Laboratory #5 : Diffraction

Objectives : To study diffraction by using helium neon laser.

Theory : Light travels in the straight line or with a smallest optical path length. However, when the light wave passes through a small window, about the size of the light wavelength, the light wave is bending around the edge and spread out. This phenomena is called light wave diffraction. As shown in Figure 5.1, a helium neon laser passes through a single slit, width a. At the distance L away from the slit there is a diffraction pattern. The location of the dark area is defined as

$$a \sin\theta = m\lambda \text{ or}$$
$$a\,\frac{y_m}{L} = m\lambda,$$

θ is an angle between an incident central propagation direction and the central minimum intensity of the diffraction pattern. The order of diffraction is m, an integer value. y_m is a distance from the central maximum intensity to the central minimum intensity of the m order. λ is the wavelength of the Helium neon laser, 632.8 nm.

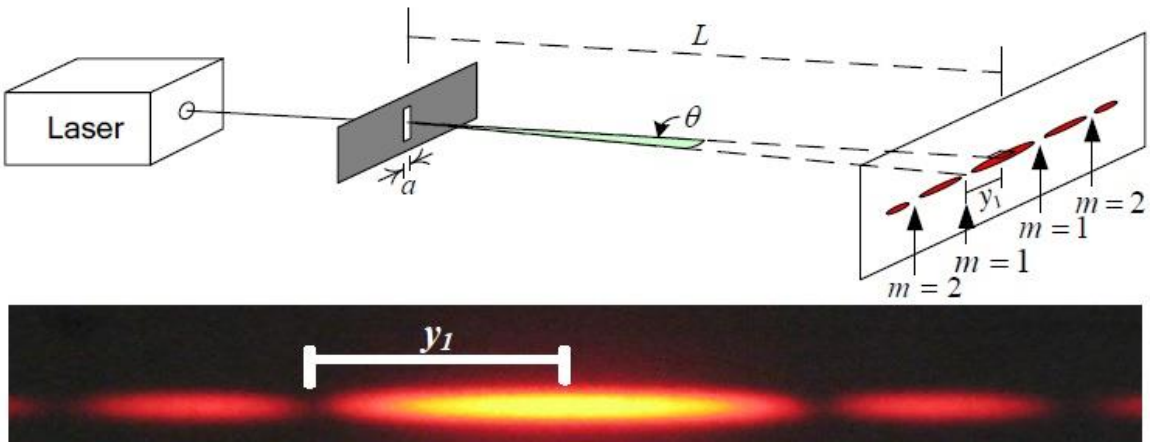


Figure 5.1 shows the diffraction pattern of the single slit.

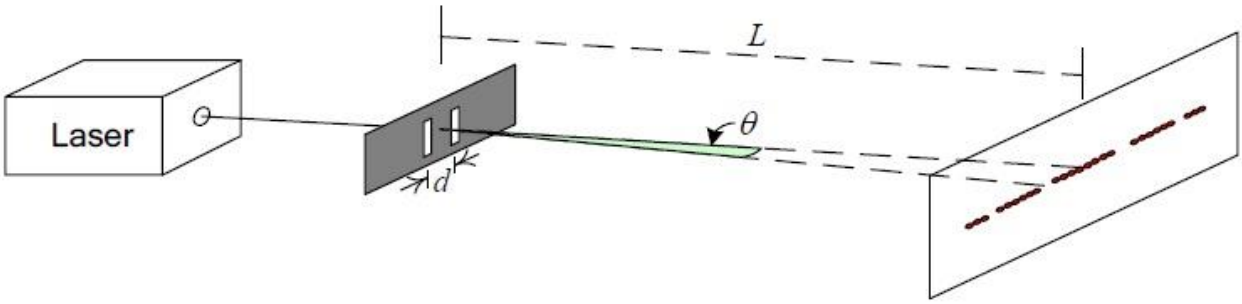
For a double slit, having slit distance d, there are diffraction and interference patterns on the screen shown in Figure 5.2. Since the single slit width a is small, the diffraction patterns are wide. The inference patterns appear within diffraction patterns. The maximum intensity of the interference patterns is defined as

$$d \sin\theta = m\lambda \quad \text{and}$$

the minimum intensity is defined as

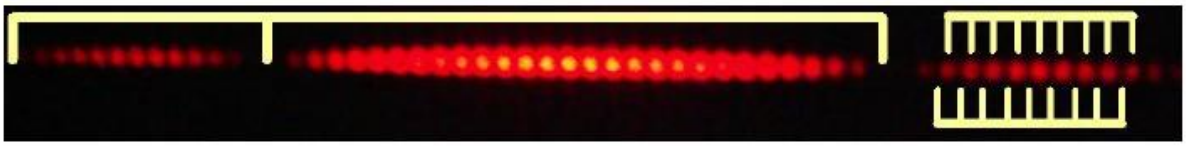
$$d \sin\theta = \left(m + \frac{1}{2}\right)\lambda ,$$

where m = 0, ±1, ±2, ...



Diffraction pattern

Maximum intensity of interference pattern



Minimum intensity of interference pattern

Figure 5.2 shows a double slit having both diffraction and interference patterns.

Experiment :

1. Use two single slits to study the diffraction by calculating the wavelength of the helium neon laser from the graph between y_m and L at m = 1 and 2.

2. Sketch the diffraction and interference patters from four double slits at the same location L.

Slit	Slit width a (.....)	Distance bt. slits d (.....)	Distance from slits to screen L (.....)	Patterns of the screen
A				
B				
C				
D				

3. Study the light wave diffraction from the transmission grating by calculating the wavelength of the helium neon laser

The maximum intensity of the diffraction pattern is defined as

$$d \sin\theta = m\lambda,$$

m is a diffraction order, 0, $\pm$1, $\pm$2, ... If the grating has ◻ lines per meter, the grating spacing d is given by

$$\frac{1}{d} = \frac{N}{m}.$$