OPTICS LAB #3

OBJECT: To understand diffraction and interference

EQUIPMENT: Optics bench

Optics box

Metal Screen

Two slit accessories

Laser source

DO NOT AIM THE LASER BEAM AT ANYONE EVEN IF YOU HATE THAT PERSON. AIMING AT YOURSELF ? LET THE NATURAL SELESCTION TAKES CARE OF YOU. SEEING THE LASER BEAM DIRECTLY WILL CAUSE BLINDNESS. WHEN THE LASER IS NOT IN USE, TURN IT OFF.

Since you will be working in a dark room, it will be very efficient if you have a flashlight with you.

Each of the slit disks is mounted on a ring which snaps into an empty lens holder. The ring should be rotated in the lens holder so that the slits at the center (where the laser beam hits) are vertical in the holder. See Figure 3. Tighten the thumb-screw on the holder so that the ring cannot rotate during use. To select the desired slits, rotate the disk until it clicks into place with the desired slits at the center of the holder. NOTE: All slits are vertical EXCEPT the comparison slits which are horizontal. The comparison slits are purposely horizontal because the wide laser diode beam will cover both slits to be compared. If you try to rotate these slits to the vertical position, the laser beam may not be large enough to illuminate both slits at the same time.

To align the laser beam and the slits, place the Diode Laser at one end of the bench. Place the slit holder on the optics bench a few centimeters from the laser with the disc-side of the holder closest to the laser. Plug in the Diode Laser and turn it on. Adjust the position of the laser beam from left-to-right and up-and-down until the beam is centered on the slit. Once this position is set, it is not necessary to make any further adjustments of the laser beam when viewing any of the slits on the disk. When you rotate the disk to a new slit, the laser beam will be already aligned. The slits click into place so you can easily change from one slit to the next, even in the dark.

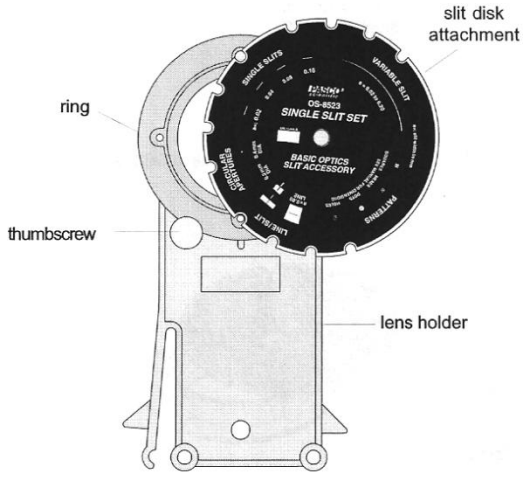
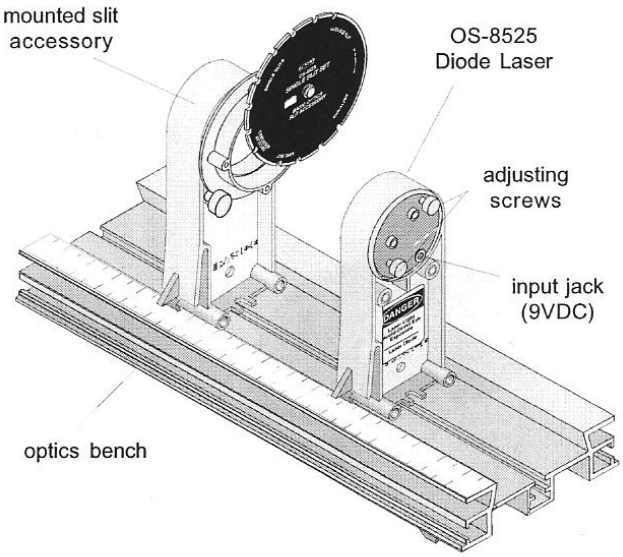


Figure 3: Slit Accessory and Lens Holder



A. Single-Slit Interference

1. Set up the laser at one end of the optics bench and place the Single-Slit Disk in its holder about 3 cm in front of the laser.

2. Cover the screen with a sheet of paper and attach it to the other end of the bench so that the paper faces the laser.

3. Turn on the laser and change the slit width from 0.02 mm to 0.08 mm. Observe the change of the interference pattern and discuss this in the conclusion section.

4. Using the slit width of 0.04 mm and mark locations of minima on the paper.

5. By measuring the distance between the slit and the screen and minimum distances from the center, calculate the slit width for each minimum and the average slit width.

6. Compare the average value with the printed value.

B. Multiple-Slit Interference

1. Set up the laser at one end of the optics bench and place the Multiple-Slit Disk in its holder about 3 cm in front of the laser.

2. Cover the screen with a sheet of paper and attach it to the other end of the bench so that the paper faces the laser.

3. Project the laser beam on to the following sets, sketch the patterns on the screen and discuss in the conclusion section.

   a. Side-by-Side slits

   b. 2 double slits with the same slit width but different slit separations

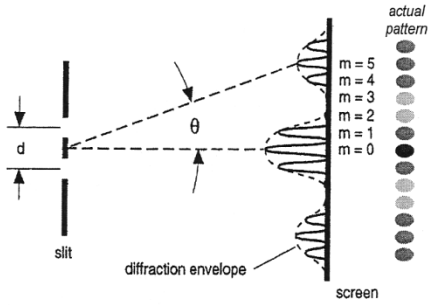
   c. 2 double slits with the same slit separation but different slit widths

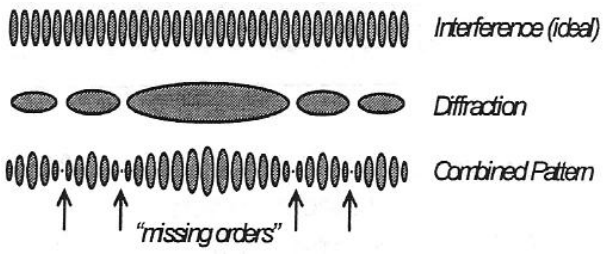
   d. Double slits/triple slits with the same slit separation and same slit widths

4. Using d = 0.25 mm and mark locations of m = 5 (5^{th} fringe).

5. By measuring the distance between the slit and the screen and the distance between m = 0 to m = 5, calculate the slit separation. (To do this, it is better to measure the distance between two 5^{th} fringes.)

6. Repeat 4 & 5 for d = .50 mm.





C. Diffraction Grating (Use 211311 lines/m instead of 6000 lines/inch)

1. Set up the laser at one end of the optics bench and place a diffraction grating mounted on a holder about 3 cm in front of the laser.

2. Put the screen about 10 cm from the diffraction grating and measure the distance between the first orders (m = 1).

3. Calculate the wavelength of the laser and compare it with the printed value.

D. CD and DVD as Diffraction Grating

1. Replace the diffraction grating with a CD.

2. Using the wavelength found in C and other data (use a 2m-stick to measure the distance between m=1's), calculate the distance between the tracks on the CD.

3. Compare the result found in 2 with the industry standard value.

4. Repeat 1 – 3 using the DVD.

E. Thickness of Tiny wires (WIRES ARE EXTREMELY THIN AND DELICATE. HANDLE THEM WITH GREAT CARE.)

1. Set up the laser at one end of the optics bench and place different size wires mounted on a holder about 3 cm in front of the laser.

2. Shine the laser beam onto the 20-micron wire (20μm – the thinnest wire you can find on the setting) and measure the distance between 2^{nd} or 3^{rd} minima.

3. Repeat the procedure A5 to calculate the width of the wire.

4. Measure the thickness of a black and a blond hair and comment in the conclusion.