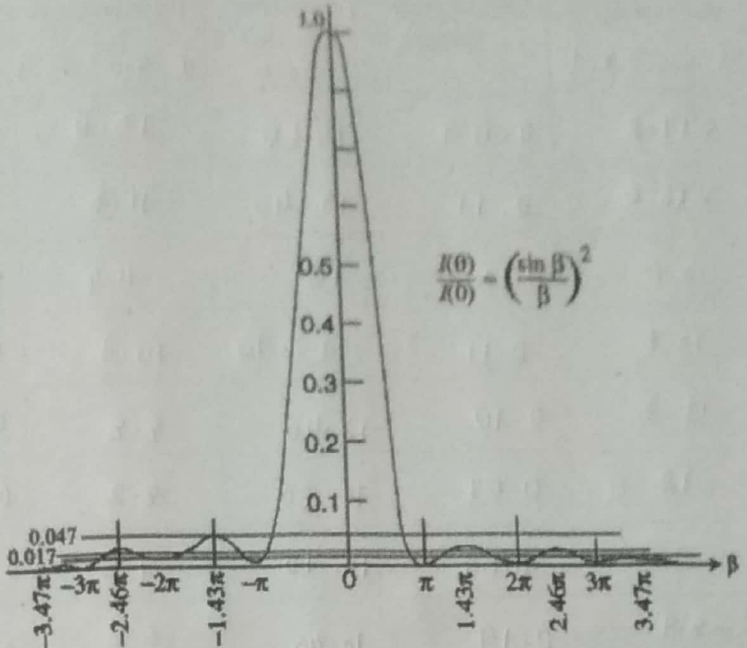

Fig. 2 Intensity distribution for single slit diffraction pattern

Observations

Wavelength of the light (λ) = 632.8 × 10^{-7} cm

Distance of the slit from the detector, D = 100 cm

TABLE – 1

Intensity distribution of the single slit diffraction pattern (x_0 corresponds to position of the central maximum). Readings of the photocell current.

Position (x ~~cm~~) mm	$\theta_{lr} = (x-x_0)/D$ (× 10^{-3} rad)	Left to right l(amp)	Position (x ~~cm~~) mm	$\theta_{rl} = (x-x_0)/D$ (× 10^{-3} rad)	Right to left r(amp)
15.50	−28.10	0.05	11.20	27.6	0.06
17	−26.60	0.07	9.70	26.1	0.07
18.50	−25.10	~~0.08~~ 0.07	7.40	23.8	0.07
19.40	−24.20	0.07	4.90	21.3	0.06
1.20	−22.40	0.05	1.60	18.0	0.08
3.00	−20.60	0.05	0.00	16.4	0.1
4.80	−18.80	0.07	18.20	14.6	0.12

Continued

Position (x cm) mm	$\theta_{lr} = (x-x_0)/D$ ($\times 10^{-3}$ rad)	Left to right I(amp)	Position (x cm) mm	$\theta_{rl} = (x-x_0)/D$ ($\times 10^{-3}$ rad)	Right to left r(amp)
6.40	-17.2	0.09	16.60	13.0	0.11
7.00	-16.6	0.11	15.40	11.8	0.09
8.00	-15.6	0.12	15	11.4	0.08
9.80	-13.8	0.11	13.90	10.3	0.06
10.40	-13.2	0.10	12.40	8.8	0.08
11.60	-12.0	0.07	11.80	8.2	0.11
14.10	-9.5	0.09	11.10	7.5	0.16
14.70	-8.9	0.19	10.40	6.8	0.24
15.80	-7.8	0.25	9.70	6.1	0.35
16.40	-7.2	0.37	9.00	5.4	0.53
17.00	-6.6	0.51	8.30	4.7	0.64
17.60	-6.0	0.71	7.60	4.0	0.81
18.20	-5.4	0.89	6.90	3.3	0.96
18.80	-4.8	1.09	6.20	2.6	1.11
19.40	-4.2	1.23	5.50	1.9	1.26
0.00	-3.6	1.39	4.80	1.2	1.37
0.60	-3.0	1.58	4.10	0.5	1.49
1.20	-2.4	1.69	3.60	0.0	1.52
1.80	-1.8	1.73	2.70	-0.9	1.48
2.40	-1.2	1.83	2.00	-1.6	1.46
3.00	-0.6	1.88	1.30	-2.3	1.40
3.60	0.0	1.89	0.7	-2.9	1.24
4.20	0.6	1.85	0.00	-3.6	1.07

INTENSITY V/s θ graph

Position (x cm) mm	$\theta_{lr} = (x-x_0)/D$ ($\times 10^{-3}$ rad)	Left to right I(amp)	Position (x cm) mm	$\theta_{rl} = (x-x_0)/D$ ($\times 10^{-3}$ rad)	Right to left r(amp)
4.80	1.2	1.70	19.20	−4.4	0.91
5.40	1.8	1.56	18.40	−5.2	0.73
6.00	2.4	1.39	17.60	−6.0	0.61
6.60	3.0	1.23	16.90	−6.7	0.39
7.20	3.6	1.00	16.30	−7.3	0.34
7.80	4.2	0.78	15.60	−8.0	0.24
8.40	4.8	0.56	14.90	−8.7	0.18
9.00	5.4	0.43	14.10	−9.5	0.16
9.70	6.1	0.40	13.50	−10.1	0.07
10.40	6.8	0.33	12.00	−11.6	0.06
11.10	7.5	0.16	11.20	−12.4	0.08
12.50	8.9	0.07	9.30	−14.3	0.11
13.90	10.3	0.06	8.40	−15.2	0.12
16.00	12.4	0.10	6.20	−17.4	0.10
18.00	14.4	0.12	5.30	−18.3	0.08
19.50	15.9	0.11	3.40	−20.2	0.06
0.20	16.6	0.09	2.40	−21.2	0.05
0.90	17.3	0.08	0.40	−23.2	0.06
1.60	18.0	0.07	18.70	−24.9	0.07
3.80	20.2	0.06	15.80	−27.8	0.06
6.00	22.4	0.06			
8.20	24.6	0.07			
11.20	27.6	0.06			

TABLE – 2

Vernier constant of the microscope:

No. of obs.	Readings corresponding to						Width of the slit $b = R \sim L$ (cm)	Width of the slit obtained from	
	left edge of the slit			Right edge of the slit				Microscope measurement (cm) mean b	Diffraction expt. (from bright/dark fringes) (cm)
	Main scale (cm)	Vernier scale (cm)	Total L (cm)	Main scale (cm)	Vernier scale (cm)	Total R (cm)			
1	0.4	46	0.446	0.45	10	0.460	0.014	0.017	(0.014 ± 0.006)
2	0.5	12	0.512	0.5	30	0.530	0.018		
3	0.6	19	0.619	0.6	38	0.638	0.019		

Error calculation

We have for dark fringes

$$b = \frac{2D\lambda}{d}; \qquad \text{where } d = (x - x_0)$$

Therefore,

$$\frac{\delta b}{b} = 2\frac{\delta D}{D} + 2\frac{\delta d}{d}$$

Here, λ is supplied. The '2' factor that appear with $\frac{\delta D}{D}$ and $\frac{\delta d}{d}$ terms in the above expression is related to the fact that D and d are obtained as a difference of two scale readings, each with an error equal to the least count of the instrument.

$$b = \frac{(2)\times(D)\times(\lambda)}{d} = \frac{2\lambda}{\theta} = \frac{2\times 632.8\times 10^{-7}}{8.9\times 10^{-3}}$$

$$= 0.0142 \text{ cm}$$

($\theta = 8.9\times 10^{-3}$ rad for the first minimum)

Error :

$$\frac{\delta b}{b} = 2\frac{\delta D}{D} + 2\frac{\delta d}{d}$$

$$= 2\times\frac{0.1}{100} + 2\times\frac{0.01}{0.05}$$

$$= 0.402$$

(relative error)

$\delta D = 0.1$ cm

$\delta d = 0.01$ cm

$D = 100$ cm

$d = 0.05$ cm

$\delta b = (0.402)(0.014) = 0.006$ cm. (absolute error)

INTENSITY V/s θ graph

Precautions

(i) Adjustment of lens, slit, laser must be made properly so that fringes are bright and distinct.

(ii) Since the linear shift d is proportional to D, it should be fairly large. A value of D of about 1.0 metres is preferable.

(iii) Make sure that a strong monochromatic source of light is used.

Questions

1. What do you understand by diffraction of light?
2. How does diffraction differ from interference?
3. When does the diffraction become appreciable?
4. How many classes of diffraction are there?
5. Distinguish between Fresnel and Fraunhofer diffraction.
6. In present experiment what kind of diffraction occurs and how?
7. What will happen if the width of the slit is increased?
8. What is the difference between a single slit and double slit fringe systems?
9. What is the source you are using in your experiment? How does it work?

References

1. Fundamental of Optics by F. Jenkins and H. White 535 JEN/F
2. Optics by A.Ghatak 535 GHA/O
3. Optics by E. Hecht 535 HEC/O

This experiment is mainly used to observe the fringe pattern i.e. maxima and minima.

$\alpha = \dfrac{\pi b \sin\theta}{\lambda}$, using this expression we can find width of the slit (b), $\because$ we can ~~foind~~ find out θ and α.

There are certain errors due to external light sources in the room which will affect the measurements of the photocell. To measure the position we should use precise instruments so that the accuracy of answer increases. We should use also coherent and monochromatic light source to get accurate results.

INTENSITY V/s θ graph
for SINGLE SLIT DIFFRACTION