Reet Sharma 106030 **Performed On: 15/02/2022**

ASSIGNMENT 05

Experiment 5: Laser based experiment II: Measuring width of an ultra-thin slit, diameter of an ultra-thin wire and counting number of slits in diffraction grating using He Ne laser

Aim:

Using He-Ne laser to

1. Measure width of a narrow slit
2. Measure diameter of a thin wire
3. Counting the number of slits in a diffraction grating.

Apparatus: He-Ne laser, a narrow slit, thin wire, and diffraction grating, optical bench with stands to mount slit, wire and grating, screen, scale etc.

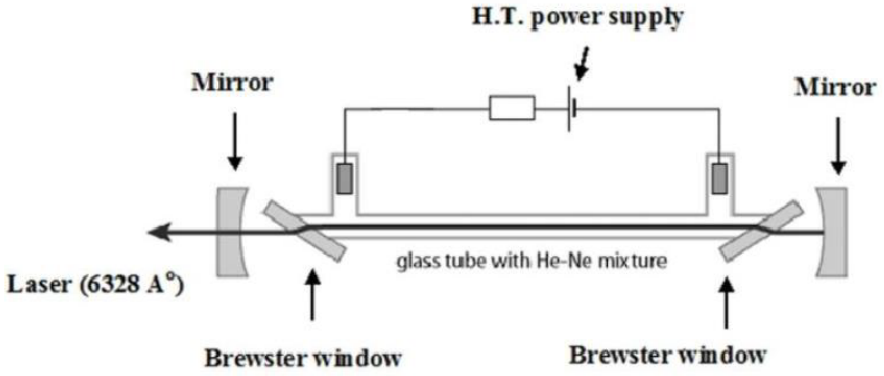

Fig. 5.1: Schematic diagram of He-Ne laser

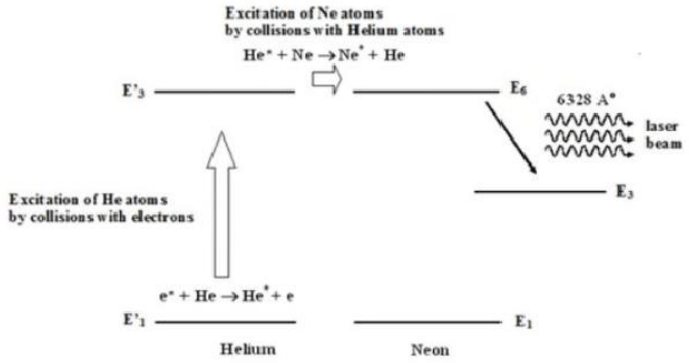

Fig. 5.2. The simplified energy level diagram of He-Ne laser

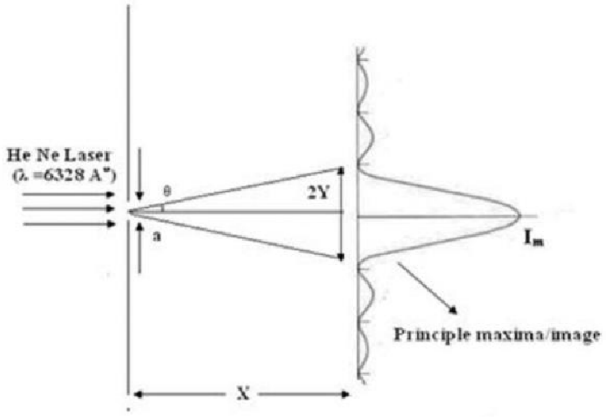

Figure 5.3: Diffraction pattern of single slit. Linear width of a central maximum (principle image of the silt) is quite wider than the slit itself.

Table 5.1: Measuring the width of the slit

Sr. No.	Parameter	Symbol	Value	Unit
1	Full linear width of the central maximum	$2Y$	4	Cm
2	Half linear width of the central maximum	$Y = \frac{2Y}{2}$	2	Cm
3	Distance between the screen and the slit	X	184	Cm
4	Angular position of the first minimum	$\theta = tan^{-1}\frac{Y}{X}$	0.6227	Deg
5	Width of the slit	$a_e = \frac{\lambda}{sin\theta}$ Where $\lambda = wavelengthof\ He\ Ne\ laser = 6328 \times 10^{-7} mm$	0.058	Mm
6	Standard width of the slit	a_s	0.05	Mm
7	Percentage deviation	$\%\ deviation = \left\|\frac{a_e - a_s}{a_s}\right\| \times 100\%$	16.82	%

Table 5.2: Measuring the diameter of the thin wire

Sr. No.	Parameter	Symbol	Value	Unit
1	Distance between the first maximum on the upper side and first maximum on lower side	X	0.05	Mm
2	The distance between the screen and the wire	D	182	Mm
3	Diameter of the wire	$d_e = \frac{\lambda \times D}{x}$ Where $\lambda = wavelengthof\ He\ Ne\ laser = 6328 \times 10^{-7} mm$	0.2303	Mm
6	Standard diameter of the wire	d_s	0.25	Mm
7	Percentage deviation	$\% \ deviation = \left\|\frac{d_s - d_e}{d_s}\right\| \times 100\%$	7.86	%

Table5.3: Counting the number of slits in the grating

Sr. No.	Parameter	Symbol/formula	Value	Unit
1	Distance between the first Maximum and the central maximum	*Yi*	7.7	Cm
2	Distance between screen And the grating	X_1	14	Cm
3	Angle of diffraction of The first minimum	$\theta = tan^{-1}\frac{Y_1}{X_1}$	28.8107	deg
4	Grating element	d= $\frac{\lambda}{sin\,\theta}$	13130.84	A°
5	Number of slits per inch In the grating	N— $\frac{2.54x10'}{d\{A\}}$ Where d=grating element as calculated in(step4), to be taken in A°	19344	Per inch
6	Standar value of the d of slits in the Number grating	N,	15000	Per inch
7	Percentage deviation	$\%Deviation$— N	3.28	%

Calculations:

1/ Measuring the width of slit:

$\Rightarrow 2Y = 4$

$\Rightarrow Y = 4/2$

$\Rightarrow Y = 2cm$

now,

$\theta = \tan^{-1}(Y/x)$

$= \tan^{-1}(2/184)$

$= \tan^{-1}(1/92)$

$= \boxed{0.622755^\circ}$

$\therefore a_e = \frac{\lambda}{\sin\theta}$

$= \frac{6328 \times 10^{-7}}{0.010869232}$

$= \boxed{0.05m}$

so, % deviation $\left|\frac{a_e - a_s}{a_s}\right| = \left|\frac{0.058 - 0.05}{0.05}\right| \times 100$

$= \frac{0.008}{0.05} \times 100$

$= \boxed{16.82\%}$

2/ Measuring the daimeter of thin wire:

$X = 0.5mm$

$D = 182mm$

$d_e = \frac{\lambda D}{X}$

$= \frac{6328 \times 10^{-7} \times 182}{0.5}$

$= \boxed{2303392mm}$

and $\boxed{d_s = 0.25mm}$

$\therefore$ % deviation $= \left|\frac{d_s - d_e}{d_s}\right| \times 100$

$= \left|\frac{0.25 - 0.2303}{0.25}\right| \times 100$

$= \frac{0.0197}{0.25} \times 100$

$= 0.0784 \times 100$

$= \boxed{7.84\%}$

3/ Counting the number of slits in the grating.

$Y = 7.7\,cm$

$X = 14\,cm$

$\theta = \tan^{-1}(Y_1/X_1)$

$= \tan^{-1}(7.7/14)$

$= \tan^{-1}(0.55)$

$= \boxed{28.8107^\circ}$

$Ne = \dfrac{2.54 \times 10^8}{d}$

$= \dfrac{2.54 \times 10^8}{13130.84}$

$\approx \boxed{19344 \text{ per inch}}$

$d = \dfrac{\lambda}{\sin\theta}$

$= \dfrac{6328 \times 10^{-7}}{0.4819187498}$

$= \boxed{13130.84 A^\circ}$

$\%\ \text{deviation} = \left|\dfrac{Ne - Ns}{Ns}\right| \times 100$

$= \left|\dfrac{19344 - 20000}{20000}\right| \times 100$

$= \dfrac{656}{20000} \times 100$

$= \boxed{3.28\%}$