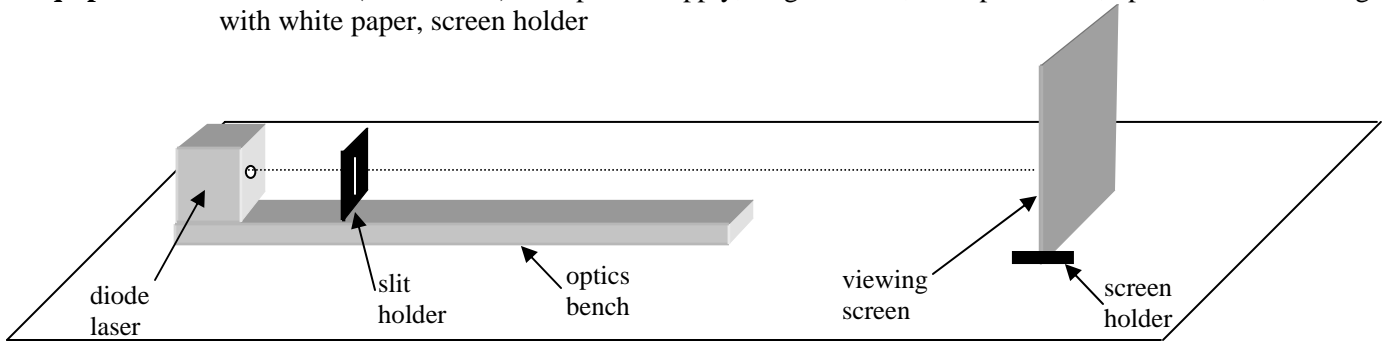


# Diffraction and Interference

- Purpose:**
1. To compare qualitatively the effect of slit width on the position of diffraction minima and maxima
  2. To compare qualitatively the effect of slit separation on the position of interference minima and maxima
  3. To determine quantitatively the location of the maxima for double slit interference
  4. To determine quantitatively the location of minima for single slit diffraction

**Equipment:** diode laser ( $\lambda = 650 \text{ nm}$ ) with power supply, single slit set, multiple slit set, optics bench, viewing screen with white paper, screen holder



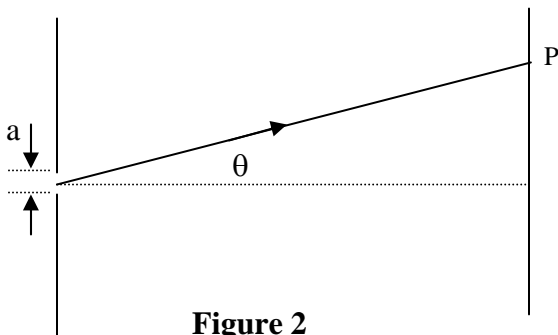
**Figure 1**

**Introduction:**

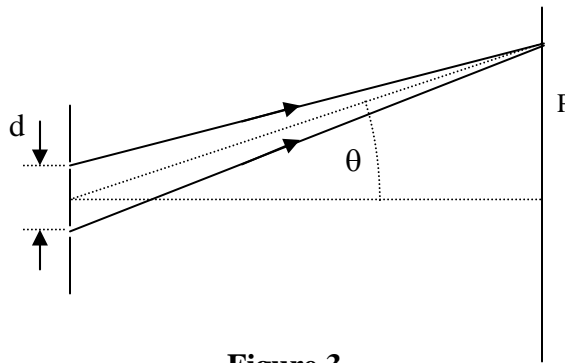
Light passing through a slit of width,  $a$ , undergoes diffraction. If the light passing through the slit is projected onto a distant screen a series of minima and maxima are observed. The location of the **minima** in the diffraction pattern are given by

$$a \sin \theta = m \lambda, m = 1, 2, 3, \dots$$

where  $\lambda$  is the wavelength of the light and  $\theta$  is the angle measured to each minima as shown in Figure 2.



**Figure 2**



**Figure 3**

Light passing through a double slit also experiences interference between the two separate slits. The equation that gives the **maxima** for the interference pattern is

$$d \sin \theta = m \lambda, m = 0, 1, 2, 3, \dots$$

where  $\lambda$  is the wavelength of the light and  $\theta$  is the angle measured to each minima as shown in Figure 3.

## Procedure:

**Notes:** Please exercise extreme caution in using the laser. Be aware at all times where the laser is pointing when it is turned on. Do not turn the laser on until your viewing screen is in place to intercept the beam and prevent it from traveling towards other students. Even a low power laser is capable of causing eye damage.

1. Set up the diode laser, optics bench and viewing screen as shown in Figure 1. After connecting the power supply to the laser, turn on the laser and observe the location of the beam on the screen. Adjust the direction of the laser beam so that the spot on the screen is at the same height as the opening for the beam emerging from the laser (i.e., make the beam level). You can also adjust the height of the entire laser if needed.
2. Place the single slit set on the optics bench at a distance of 5-10 cm from the laser. Position the screen so that it is 2m from the slit set. Rotate the slit set so that one of the single slits is positioned in front of the opening in its support. Now make final adjustments in the direction of the laser so that the beam is centered on the slit. With room lights off, you should see a nice diffraction pattern on the screen. Draw this pattern in your report.
3. There are four different single slits on the circular set. Observe diffraction patterns produced by the different slit widths. There are a number of different patterns on the set. Note the slit widths,  $a$ , for each slit, draw each pattern and **comment on the differences. How do the patterns make sense considering the above equation?**
4. Temporarily remove the slit set from the optical bench and mark the position of the beam where it hits the paper mounted to the viewing screen. Now, position the single slit with  $a = 0.04$  mm in the path of the laser beam. Mark on your paper the distance out from the center mark ( $\theta = 0$ ) for the first four minima on each side of the central maxima. Average the left and right distances for each and calculate the average angles for the four diffraction minima. Use an excel spreadsheet to record all the data. Find the percent difference between these numbers and those predicted by equation 1. (**\*Can you use the small angle approximation? Why or why not?\***)
5. Place the multiple slit set on the optics bench at a distance of 5-10 cm from the laser. Position the screen so that it is again 2m from the slit set. Rotate the slit set so that one of the double slits is positioned in front of the opening in its support. Now make final adjustments in the direction of the laser so that the beam is centered on the slits. With room lights off, you should see a nice interference (modulated by diffraction) pattern on the screen.
6. There are four different double slits on the circular set. Observe the interference patterns produced by the different double slits. Note the slit widths,  $a$ , and the slit separation,  $d$ , for each, comment on the differences observed, and explain. There are a number of different patterns on the set. Draw at least four patterns and comment on the differences. **How do the patterns make sense considering the above equation?**
7. Mark the location of the beam on the paper mounted to the viewing screen ( $\theta = 0$ ) if necessary. Now, position the double slit with  $a = 0.04$  mm and  $d = 0.25$  mm in the path of the laser beam. Mark the fringes out from the center mark ( $\theta = 0$ ) to the 5<sup>th</sup>, 10<sup>th</sup>, 15<sup>th</sup>, and 20<sup>th</sup> interference maxima on either side of the central maxima. Average the left and right distances for each fringe and calculate the average angles for the four interference maxima. Record all the data in your spreadsheet. Find the percent difference between these numbers and those predicted by equation 2.