Fresnel Biprism

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Abstract

Using a fresnel biprism and a lens to create an interference pattern, the wavelength of sodium light was determined to be 602 ± 1nm.

Aims

The aim of this experiment is to determine the wavelength of sodium light using a fresnel biprism.

Introduction and Theory

This experiment is similar to the Young's Slits experiment, however, it differs in that instead of having a beam of light pass through two slits, the source of light instead passes through one slit, and then passes through a biprism which creates two virtual sources. The rays created then pass through a convex lens, causing them to interfere with one another.

The experiment is superior to that of Young since the unwanted diffraction effects created when the light passes through the two slits is eliminated.

The virtual sources of light can be thought of in the same way as the real sources in Young's Experiment, and thus the same formulae can be used to compute the wavelength of a source.

The distance between fringes is given by

$$s = \frac{\lambda D}{d}$$

where D is the distance from the slit to the screen and d is the distance between the two sources. However, since the two sources are virtual, this distance cannot be measured directly, we must use the simple lens formula from optics:

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

Since we know $D = u + v$ we have

$$\frac{1}{f} = \frac{1}{D - v} + \frac{1}{v}$$

,

rearranging, we have

$$v^2 - vD + Df \text{ and also } u^2 - uD + fD = 0$$

which gives us the solutions

$$u_{1,2} = \frac{D \pm \sqrt{D^2 - 4Df}}{2}$$

and

$$v_{1,2} = \frac{D \mp \sqrt{D^2 - 4Df}}{2}$$

The magnification of an image d_i is given by $M_i = -d_i/d$.
Since $u_1 = v_2$ and $u_2 = v_1$ we have

$$\frac{v_1 u_1}{u_2 v_2} = M_1 M_2 = \frac{d_1 d_2}{dd}$$

and hence $d = \sqrt{d_1 d_2}$.
Combining this with our first formula gives us

$$s = \frac{\lambda D}{\sqrt{d_1 d_2}}$$

Experimental Method

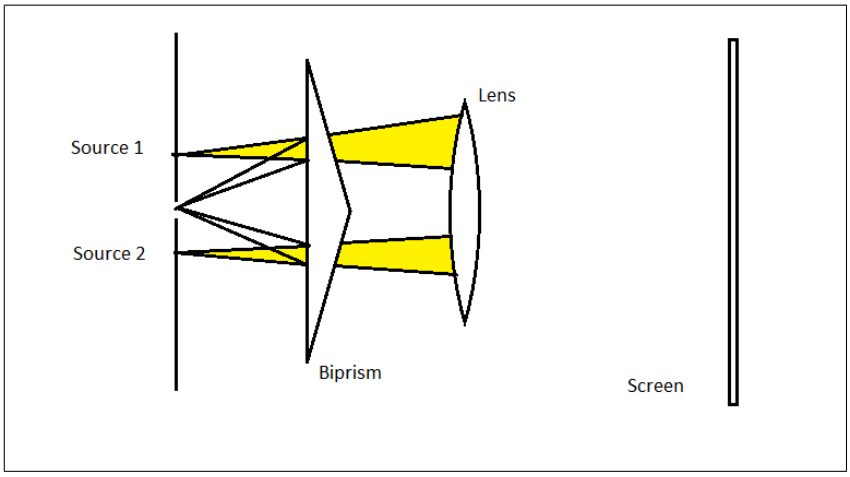

Figure 1: Experimental setup

The apparatus is set up as in Figure 1.

The sodium lamp was left for a few minutes to warm up completely. Once warm, the biprism was slid to approximately 20 cm away from the slit. The positions of the two real images of the sources were found by sliding the screen along the rail and their positions recorded. Then the lens was removed and the positions of 30 consecutive dark fringes were recorded.

Results and Analysis

- The distance D was found to be 85.3 ± 0.2cm.
- The distances between the virtual sources were found to be $d_1 = 0.176 \pm 0.001$m and $d_2 = 0.714 \pm 0.001$.
- The distance between each fringe was found to be 0.0145 ± 0.0001cm.

  Using the formula

  $$s = \frac{\lambda D}{\sqrt{d_1 d_2}}$$

  we found the wavelength of the source to be 602 ± 1nm.

Discussion and Conclusion

The result came very close to the established value of 589.3 nm, however the result was not within experimental error. This is most likely a result of the difficulties in measuring d_1 and d_2. In retrospect the errors involved in finding the exact location of a perfectly in focus image were greatly understated.