Wave Optics

1 Laser Safety

We will use low-power lasers in this experiment. These lasers will not burn your skin if the laser beam hits you. However, the laser will hurt your eye if the laser beam enters your eye. So, DO NOT SHINE THE LASER IN ANYONE'S EYE! The laser beam will reflect off of metal, and there are random metal objects in the lab, so it is best not to move the laser around with the beam on. We do not want the reflected beam to accidentally shine into someone's eye. If you need to move the laser, do it with the beam off. You can make small positioning adjustments with the beam on.

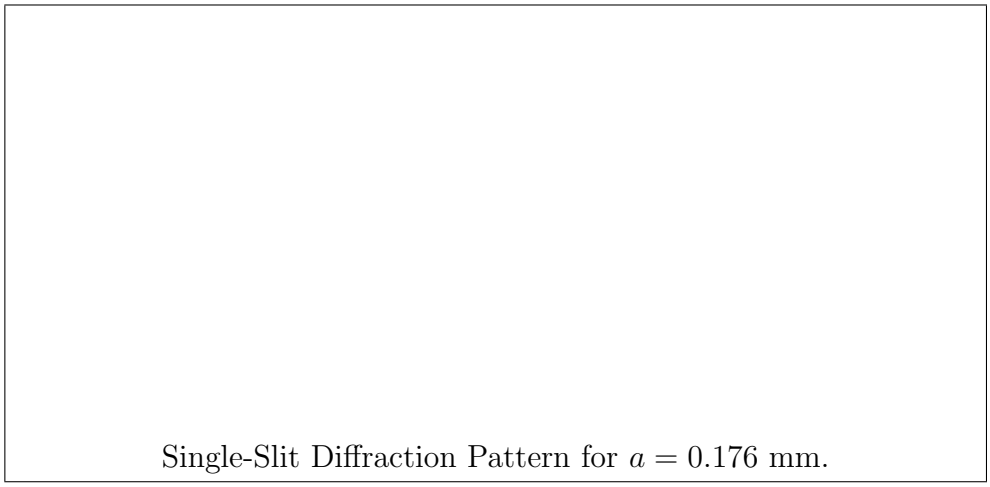
2 Reading the Slit Film Slides

We will be using rectangular slit film slides that have single slits, double slits, and some more exotic slit arrangements. There is a little directions card that shows schematically the various slit arrangements. Next to each slit arrangement, there are three numbers. The table below shows the ones we will use.

1 4 -	Single slit with width $a = 0.176$ mm
1 2 -	Single slit with width $a = 0.0879$ mm
1 1 -	Single slit with width $a = 0.0439$ mm
2 2 2	Double slit with slit separation $d = 0.176$ mm
2 2 6	Double slit with slit separation $d = 0.35$ mm
2 2 14	Double slit with slit separation $d = 0.70$ mm

3 Single-Slit Diffraction

Point the laser at a wall about 2 m away and turn it on. Now direct the beam through a single slit of width 0.176 mm. Shine the laser through the slit so that the light exiting the slit hits the wall. Put this paper up against the wall so that the light hits it, and in the box below trace the diffraction pattern. Identify on your tracing which places are bright and which are dark.



Single-Slit Diffraction Pattern for $a = 0.176$ mm.

Measure the distance from the slits to the wall.

Slit-to-wall distance	

Figure out a way to use your diffraction pattern to determine the wavelength of light produced by the laser. Describe how you will do it below.

Determine the wavelength of light produced by the laser, and record it.

Laser wavelength	

What color is the laser light?

Laser color	

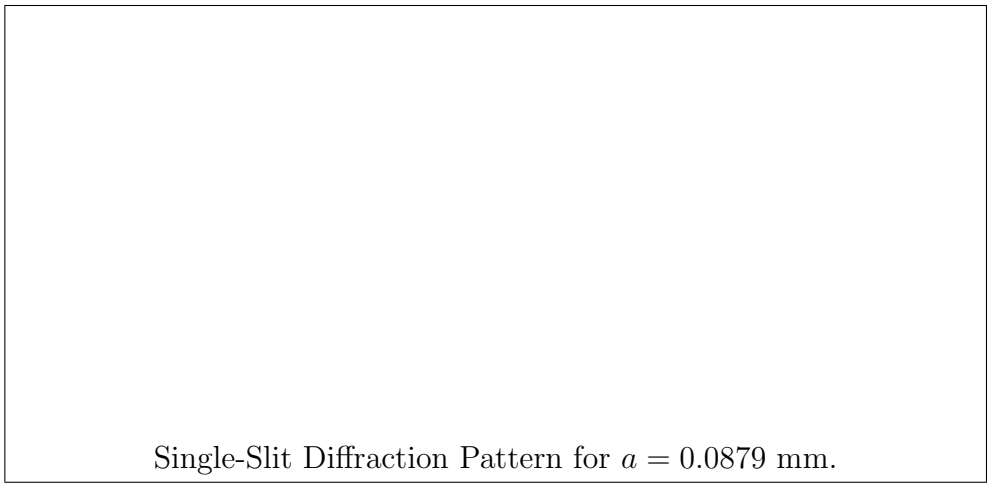
Look in your textbook or online and figure out what range of wavelengths corresponds to the color of the laser. Write this wavelength range below. Does the wavelength you calculated above fall in this range?

Wavelength range	

What is the frequency of the laser?

Laser frequency	

Now trace a diffraction pattern for a slit width of 0.0879 mm.

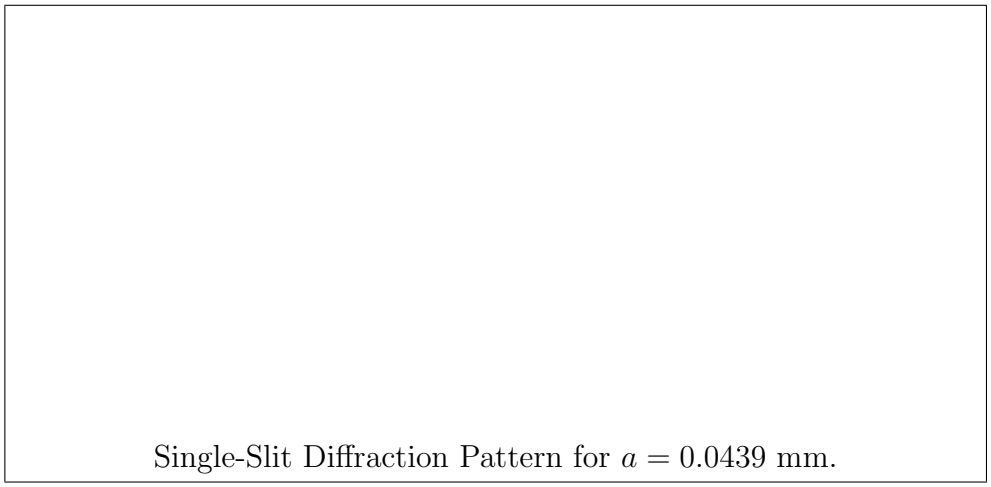


Single-Slit Diffraction Pattern for $a = 0.0879$ mm.

Recalculate the laser wavelength based on the data you obtain with the new slit width.

Laser wavelength	

Now trace a diffraction pattern for a slit width of 0.0439 mm.



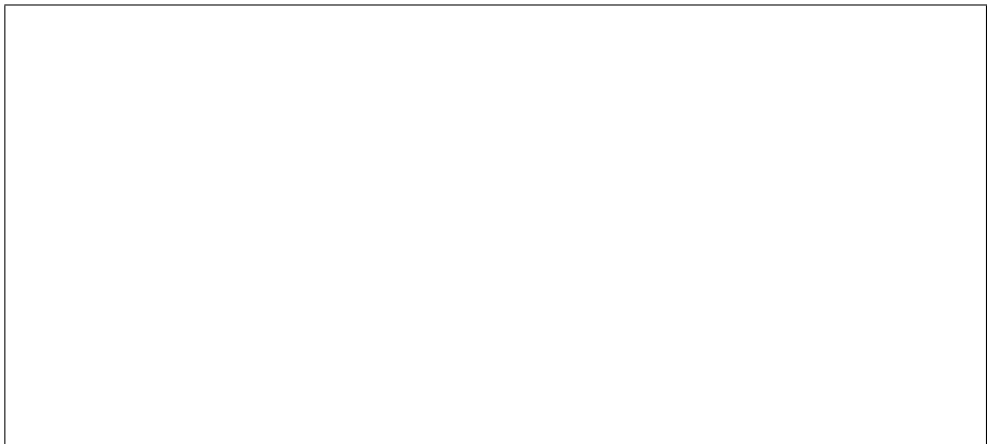
Single-Slit Diffraction Pattern for $a = 0.0439$ mm.

Recalculate the laser wavelength based on the data you obtain with the new slit width.

Laser wavelength	

4 Two-Slit Interference

Point the laser at a wall about 2 m away and turn it on. Now direct the beam through a pair of slits spaced 0.176 mm from each other. Shine the laser through the two slits so that the light exiting the slits hits the wall. Put this paper up against the wall so that the light hits it, and in the box below trace the interference pattern. Identify on your tracing which places are bright and which are dark.



Two-Slit Interference Pattern for $d = 0.176$ mm.

Measure the distance from the slits to the wall.

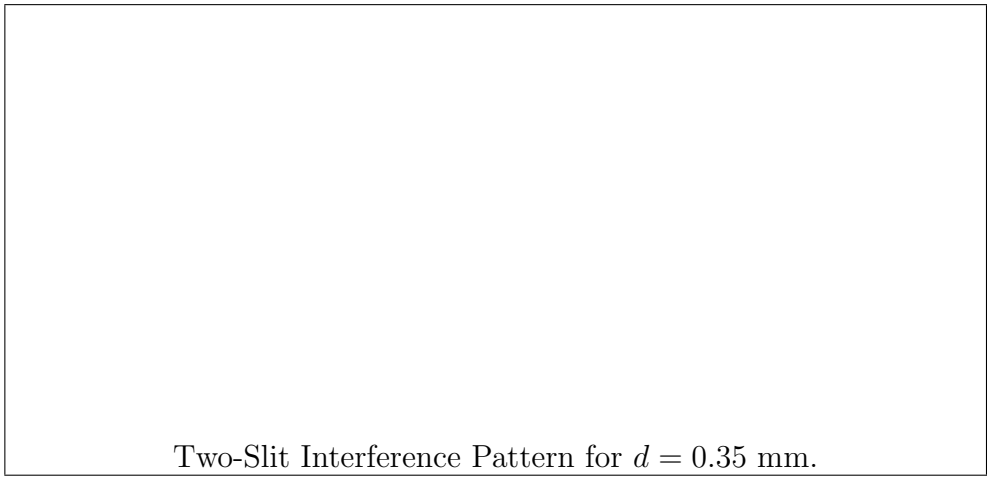
Slit-to-wall distance	

Figure out a way to use your interference pattern to determine the wavelength of light produced by the laser. Describe how you will do it below.

Determine the wavelength of light produced by the laser, and record it.

Laser wavelength	

Now, choose the 0.35 mm slit separation. Trace the interference pattern below.

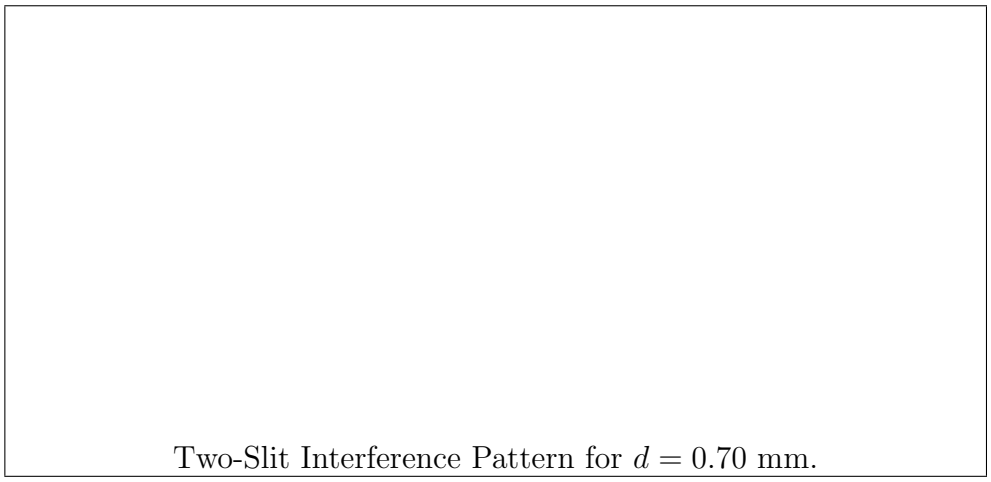


Two-Slit Interference Pattern for $d = 0.35$ mm.

Recalculate the laser wavelength based on the data you obtain with the new slit separation.

Laser wavelength	

Now, choose the 0.70 mm slit separation. Trace the interference pattern below.



Two-Slit Interference Pattern for $d = 0.70$ mm.

Find the laser wavelength based on this interference pattern.

Laser wavelength	

5 Questions

1. When the slit width increases, the distance between dark spots on a diffraction pattern

2. When the slit separation increases, the distance between dark spots on an interference pattern