A$ between these two points, the distance $L_2$ between the lens and screen and distance $L_1$ between the sources and lens (2) with the focal length f = +5 mm.
5. Determine $a$ according to the formula (2).

*Exercise 3. The determination of the laser radiation wavelength.*

1. Remove the lens (5) with the focal length f = +200 mm. Set up the screen (4) on the end of the optical bench.
2. In order to determine the distances d between the intensity maxima, put a sheet of paper on the screen and mark the locations of maximum light intensity (or, alternatively, minimum light intensity) using a soft pencil. Calculate the width $d$ of the fringe.
3. Measure the distance $L$ between the short-focus lens (2) and the screen (Fig. 2).

4. According to the formula (1) determine the laser radiation wavelength $\lambda$.
5. Estimate the determination error of this value.