INDOSAW
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INSTRUCTION MANUAL FOR

DIODE LASER DIFFRACTION EXPERIMENT

(Cat. No. SK078)

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EXPERIMENTS:

1. Diffraction of light by single slit.
2. Diffraction of light by double slit.
3. Diffraction of light by multiple slit.
4. Diffraction of light by fine wire.
5. Diffraction of light by cross wire.
6. Diffraction of light by wire mesh.
7. Diffraction of light by transmission grating.
8. Diffraction of light by coarse grating.
9. Diffraction of light by circular aperture (Pinhole).

PRINCIPLE AND WORKING:

The diode laser diffraction pattern is closely studied using a detector mounted on translation stage. In the present setup, the intensity in the terms of current or voltage is noted at closed intervals by traversing the detector with digital multimeter. The intensity versus distance curve is plotted on a graph for calculations. The device consists of one meter long optical bench with two transversal saddles for laser and slit mount and one transversal saddle with micrometer for detector.

CONTENTS :

1.	Optical Bench	1
2.	Transversal Saddle	2
3.	Transversal Saddle with Micrometer	1
4.	Diode Laser with Power Adaptor	1
5.	Slit Holder	1
6.	Pin Hole Photo Detector	1
7.	Digital Multimeter	1
8.	Diffraction Slide Sets	1
9.	Single Wire	1
10.	Cross Wire	1

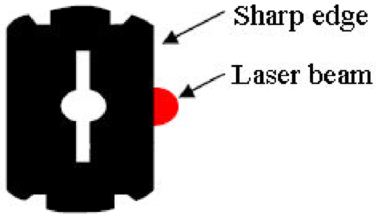
DIFFRACTION SLIDE SETS:

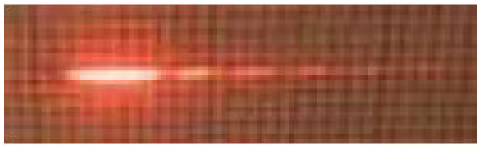
1. Slit (Single, Double, Three, Four, Five, & Six) Nominal width=0.06mm and Separation=0.20mm
2. Coarse Grating-1 4 lines/mm, line/space ratio 3:1
3. Coarse Grating-2 4 lines/mm, line/space ratio 6:1
4. Coarse Grating-3 8 lines/mm, line/space ratio 3:1
5. Diffraction grating 80 lines / mm
6. Diffraction grating 300 lines / mm
7. Single slit – Tapered
8. Double slit – Tapered
9. Metal gauze - 300 mesh
10. Circular apertures 1.0, 0.60, 1.40, 0.30 mm nominal dia.
11. Hologram-Transmission type
12. Polaroids

DIFFRACTION PATTERNS CREATED BY DIFFERENT OBJECTS:

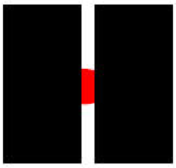
OBJECT | **DIFFRACTION PATTERN**

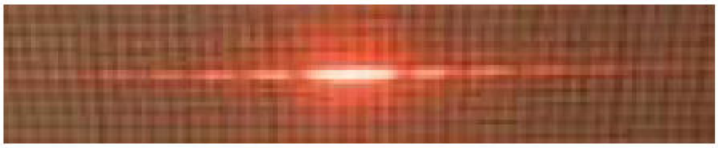
- **Sharp edge (i.e. razor blade)**



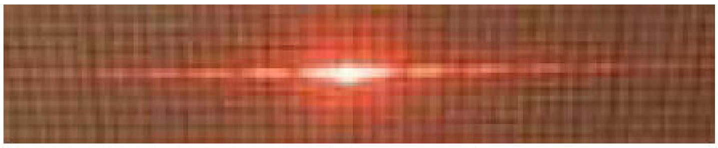


- **Slit**

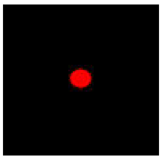


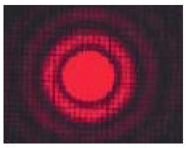


- **Wire**



- **Circular hole**

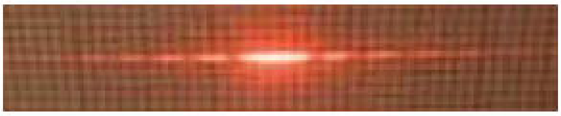




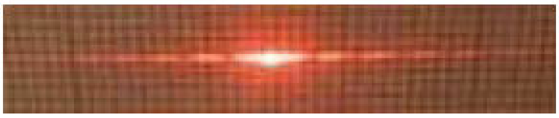
DIFFRACTION FROM SLIT AND WIRE

The distance from the minimums to the center of the diffraction pattern is still the same for the diffraction pattern caused by a wire of the same thickness as a slit. The only difference is that the center of the diffraction pattern looks brighter because the percentage of the laser beam that is not diffracted by the wire add to the intensity of the center of the pattern.

Diffraction pattern from a slit



Diffraction pattern from a wire

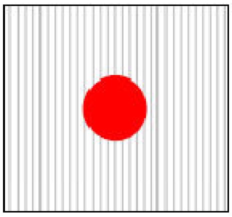


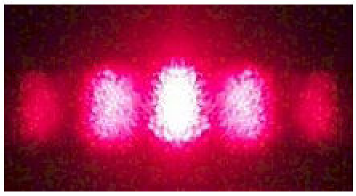
DIFFRACTION PATTERN CREATED BY AN OBJECT WITH A PERIODIC STRUCTURE

If a laser is used to observe diffraction, below are some examples of diffraction patterns that are created by certain objects with repeating patterns:

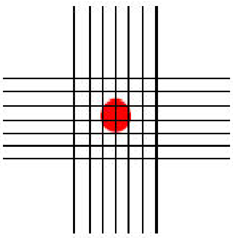
OBJECT (looking end-on) | **DIFFRACTION PATTERN**

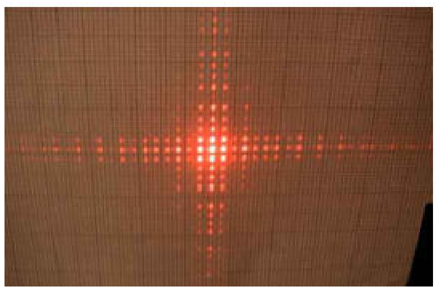
- **Grating**





- **Mesh**





DIFFRACTION FROM A SINGLE SLIT

THEORY

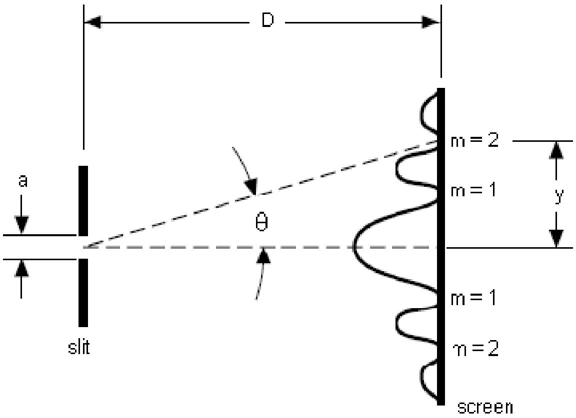
Diffraction of light occurs as it passes through a slit, the angle to the minima in the diffraction pattern is given by

$$\mathbf{a \sin(\theta)=m\lambda}$$

where a is the slit width, θ is the angle from the center of the pattern to the mth minimum, λ is the wavelength of the light, and m is the order

Since the angles are usually small, it can be assumed that

$$\sin(\theta) \sim \tan(\theta),$$



and $\tan(\theta)=y/D$, where y is the distance on the screen from the center of the pattern to the mth minimum and D is the distance from the slit to the screen as shown in Figure. Therefore the slit width:

$$\mathbf{a = m\lambda D/y} \quad (m = 1,2,3,....)$$

SETUP PROCEDURE

1. Set up the diode laser at one end of the optics bench and place the slit holder about 5 cm in front of the laser.
2. Put the photo-detector at other end of the optical bench. Adjust the vertical and horizontal position and laser and detector so that beam falls at the center of the pin hole.
3. Connect the multimeter to the detector.
4. Mount the single slit in slit holder and adjust the position of the laser beam from left-to-right and up-and-down until the beam is centered on the slit.
5. Determine the distance from the slit to the detector.
6. Now move the detector position by micrometer transversal saddle and not the value of detector output and position of detector.

INTERFERENCE FROM A DOUBLE SLIT

OBJECTIVE:

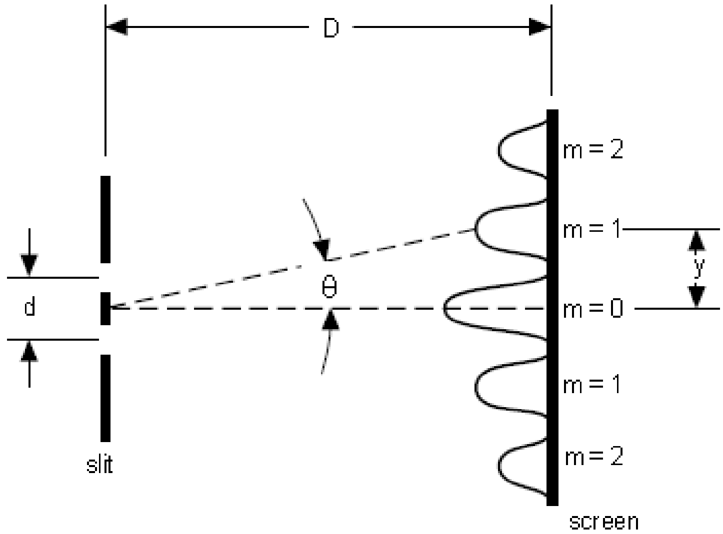
To examine the diffraction and interference patterns formed by diode laser light passing through two slits and verify that the positions of the maxima in the interference pattern match the positions predicted by theory.

THEORY

When light passes through two slits, the two light rays emerging from the slits interfere with each other and produce interference fringes. The angle to the maxima (bright fringes) in the interference pattern is given by

$d \sin\theta = m\lambda$ (m = 0, 1, 2, 3, …)

where d is the slit separation, θ is the angle from the center of the pattern to the mth maximum, λ is the wavelength of the light, and m is the order.

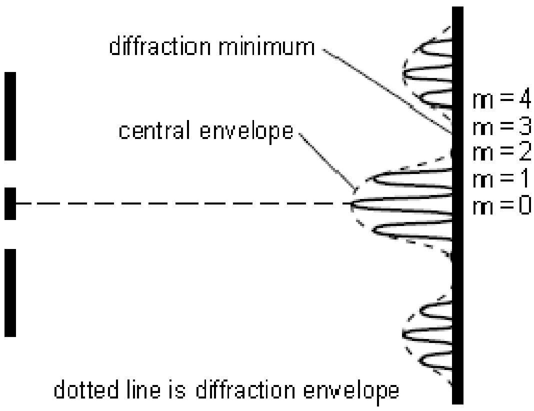


Since the angles are usually small, it can be assumed that

$\sin\theta \approx \tan\theta$

From trigonometry, $\tan\theta = y/D$, where y is the distance on the screen from the center of the pattern to the mth maximum and D is the distance from the slits to the screen as shown in Figure 2. The interference equation can thus be solved for the slit separation:

$d = m\lambda D/y$ (m = 0, 1, 2, 3,…)



While the interference fringes are created by the interference of the light coming from the two slits, there is also a diffraction effect occurring at each slit due to Single Slit diffraction. This causes the envelope as seen in Figure.