Prelab #8: Two-Slit interference

5.0 Watch the videos and read the manual first, and record how much time you spent on this effort (2pt)

→ 15mins

5.1 Summarize the experiment in no more than 5 sentences: What physics phenomenon are you investigating, what will you be measuring (observables), what physics quantities will you be determining from this experiment (2pt)

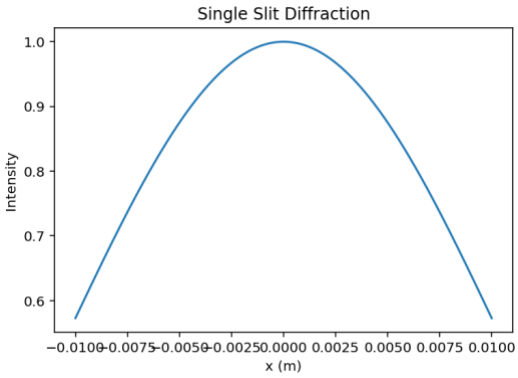
→ In this experiment we explore the wave behavior of light by studying diffraction from a single slit and interference from a double slit. We measure how the intensity changes across the pattern at the detector as we move it along the screen. From these measurements we determine the slit width, the slit separation, and compare our data to the Fraunhofer diffraction model. We also see how the single slit creates the broad diffraction envelope while the double slit produces sharp interference fringes inside that envelope. Overall, we use the intensity pattern to confirm key wave properties of light

5.2 The experiment is called double-slit with each single slit being 0.01 mm wide, the screen/detector is 0.5m from the slit, and the wavelength of the light used is 500nm.

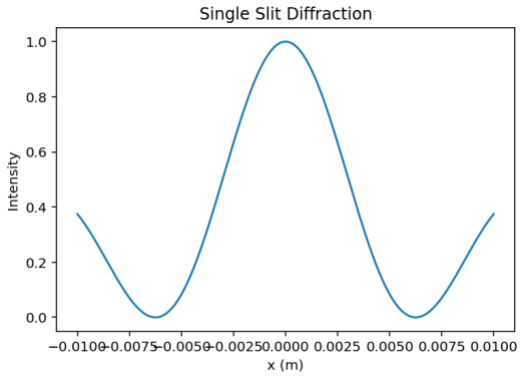
A. One can observe interference patterns even if there is a single slit for the laser light to pass through. Why? Use your own words. (1pt)

→ A single slit still creates a pattern because every point across the slit acts like a small wave source. These waves interfere with each other, causing bright and dark regions even though there is only one slit.

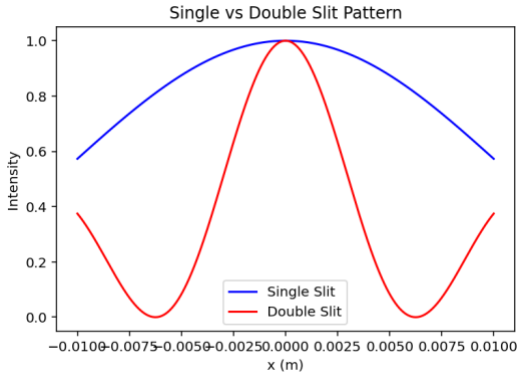
B. Use python to graph the intensity (of the lights at the screen/detector) from a single slit, as a function of distance from the center. Assume the slit is 0.01 mm wide, the screen/detector is 0.5m from the slit, and the wavelength of the light used is 500nm. (2pt)



C. Use python to graph the intensity (of the lights at the screen/detector) from the double slit, as a function of distance from the center. Assume the slit separation is 0.02 (2pt)



D. Graph Part B and C on top of each other. What do you see? Explain it in your own words (1pt)



→ When both graphs are plotted together, the double slit fringes appear inside the single slit envelope. The envelope sets the overall brightness, and the double slit adds the fine structure.

Code:

```
import numpy as np
import LT.box as B

#5.2.B

# Parameters
lam = 500e-9              # wavelength (m)
D = 0.01e-3               # slit width (m)
L = 0.5                   # distance to screen (m)

# Screen coordinates
x = np.linspace(-0.01, 0.01, 2000)
theta = np.arctan(x / L)

# Fraunhofer single slit
phi = (2 * np.pi / lam) * D * np.sin(theta)
I_single = (np.sin(phi/2) / (phi/2))**2

# Plot
B.pl.figure()
B.plot_line(x, I_single)
B.pl.xlabel('x (m)')
B.pl.ylabel('Intensity')
B.pl.title('Single Slit Diffraction')

#5.2.C

# Parameters
S = 0.02e-3             # slit separation (m)

x = np.linspace(-0.01, 0.01, 2000)
theta = np.arctan(x / L)

phi = (2 * np.pi / lam) * D * np.sin(theta)
psi = (2 * np.pi / lam) * S * np.sin(theta)

I_single = (np.sin(phi/2) / (phi/2))**2
I_double = I_single * (np.cos(psi/2))**2

B.pl.figure()
B.plot_line(x, I_double)
B.pl.xlabel('x (m)')
B.pl.ylabel('Intensity')
B.pl.title('Single Slit Diffraction')

#5.2.D

B.pl.figure()
B.plot_line(x, I_single, color='blue', label='Single Slit')
B.plot_line(x, I_double, color='red', label='Double Slit')

B.pl.xlabel('x (m)')
B.pl.ylabel('Intensity')
B.pl.title('Single vs Double Slit Pattern')
B.pl.legend()
```