EXPERIMENT 9. DOUBLE SLIT DIFFRACTION

Overview

When a laser beam passes through two equal, narrow, parallel stilts, each slit produces an identical diffraction pattern. If the slits are close enough together, the diffraction patterns overlap and interference occurs. In this experiment, we will observe double-slit diffraction and examine the characteristic diffraction and interference patterns produced as the slit widths and spacing are varied.

Procedure

A. Place the diffraction slide mosaic (# IF-508 furnished with the Optics Education Kit) in front of the laser so the beam is transmitted through the first of the four double slits (labeled 25_u x 25_u). The distance between slits is approximately $4.5\text{x}10^{-5}$ m. Observe the diffraction pattern that appears on a screen one meter from the laser. At first glance, the pattern seems similar to the diffraction pattern produced by a single slit, but on closer observation, you can see several interference fringes within the diffraction pattern produced by a single slit. Use a photometer or power meter to measure the light intensity of the interference maxima (bright fringes) in various parts of the diffraction

B. Using the same set-up as in Step A, observe the double-slit diffraction pattern that is produced by the second pair of slits (marked 25_u x 35_u). These slits are the same width, but their separation, d, is approximately $5.8\text{x}10^{-5}$ m. Compare this diffraction pattern with that obtained in Step A, referring to the original pattern if necessary.

C. Observe the diffraction pattern produced by the third pair of slits (marked 25_u x 50_u). The separation, d, is approximately $7.5\text{x}10^{-5}$m. Compare this pattern with those from steps A and B.

D. Considering the findings and observations you made in steps A-C, predict the diffraction pattern of the fourth pair of slits (marked 50_u x 50_u). The slit width, w, is twice that of the others, and separation, d, is approximately 10 x 10^{-5} m. Use the laser to check the accuracy of your prediction.

E. The well-known formula that relates the wave-length of light and the spacing of interference fringe is:

$$\lambda = d\ \sin\theta$$

Where: λ is the wavelength of light (632.8 x 10^{-9} m for a helium-neon laser)
d is the distance in meters between splits
$\sin\theta$ is the distance between two adjacent interference fringes on the screen divided by the distance between the diffraction slide and the screen

F. Using long distances between the laser and the screen to minimize error, calculate the exact distance, d, between each pair of slits on your slide.

G. Use a different distance between the laser and the screen and repeat Step F. The results obtained for slit separation in each case should be identical.