Young's Experiment

1 Objective

- Study the interference pattern caused by single slit diffraction.
- Study the interference pattern caused by double slit diffraction (Youngs Experiment).

2 Prelab Questions

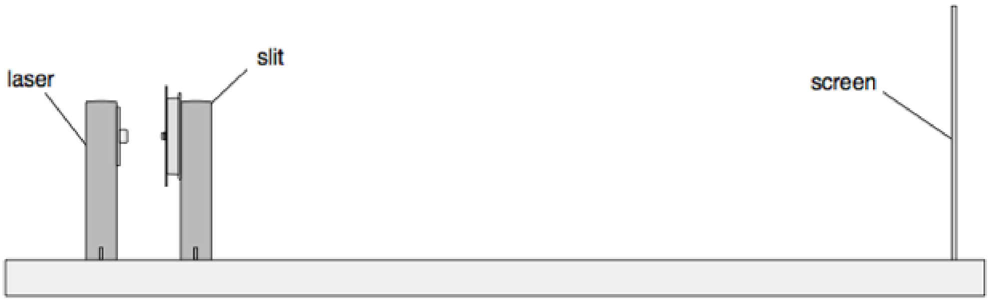
1. Give a general explanation of the phenomenon of light interference: constructive interference, destructive interference and what is meant by bright/dark fringes.
2. What are the main differences between a laser source and an incandescent light source?

3 Principles

Light from a diode laser is directed towards a slit disk. The light is then allowed to interfere and the interference pattern is studied.

4 Apparatus

- Diode laser.
- Precision optical bench.
- Single and double slit disks.
- Screen.
- Angular metric ruler.



5 Precautions

1. Laser light is dangerous and can potentially cause visual impairment. Never look directly into any laser beam. Prolonged exposure will cause flash-blindness, afterimages and glare which will reduce or cause complete loss of visibility in the central field of vision.
2. Optical systems are sensitive and are often fine-tuned. Be very careful with the equipment, as a slight nudge might damage the equipment.
3. Stray light can obscure the images seen on the screen. Preform the experiment in pitch-black darkness.

6 Experimental Steps

6.1 Single Slit Diffraction:

1. Place the angular metric rulers under the lamp to *"charge"* the glow-in-the-dark tips.

2. Arrange the equipment on an optical bench as seen above, placing the Single Slit Disk about 3cm in front of the laser. Keep in mind that the slit and laser are offset from the centre line of their holders.
3. Determine the distance D between the slit and the screen.
4. Switch on the laser and observe the resultant interference pattern on the screen.
5. Using the angular metric ruler, determine the separation between the first two minima $m = 1$ appearing on the screen.
6. Repeat step [5] for the second and third two minima $m = 2$ and $m = 3$ appearing on the screen.
7. Using a regular ruler, measure the distance between the tips of the angular metric ruler. Record the distance for the first, second and third minima as x_1, x_2 and x_3 respectively.

6.2 Double Slit Diffraction:

1. Place the angular metric rulers under the lamp to *"charge"* the glow-in-the-dark tips.
2. Exchange the Single Slit Disk with the Double Slit Disk, mounting it about 3cm in front of the laser. Keep in mind that the slit and laser are offset from the centre line of their holders.
3. Determine the distance D between the slit and the screen.
4. Switch on the laser and observe the resultant interference pattern on the screen.
5. Using the angular metric ruler, determine the separation between the first two maxima $m = 1$ appearing on the screen.
6. Repeat step [5] for the second and third two maxima $m = 2$ and $m = 3$ appearing on the screen.
7. Using a regular ruler, measure the distance between the tips of the angular metric ruler. Record the distance for the first, second and third minima as x_1, x_2 and x_3 respectively.

7 Evaluation

1. Calculate the distance y_m between the centre of the pattern and the m^{th} minima using the equation:

$$y_m = \frac{x_m}{2} \tag{1}$$

2. Calculate the wavelength of the laser using the equation:

$$\lambda = \frac{a y_m}{mD} \tag{2}$$

   Where a=0.08mm, denoting the width of the slit for the Single Slit Disk.

3. Find $\bar{\lambda}_{exp}$ and compare it to the theoretical value of the wavelength, obtained from the laser source itself.

4. Repeat the same calculations for the Double Slit Diffraction, where a=0.50mm, denoting the double slit separation for the Double Slit Disk.

8 Postlab Questions

1. Calculate the wavelength of a laser light used to produce an interference pattern on a screen 5.87m away if the distance between the central bright fringe and the fourth bright fringe is 8.21cm. The slit separation is 0.15mm.

2. If light did not exhibit a wave-like property, what would you expect to see on the screen? Draw an illustration of your expectations.

3. In the second part of the experiment, explain why you can see a set of smaller interference patterns enveloped within the bigger interference pattern.