PHY 157
Double-Slit Interference of Light
(Experiment 7)

Name: ______________________________

1 Introduction

In this lab you will observe and study diffraction and interference effects produced by light.

Coherent light from a helium-neon laser will be used to produce diffraction and interference patterns from a slit pattern. The results from measurements will be compared to the expected theoretical results.

Before the invention of the laser, it was very difficult to study the wave properties of light because sources of *monochromatic and coherent* light are very dim. Usually diffraction and interference patterns were captured using long exposures on photographic film. The laser is a very intense source of both monochromatic and coherent light. Diffraction and interference patterns are easily observed on a paper screen in a darkened room. The laser used in this experiment is a 0.5 milliwatt helium-neon (He-Ne) laser, operating at a wavelength of $\lambda = 632.8$ nm.

Note: The light from the laser is very dangerous to your eyes. **Never look directly into the laser beam or its reflection from a shiny surface.** While working with the laser, keep it pointed away from other groups. The slit pattern that you will place into the laser beam is fabricated from metal foils and can produce intense reflections. Please be careful about reflections as you work around the laser beam.

2 Apparatus

- Helium-neon laser
- Component holders
- Laser slide set (see Table 1 for contents)
- Magnetic optical bench
- Metric tape
- Meter stick
- White paper screen
- Night light

3 Procedure

1. Choose one of the double-slit patterns on a double-slit slide. Record the distance between the slits (written on the slide): $d =$ ______________________

2. Project the interference pattern from a double-slit pattern of your choice onto the screen. Measure and record the distance L from the double slit slide to the screen: $L =$ ______________________

3. Measure and record the distance $2y_8$ between the 8^{th}-order bright fringe on one side of the center of the screen and the same bright fringe on the other side of the center of the screen. This gives the *measured* value of $2y_8$:

   $2y_8$ (measured) = ______________________

4. Using the known slit spacing d and distance L, you can now compute an expected value for the distance you measured ($2y_8$). The angular position θ of the m^{th} *bright* fringe is given by the expression

   $$d \sin\theta = m\lambda, \tag{1}$$

   where d is the distance between the two slits, λ is the wavelength of the ligth, and m is an integer (0, 1, 2, 3, ...). Since $\tan\theta = y_m/L$ (Figure 1), the distance $2y_m$ on the screen between two occurrences of the same order bright fringe is given by

   $$2y_m = 2L\tan\theta. \tag{2}$$

Using $\tan\theta \approx \sin\theta$ for small θ, we can combine equations (1) and (2) to get

$$2y_m = 2L\frac{m\lambda}{d}. \tag{3}$$

Since you are finding the distance between the two 8$^{\text{th}}$-order bright fringes ($2y_8$), you will have $m = 8$. Also recall that the laser you're using has a wavelength $\lambda = 632.8$ nm.

Use equation (3) to compute a *theoretical* value for $2y_8$:

$2y_8$ (theoretical) = ____________________________

(Remember to convert all your distances to the same units first before applying equation (3).)

How well does this theoretical value match your earlier measured value?

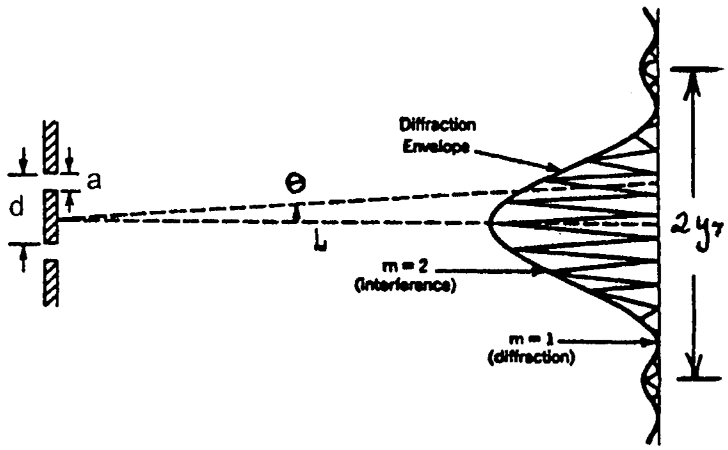
Diffraction
Envelope
a
d
θ
L
2y
m = 2
(interference)
m = 1
(diffraction)

Figure 1.

List of Contents in the Laser Slide Set

Each Laser Slide Set consists of a small plastic box containing the following items:

1) Single slit slide ..... 4 widths [(a=0.02mm, 0.04 mm, 0.08 mm, & 0.16 mm)]
2) Double slit slide..... 4 sets [(a=0.04mm, d=0.250 mm), (a=0.04mm, d=0.500 mm)], ... [(a=0.08mm,d=0.250 mm), (a=0.08mm, d=0.500 mm)]
3) Circular apertures .. 2 diameters [(0.04 mm & 0.125 mm)]
4) Multiple slit slide .. 2 slits, 3 slits, 4 slits, & 5 slits [(a=0.04 mm, d=0.125 mm)]
5) Diffraction mosaic slide (see sketch below)
6) Transmission grating ...... 5276 lines/cm
7) Transmission hologram
8) 2 polarizer slides
9) 1 blank holder
10) lens f = + 18 mm lens
11) lens f = + 48 mm lens
12) lens f = - 22 mm lens

gratings	double slits	a, μm	d, μm
A: 245 lines/cm	25x25:	25	50
B: 490 lines/cm	25x35:	25	60
C: 960 lines/cm	25x50:	25	75
	50x50:	50	100

Table 1.