USING FRESNEL BIPPRISMS TO EXPLAIN THE THEME OF LIGHT INTERFERENCE

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Abstract. *This article highlights the importance and benefits of the biprism in explaining the interference of light. It is interesting to explain a subject using a biprism, because it is easy to create an interference scene, a biprism has a simple structure. The resulting image will not have a complex structure.*

Keywords: *monochromatic light, light interference, coherent sources, Fresnel biprism, helium-neon laser, phase difference, interference maxima, interference landscape.*

At present, the organization and conduct of lessons using modern technologies is a call of the times. Given this, it is important to pay special attention to laboratory work, practical exercises and virtual laboratories in teaching young people. For example, when explaining the topic "Light interference", performing laboratory work and demonstrating this phenomenon in practice will help the listener broaden his horizons and understand the topic more deeply. Light interference is an optical phenomenon that shows the wave nature of light. Before explaining the topic of interference, it is appropriate to refer to such concepts as a light source, monochromatic light, coherent waves, coherent sources. Like mechanical waves, light waves can strengthen or weaken each other when they meet. As a result, light and dark rings are alternately formed on the screen with the center lying at one point.

When waves with the same frequency and phase difference do not change, they strengthen or weaken each other when they meet, this is called interference. We have encountered the phenomenon of interference many times in our daily life. A drop of oil spilled on the surface of water or oil products floating in different colors and a soap bubble floating in the air create an interference scene. Waves with the same frequency phase difference are called coherent waves, the sources generating these waves are called coherent sources. In fact, the light waves from the two sources are not coherent. Therefore, to create a coherent wave, two or more coherent waves are artificially created from one source through a light filter. The maximum condition is said to be met when the light waves combine and amplify each other, and the minimum condition is met when they decay. For exactly one of the points to be a constant maximum or minimum, the phase difference of the waves must be constant.

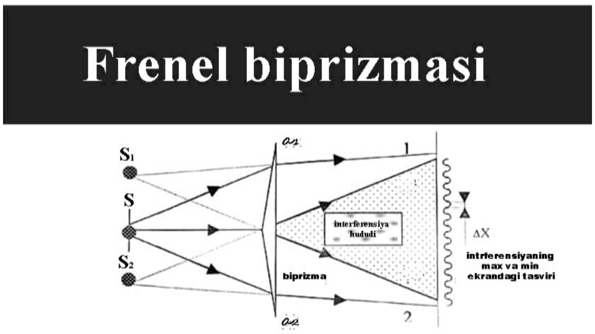

figure 1

The fulfillment of the maximum or minimum condition at a point depends on the path difference.

Naturally, when explaining coherent waves to students, these abstract statements are incomprehensible. So let's see how two waves can be generated from the same source and why they are coherent. The Fresnel biprism will help us with this. Fresnel biprism To observe the interference of light, a Fresnel mirror and two prisms are used (Fig. 1). The Fresnel biprism and the resulting interference scheme are presented. Two identical glass prisms with very small □1 and □2 are pressed against each other by the smallest surfaces. A biprism consists of two prisms with small angles of refraction (about 300) and their bases resting on each other. If a light source S is placed on one side of the prism, then its abstract images S1 and S2 will appear. So we create two coherent sources. On screen E, coherent waves from two sources S1 and S2 combine to form interference. If the source S is natural light, bands of different colors are formed on the screen; if it is monochromatic light with a certain wavelength, then only these colored bands are located on the screen one after the other at a certain distance. We observe interference in the laboratory using a monochromatic helium-neon laser beam with a specific wavelength. In this case, we see that peculiar red and black stripes form on the screen. Monochromatic light from a light source S enters the biprism through a lens, and, in turn, two light beams S1 and S2 exit the biprism as coherent waves. These coherent waves crossing the screen form a uniform interference pattern. Let's get acquainted with modern laboratory work (Figure 2). Necessary equipment: lens with a helium-neon laser, 2- Frinel biprism, 3- screen, 4- optical bench, 5- lens with a focal length of +200 mm.

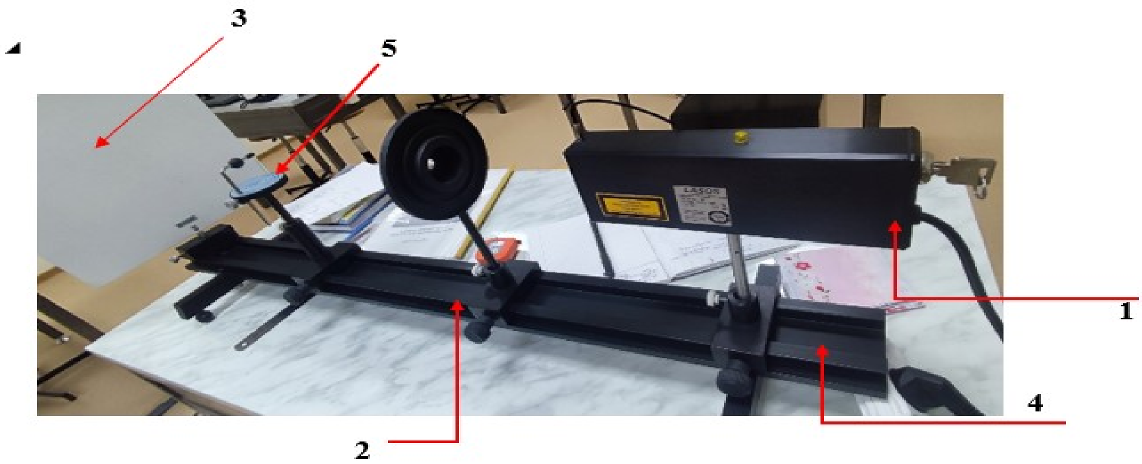

figure 2

We observe interference through monochromatic light with a specific wavelength. When performing laboratory work, we will draw up a diagram, as shown in the image above. A biprism consists of two prisms with small angles of refraction (about 300) and their bases resting on each other. After refraction in the biprism, the beam of light emerging from the slit splits into two overlapping beams, as if coming out of two abstract images of the slit. Since these sources are coherent, a stable interference pattern is formed in the space behind the biprism in the region where the beams cross. This can be used to find the wavelength of interfering light:

$$\lambda = \frac{aB^2}{DNb}$$

Here: a is the distance from the He-Ne laser to the lens, b is the distance from the lens to the image, D is the algebraic sum of a and b, the distance from the laser to the interference scene, the number of interference maxima formed on the N-screen, B is the thickness of the interference scenes.

After installing the equipment, we will begin work. The biprism is installed at a distance of 70-80 cm from the slit so that the refractive ribs are in a vertical position. A lens with a focal length of +200 mm is installed 30-50 cm from the biprism. The illuminator window, slit center, biprism and lens must be at the same height. The slot is narrowed to a certain level and, by slightly turning it around the horizontal axis of the biprism, the slot is brought to a position parallel to the edge of the biprism. Thus, the interference scene becomes very clear. We write down the necessary results according to the working formula and fill in this table, we get the result 5-7 times (Table 1).

From the first 3 results in the table, the values of b and a were changed without changing D and the wavelength of monochromatic light was determined. The following two results were obtained by changing the value of D. The error obtained by these results is very small, and the result is very close to the theoretical value of the wavelength of light.

Table 1

№	a(cm)	b (cm)	D (cm)	N	λ (nm),	$\Delta\lambda$ (nm),	E (%)
1	30	415	445	23	636	2,8	
2	25	420	445	26	630	8,8	
3	35	410	445	27	639	0,2	0,7
4	25	415	440	19	648	9,2	
5	35	405	440	49	641	2,2	

In conclusion, the topic of light interference is relatively complex and, due to the lower level of observation in practice, creates abstract concepts and ambiguities for students. The organization of the lesson with laboratory work or practical exercises will be the basis for better understanding, imagination and memory of students. The purpose of using the Fresnel biprism when explaining the topic of interference is so that the student can do the laboratory work on their own, since there is no sophisticated equipment in the work, the results are accurate and the percentage of error does not reach 1%. The values are consistent with the theoretical data and there is no ambiguity. The student is directly involved in the creation of the interference landscape, takes measurements and can control the process. He gives practical answers to all his questions. The organization of classes through this laboratory work in higher educational institutions and schools is a convenient and effective way to interest students in science and increase their level of knowledge.

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