Optics Lab 6

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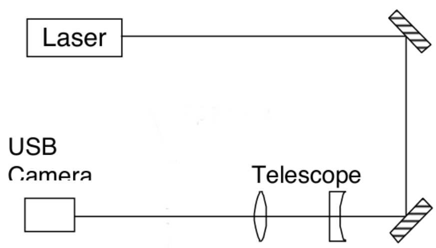
1 Overview of Experiment

In this lab we explored Fraunhofer diffraction with both a circular aperature and rectangular aperature and we also looked at Fresnel diffraction with circular aperature. The first part of th lab involved building a beam expander using a -25 mm focal length lens followed by a 100 mm focal length lens, this is labeled as the telescope in the figure below. After this was done we used the usb camera to find the pixel per cm. This was done by imaging a ruler on the usb camer and dividing the number of pixels over the range imaged. We then used the lens equation to find ratio of cm per pixel. This was approximately found to be $6.72 \times 10^{-4} \frac{cm}{pixel}$

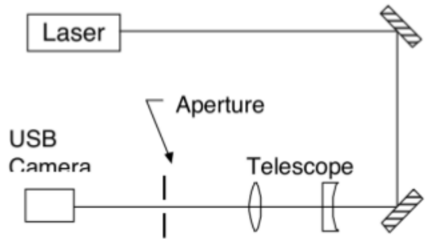
Figure 1.1: Finding the pixel per cm



2 Fraunhofer Diffraction with Circular and Rectangular Apertures

The experimental setup is shown below for this is shown in figure 2.1.

Figure 2.1: Experimental Set Up



2.1 Rectangular Aperature

We used the rectangular aperature to find the intensity profile and this is plotted with respect to the distance (cm), shown below,

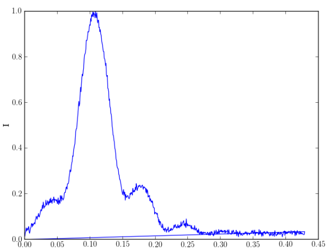


Figure 2.2: Intensity Profile 1

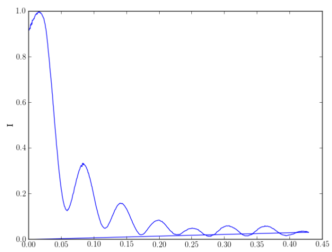


Figure 2.3: Intensity Profile 2

The size of the aperature can be found using the transverse intensity along the β axis as explained in Hecth page pg. 466. We then use the formula 10.44 in Hecht and set it to the first minimum. R was found to be 60 cm and Y was the domain.

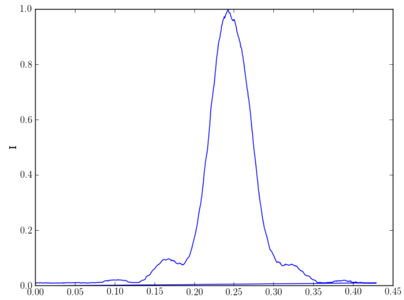
$$b = \frac{2R\pi}{kY} \tag{2.1}$$

The diameter of the aperature was found to be 0.8 mm.

2.2 Circular Aperature

With the circular aperature we found the intensity profile shown below,

Figure 2.4: Circular Aperature Fraunhofer Diffraction



We use the equation given in Hecht(10.57).

$$a = 1.22 \frac{R\lambda}{2q_1} \tag{2.2}$$

from the graph we find q_1 to be, 0.36 cm. So we find the aperature size to be, 0.1 mm.

3 Fresnel Diffraction with Circular Aperature

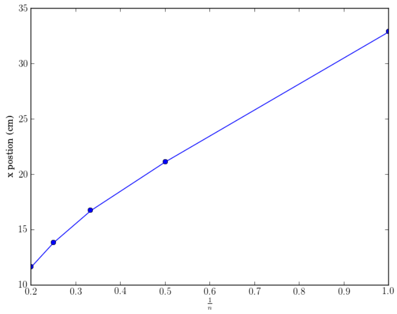
In the case of fresnel diffraction with circular aperature. We moved the 100 mm focal length glass over a varying distance and observed the pattern shown on pg.493 in Hecht thus we were able to create a table below, showing these values.

Table 3.1: zones in a circular aperature

m	x(cm)
1	32.9
2	21.15
3	16.75
4	13.85
5	11.65

We then plot the position vs $\frac{1}{n}$ and the plot is shown in figure 3.1.

Figure 3.1: Position of Minima



from this we fit the data, to the equation $x_n = \frac{R^2}{2n\lambda}$ and find the aperature size to be 0.23 mm.

4 Conclusion

There was quite a bit of uncertainty related counting the minima for the fresnel diffraction experiment because as the magnifying lens got closer to the aperature the distance between each zone became closer. So the aperature size was determined smaller region with more data.