

20CSE1030

Aim: To determine the width of slit using HeNe laser and travelling microscope

Apparatus:

1. Metre bench
2. Travelling microscope
3. Slits
4. Board or vertical paper holder
5. He-Ne laser

Theory:

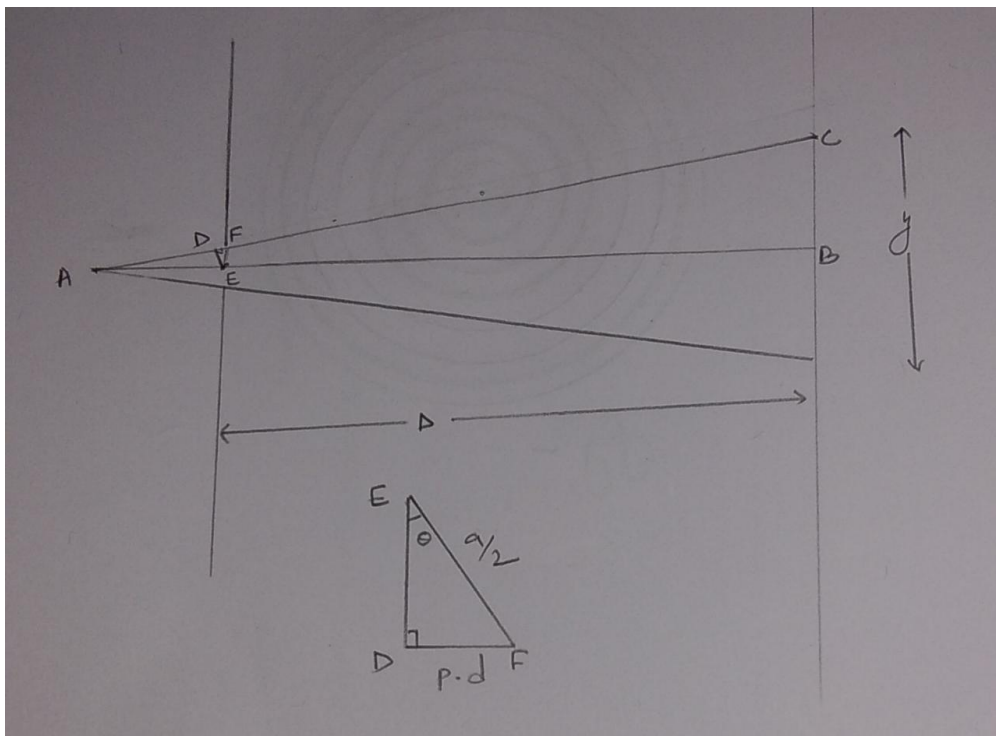
Diffraction refers to various phenomena that occur when a wave encounters an obstacle or opening. It is defined as the bending of waves around the corners of an obstacle or through an aperture into the region of geometrical shadow of obstacle or aperture.

There are two types of Diffraction.

- Fresnel Diffraction.
- Fraunhofer diffraction.

Fresnel: When there is a finite distance between the slit and the screen and when the light from the point source reaches the obstacle, the waves produced are spherical and the pattern of the image of the object is a fringed image.

Fraunhofer: When the waves from the light source are λ in the form of wave fronts, and they are infinite. ~~The distance~~



Consider $\triangle AED$, $\triangle DEF$ and $\triangle ABC$

let $\angle CAB = \theta$

also $\angle DEF = \theta$

$$\sin \theta = \frac{DF}{FE} \quad FE = \frac{\text{slit width}}{2}$$

$DF \rightarrow$ path difference

for 1st minima $p.d. = \frac{\lambda}{2}$

$$DF = \frac{\lambda}{2}$$

$$\sin \theta = \frac{\lambda/2}{a/2}$$

$$\sin \theta = \frac{\lambda}{a}$$

$y \rightarrow$ width of central maxima

from $\triangle ABC$

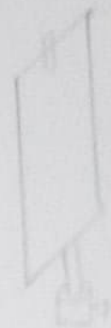
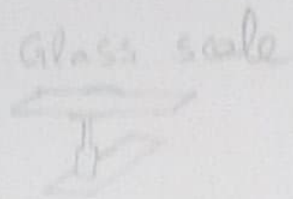
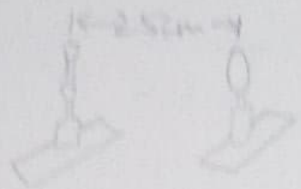
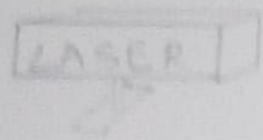
$$\sin \theta = \frac{y/2}{D}$$

$$\frac{\lambda}{a} = \frac{y}{2D}$$

$$a = \frac{2\lambda D}{y}$$

Procedure .

- 1) Keep the laser focussing on the slit and place the lens of focal length in between the slit and screen.
- 2) Then fix a graph paper on the screen so that you can note the bright and dark fringes.
- 3) Adjust the screen in such a way that you should get the fringes properly.
- 4) Take the readings on the table.
- 5) Repeat the experiment for microscope. Focus the microscope in such a way that it is focussing the slit.
- 6) Then note down the scale reading from travelling microscope.
- 7) Repeat the whole process for the blade.
- 8) Note the values in the table.



Screen or
wall

-10cm lens + 20cm
lens

setup of the experiment

Observations:

$$\lambda = 6328 \text{ \AA}$$

Using laser for slit.

Sr. No.	W (mm)	D (cm)	a (mm)
1	6	40	0.08437
2	9	60	0.08437
3	13.5	90	0.08437

formula
$$a = \frac{2 \lambda D}{W}$$

$$= \frac{2 \times 6328 \times 10^{-10} \times 10^{-2}}{10^{-3}}$$

Calculations.

for obsv (1)
$$a = \frac{2 \lambda D}{W}$$

$$= \frac{2 \times 632.8 \times 10^{-9} \times 40 \times 10^{-2}}{6 \times 10^{-3}}$$

$$= 8437.3 \times 10^{-8}$$

$$= 8.4373 \times 10^{-5}$$

$$= 0.08437 \text{ mm}$$

for obsv (2)

$$a = \frac{2 \times 632.8 \times 10^{-9} \times 60 \times 10^{-2}}{9 \times 10^{-3}}$$

$$= 8437.3 \times 10^{-8} \text{ m}$$

$$= 8.437 \times 10^{-5} \text{ m}$$

$$a = 0.08437 \text{ mm}$$

for obsv (3)

$$a = \frac{2 \times 632.8 \times 10^{-9} \times 90 \times 10^{-2}}{13.5 \times 10^{-3}}$$

$$= 8437.3 \times 10^{-8} \text{ m}$$

$$a = 0.08437 \text{ mm}$$

width of slit $a_{avg} = \frac{0.08437 + 0.08437 + 0.08437}{3}$

$a_{avg} = 0.08437 \text{ mm}$

Using laser for blade

Sr. No.	W (mm)	D (cm)	a (mm)
1	7	80	0.14464 mm
2	9	100	0.140622 mm
3	6.5	70	0.13629 mm

Calculations.

for obsv (1) $a = \frac{2\lambda D}{W}$

$$= \frac{2 \times 632.8 \times 10^{-9} \times 0.8}{7 \times 10^{-3}}$$

$$a = 0.14464 \text{ mm}$$

for obsv (2) $a = \frac{2 \times 632.8 \times 10^{-9} \times 1}{9 \times 10^{-3}}$

$$a = 0.14062 \text{ mm}$$

for obsv (3) $a = \frac{2\lambda D}{W}$

$$a = \frac{2 \times 632.8 \times 10^{-9} \times 0.7}{6.5 \times 10^{-3}}$$

$$a = 0.13629 \text{ mm}$$

$$\text{Width of blade } a_{\text{avg}} = \frac{0.14464 + 0.14062 + 0.13629}{3}$$

$$a_{\text{avg}} = 0.14051 \text{ mm}$$

Using TM for slit

Sr. No	MSR	VSR	TR (mm)	1-2
1	7.2	22	72.22	D. D9mm
2	7.2	13	72.13	

Using TM for blade

Sr. NO.	MSR	VSR	TR (mm)	1-2)
1	6.8	11	68.11	0.09mm
2	6.8	2'	68.20	

Conclusion: Theoretical analysis of diffraction patterns using HeNe laser is verified and the slit width and blade width as measured by this process is nearly matching with the readings of travelling microscope method.

Result

The slit width as per HeNe diffraction method is 0.08437mm

The blade slit width as per HeNe diffraction method is 0.14051mm .