S. Kunal Keshan

RA2011004010051

ECE – A

Physics: Electromagnetic Theory, Quantum Mechanics, Waves and Optics- 18PYB101J

EXPERIMENT - 10

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DETERMINATION OF LASER PARAMETERS - DIVERGENCE AND WAVELENGTH FOR A GIVEN LASER SOURCE USING LASER GRATING

AIM:

To determine the divergence and wavelength of the given laser source using standard grating.

APPARATUS REQUIRED:

Laser source, grating, a screen etc.

PRINCIPLE:

When a composite beam of laser light is incident normally on a plane diffraction grating, the different components are diffracted in different directions. The m^{th} order maxima of the wavelength λ, will be formed in a direction θ if $d \sin\theta = m\lambda$, where d is the distance between two lines in the grating.

FORMULA:

1. The angle of divergence is given by

$$\phi = \frac{a_2 - a_1}{2(d_2 - d_1)}$$

where a_1 = Diameter of the laser spot at d_1 from the laser source.

a_2 = Diameter of the laser spot at d_2 from the source.

2. The wavelength of the laser light is given by,

$$\lambda = \frac{\sin\theta_m}{Nm} \quad m$$

where, m = order of diffraction

θ_m = ~~and~~ Angle of diffraction corresponding to the order m.

N = number of lines per metre length of the grating

θ = $\tan^{-1}(x/D)$

x = Distance between/from the central spot to the diffracted spot (m)

D = Distance btwn grating and screen.

OBSERVATION:

Distance between grating and Screen (D) = 30 cm.
Number of lines per metre length of the grating = N = 10^5 lines/m

d_1 = 20 cm d_2 = 40 cm
a_1 = 0.4 cm a_2 = 0.5 cm.

CALCULATION:

Angle of Divergence, $\phi = \frac{0.5 - 0.4}{2(40-20)} = 0.0025$.

Wavelength, D = 0.3 m., N = 10^5

1. $\tan^{-1}\left[\frac{1.9}{0.30}\right] = 81^\circ = \theta$.

$\lambda = \frac{\sin 81}{10^5 \times 1} = 9876.8\ \text{Å}$.

2. $\tan^{-1}\left[\frac{3.9}{0.3}\right] = 85.6^\circ = \theta$

$\lambda = \frac{\sin 85.6^\circ}{10^5 \times 2} = 4985.2\ \text{Å}$

3. $\tan^{-1}\left[\frac{5.9}{0.3}\right] = 87^\circ = \theta$

$\lambda = \frac{\sin 87}{10^5 \times 3} = 3328.7\ \text{Å}$.

4. $\tan^{-1}\left[\frac{7.9}{0.3}\right] = 87.8^\circ = \theta$

$\lambda = \frac{\sin 87.8}{10^5 \times 4} = 2498.1\ \text{Å}$

5. $\tan^{-1}\left[\frac{10}{0.3}\right] = 88.2^\circ = \theta$

$$\lambda = \frac{\sin 88.2}{10^5 \times 5} = 19990 \text{ Å}.$$

$$\text{Mean } \lambda = \frac{226878}{5} = 4537.5 \text{ Å}$$

RESULT:

1. The angle of divergance = 0.0026.
2. The wavelength of the given monochromatic source is 4537.5 Å.

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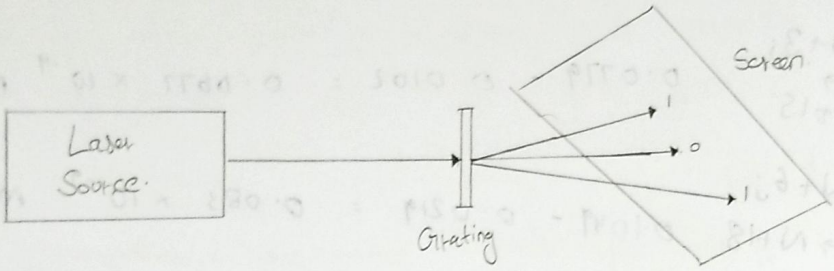

Experimental Setup for Laser Grating.

Table:

S.No	Order of Diffraction (m)	Distance between diffracted orders from the Central Spot (x) m		Mean (x) m	Angle of Diffraction $\theta = \tan^{-1}[x/D]$	$\lambda = \frac{5n\theta_m}{Nm}$ (Å)
		Left	Right			
1.	1	1.9	1.9	1.9	81°	98768
2.	2	3.9	3.9	3.9	85.6°	49252
3.	3	5.9	5.9	5.9	87°	33287
4.	4	7.9	7.9	7.9	87.8°	24981
5.	5	10.	10	10.	88.2°	19990

Mean: 45387.5 Å