§ 1 Introduction

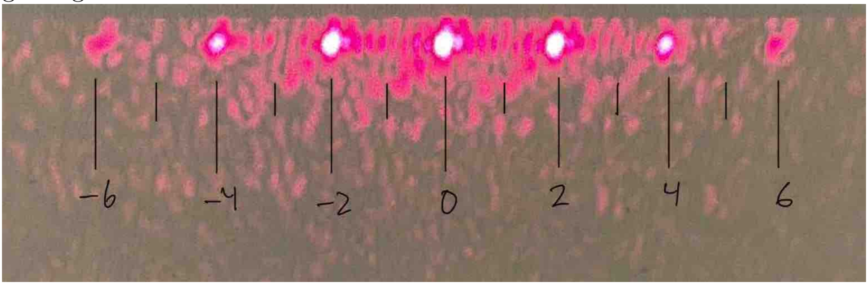
In this lab you will observe that light is a wave.

§ 2 Background

Diffraction grating: has local maximum of intensity at angles θ_n with

$$d \sin\theta_n = n\frac{\lambda}{2}$$

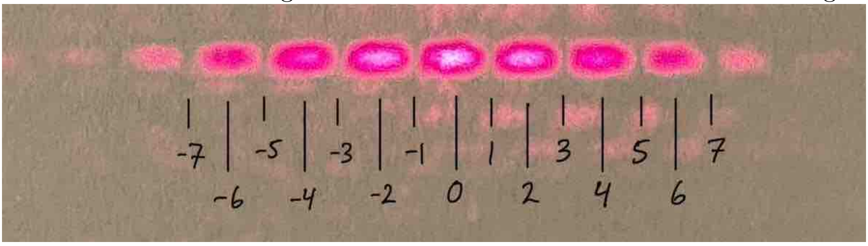
with n and even integer and where d is the distance between lines of the grating.



Double slit: the angles θ_n defined by

$$d \sin\theta_n = n\frac{\lambda}{2}$$

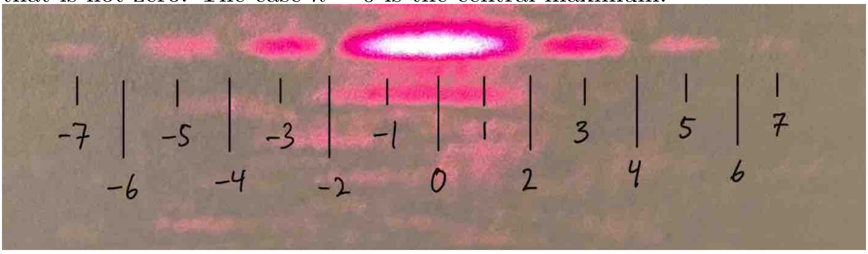
where d is the center to center distance between the slits are a local maximum if n is an even integer and are a local minimum if n is an odd integer.



Single slit: the angles θ_n defined by

$$a \sin\theta_n = n\frac{\lambda}{2}$$

where a is the width of the slit are a local minimum if n is an even integer that is not zero. The case $n = 0$ is the central maximum.

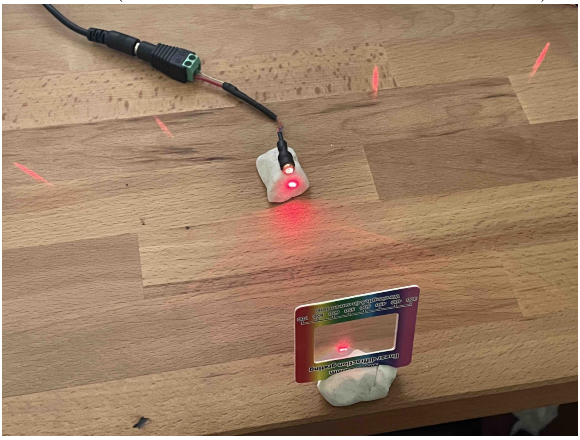


§ 3 Calibration

Now use the modeling clay to mount the laser to the table top so that the beam is parallel to the floor and strikes a wall that is at least 2 meters away. The beam needs to be normal to the wall, that is perpendicular to the wall in both the horizontal and vertical directions.

1) Find the laser and connect it to the power supply. Be sure that the red wire is connected to the positive side of the connector.

2) Use the modeling clay to mount the laser to the table top so that the beam is parallel to the floor and strikes a wall that is at least 2 meters away.
3) Use some more modeling clay to place the diffraction grating in front of the laser. You can align the grating with the laser beam by looking for the reflection from the grating. You want the reflection to go back into the laser. In the image below the grating has been deliberately unaligned so that you can see the reflected beam on the modeling clay holding the laser (and the side reflections on the table).



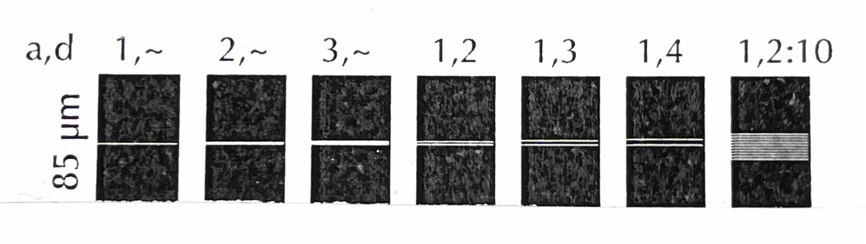
4) Measure the distance L from the diffraction grating to the wall.
5) Measure the positions of the first diffraction maximums x_{+2} and x_{-2} with the central dot of the diffraction pattern at $x = 0$.
6) With using $\tan\theta_n = \frac{x_n}{L}$ compute θ_{+2} and θ_{-2}.
7) Use these angles and the known diffraction grating spacing $d = \frac{1\text{mm}}{500} = 2\mu\text{m}$ and the relationship

$$d\sin\theta_n = n\frac{\lambda}{2}$$

to estimate the wavelength of the laser. We will use this estimate of the wavelength for the rest of this lab.

§ 4 Single Slit

Find the transparency film.



There are three single slit apertures, three double slit apertures and one aperture with 10 slits. The approximate sizes a and d are marked on each in units of 85μm. These are the nominal dimensions not the actual dimensions.

Remove the diffraction grating from the modeling clay and place the film in its place. Make a diffraction pattern for each of the three single slits. Put a piece of paper on the wall where the diffraction pattern is formed and circle the bright spots. Measure the distance L from the film to the wall. Use measurements of the pattern on the paper and the relationship

$$a \sin \theta_n = n \frac{\lambda}{2}$$

to estimate a for each. Compare with the nominal value.

▷ Question 1

There are a number of local maxima of intensity in the diffraction pattern for a single slit aperture. The local maxima at the center is different. How is it different?

§ 5 Multiple slits

Now do the same for the apertures with multiple slits. Make a diffraction pattern for each of the four apertures and record the pattern by circling the maxima. Use measurements of the pattern to estimate d for each aperture.

▷ QUESTION 2
When the distance d between the slits increases does the distance between diffraction pattern maximum increase, decrease, or stay the same?

▷ QUESTION 3
The 10 slit aperture has the same spacing d as one of the two slit apertures. What is the same about these two diffraction patterns? What is different about these two diffraction patterns?