San Diego Mesa College Name:_____

Physics 197 Laboratory Experiment Date: _____

Title: Interference and Diffraction of Light

Objective:

To investigate and understand how the interference and diffraction effects as light interacts with a medium reveal information about the internal structure of the object.

Theory:

Energy that passes through an aperture is bent, or diffracted, according to the relative sizes of the aperture and the wavelength of the energy. The light arriving at a point in space may combine constructively or destructively according to the relative difference in pathlengths from one end of the aperture to the other. This phenomenon is called 'phase-shift by transmission', indicating that the phenomenon is due to the distances traveled by the energy.

For a coherent energy source the conditions for interference are as follow. If two waves to arrive perfectly in phase, they will combine constructively. This indicates that the path difference is a multiple of the wavelength:

$$|L_2 - L_1| = N_2\lambda - N_1\lambda = m\lambda$$

$$m = 0,1,2...$$

For waves that arrive perfectly out of phase, there must be a relative path difference that is an odd multiple of one-half wavelength:

$$|L_2 - L_1| = N_2\lambda - N_1\lambda = (m + \frac{1}{2})\lambda$$

$$m = 0,1,2...$$

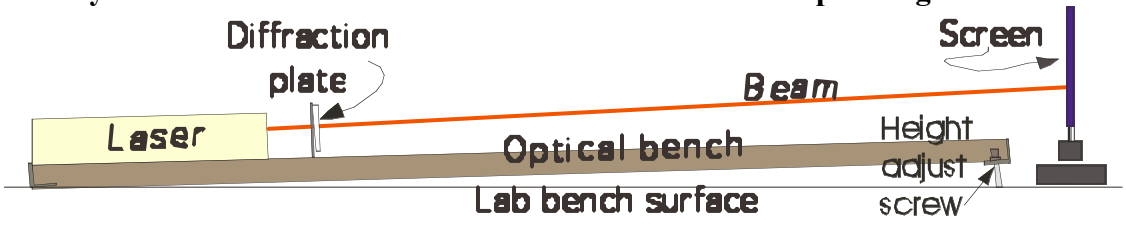
In this experiment, you will examine the patterns caused by coherent light passing through multiple types of apertures and use this information to re-create the structures that produced them.

Equipment:

Helium-Neon Laser (632.8 nm wavelength)	Optical Bench
Screen Holder	Screen
Magnetic Plate Holder	Meter Sticks

Setup and Procedure: Part I: Variable Aperture Diffraction

Although it produces a low-power output, the laser can seriously damage the human eye. Please exercise common sense and caution when operating the laser.



1) Set up the equipment according to the diagram and position the diffraction plate so the row containing the square, cross and circle is able to intercept the laser beam.
2) Position the square, irregular circle and finally the cross in front of the laser.
3) Observe the pattern that is produced, sketch it and make some brief comments about the pattern in relation to the object that produced it.

Data: Part I: Diffraction produced by variable objects

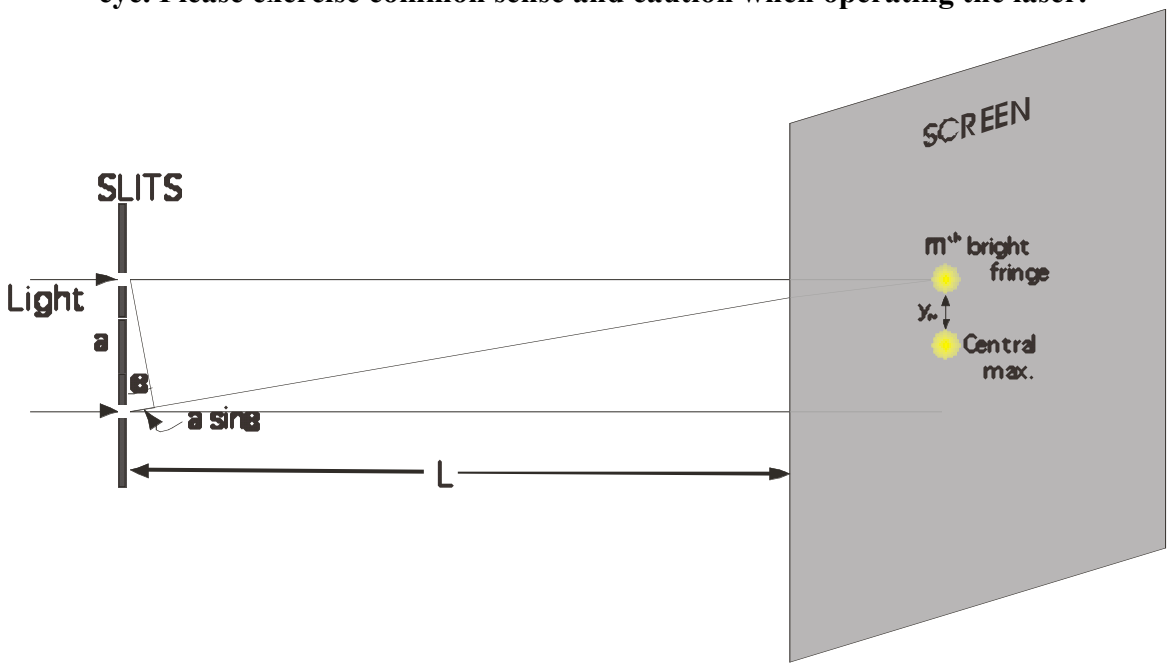
Square

Irregular Circle

Cross

Procedure: Part II: Multiple Slit Diffraction

Although it produces a low-power output, the laser can seriously damage the human eye. Please exercise common sense and caution when operating the laser.



1) Begin with the condition for constructive interference and use the diagram to derive an expression which predicts the location of a bright fringe with respect to the central maximum in terms of the slit spacing and wavelength of energy incident upon them.

2) Position the double slit in the path of the laser beam and adjust the system until you see a series of interference fringes on the screen. The fringes will appear as oblong dots on the screen.
3) Measure the distance from the middle of the central maximum to the middle of the bright fringe and record it in the data table.
4) For each measurement, calculate the slit separation then average the result.
5) Repeat this process using the multiple slit diffraction aperture.
6) Comment on the difference in the appearance, intensity, etc of the interference fringes as you switched from a double slit to a multiple slit system.

Data: Part II: Diffraction from Regular Apertures

Double Slit Aperture		
Order Number (m)	Position (Y_m)	Aperture Separation (d)
1		
2		
3		
4		
5		
6		
7		

Show a sample calculation, with units

Average Separation:_____

Multiple Slit Aperture		
Order Number (m)	Position (Y_m)	Aperture Separation (d)
1		
2		
3		
4		
5		
6		
7		

Show a sample calculation, with units

Average Separation:_____

Comment on the changes in the appearance of the interference patterns.

Conclusion: Briefly discuss the physics involved in the experiment, summarize the data, address potential sources of error and methods to reduce or eliminate them, and state whether or not the experimental results validate the theory.