Optics Lab 5

Harsukh Singh

February 27, 2014

1 OVERVIEW OF EXPERIMENT

This lab explored the process of diffraction with the single, double and many slit aperatures. This process of diffraction is called the Fraunhofer diffraction since the point of observation is very distant from the coherent line source $R >> D$. The experimental set up is shown in the figure 1.1, the laser where the laser is aligned to the optical rail (the focus is set at infinity). The fringe location is y and distance from the screen is D.

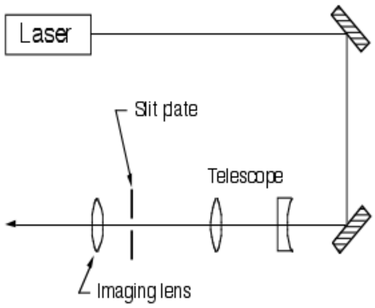

Figure 1.1: Experimental Set-up

The zeros of the irradiance (dark fringes) of the single slit can be decribed $bsin(\theta_m) = m\lambda$ where m is an integer. The width of the slit(s) throught the experiment was approximately 0.05 mm and the distance from the screen was approximately 65 cm. The irradiance resulting from the fraunhofer approximation can be described by $\frac{I(\beta)}{I(0)} = sinc^2(\beta)$, shown figure 1.2. The data collected is shown in table 1.1.

Table 1.1: data

fringe 3	1.75 cm
fringe 2	1.05 cm
fringe 1	0.5 cm

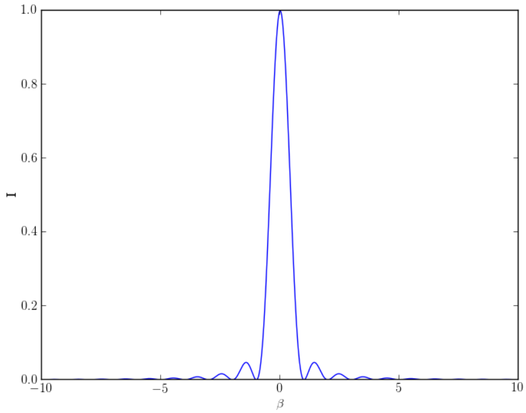

Figure 1.2: Irradiance

We can experimentally find the slit width b by counting the number of fringes at each location knowing that the distance from the center fringe to first so $\theta = tan^{-1}(\frac{y}{D})$. Using the condition for the minimum we find that the slit width is, $b \approx \frac{m\lambda D}{y}$. Then we find the ratio of $\frac{b}{a} = \frac{m_b}{m_a}$ the derivation is shown below. This can be done by counting the number of principal maxima dark fringes. Thus this gives us the ratio of b to a. The table of the data collected is shown in table 1.2.

$$\frac{bsin(\theta_b)}{asin(\theta_a)} = \frac{m_b y_b}{m_a y_a} \tag{1.1}$$

Using the small angle approximation we arrive at our result.

Table 1.2: data

fringe 3	1.00 cm
fringe 2	0.75 cm
fringe 1	0.3 cm

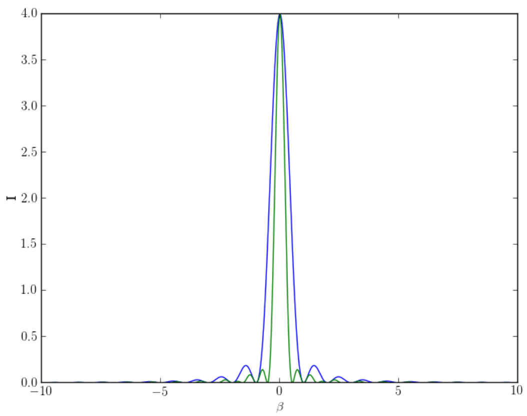

Figure 1.3: Double slit pattern compared single slit a= 3b

We tested the derivation (eqn (1.1)) and we find that it does work.

2 Multiple Diffraction Gratings

In this section we use equation 1.1 and we find the ratios shown in table 2.1. The ratios show the number of principal maxima to second dark fringe (this was the most accurate measurement we could do for this experiment). The number of slits the number of subsidiary maxima.

Table 2.1: data

3 slits	$\frac{2}{3}$
4 slits	$\frac{2}{4}$
10 slits	$\frac{2}{3}$

These readings have experimental error attached to them because the object was not an exact flat surface as well as measuring every principal maxima between the dark fringes for the single slit may not be entirely accurate due to variance in distance between them. We can describe the pattern of irradiance by the equation,

$$I(\theta) = \frac{I(0)}{N^2} sinc^2(\beta) \left(\frac{sin(N\alpha)}{sin(\alpha)} \right)^2 \tag{2.1}$$

We next observed the diffraction pattern from the diffraction slide the screen was $D = 9.5cm$ and the spacing between the observed pattern was $y = 5.65cm$. We changed the angle of the slide and observed the spacing between the pattern decrease or increase. The grating spacing a was determined by $1/N$ (N being the number of fringes).

We next used the white light and observed the rainbow pattern.

3 FUN EXPERIMENT

Here we used a disk with scratches that made a diffraction pattern. The distance between is each grating is 1 mm.

4 CONCLUSION