

Interference

It is the wave nature of light that leads to an explanation of the experimental arrangements and observations described below.

I. Young's Double Slit

The objective is to experimentally find the spacing between the double slits by observing and measuring the interference pattern from a known wavelength (He Ne laser $\lambda=632.8$ nm).

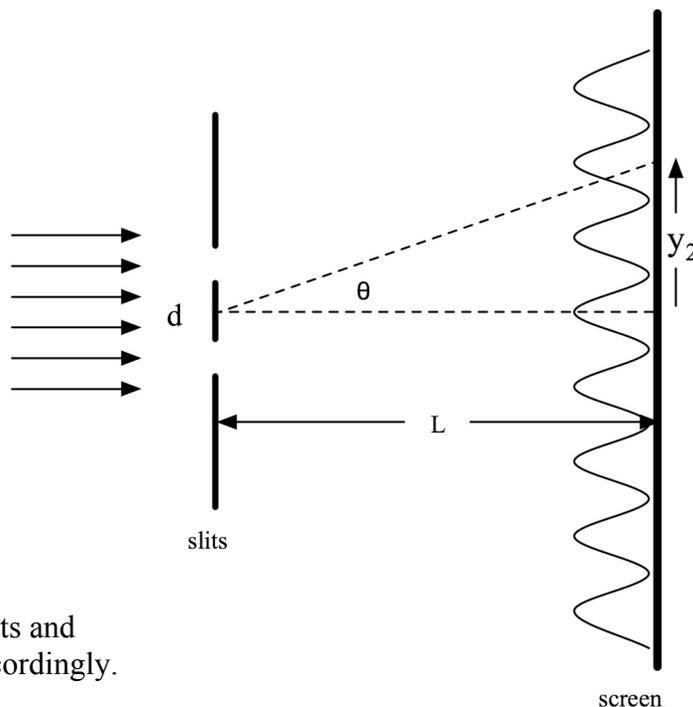
The angular and linear positions of the bright spots (constructive interference) are described by the relationships:

$$m\lambda = d \sin\theta_m \quad [\text{eqn. 1}]$$

$$y_m = L \tan\theta_m \quad [\text{eqn. 2}]$$

for small angles, $\sin\theta \approx \tan\theta$

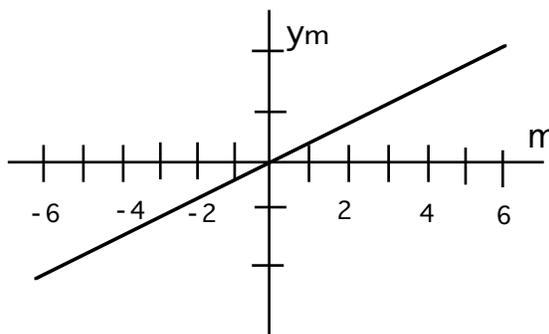
$$\text{therefore } y_m = \frac{L\lambda}{d} m \quad [\text{eqn. 3}]$$



Procedure:

1. The above model assumes the light shines on the slits and the screen at right angles, so adjust the laser beam accordingly. Measure the slit to screen distance L .
2. On the screen showing the interference pattern, mark the centers of the bright spots for about 10 spots.
3. Eqn. 3 above suggests a linear relationship between the distances y_m and the integers m , with a slope of $L\lambda/d$.
4. Use a ruler to measure the y_m , the distance from the central bright spot to each of the other bright spots marked on the screen.
5. Plot y_m vs. m as shown below. (m is a positive integer for spots on one side of the central spot and negative for the other side. Use the same scheme for y_m , positive for one side, negative for the other.)
6. Find the slope and use the value to solve for d since you can measure L and are given λ .
7. Compare this experimental value of the slit spacing d to the value found on the card or given by the lab instructor. Compute the percent difference.

$$\text{slope} = \frac{L\lambda}{d}$$



II. Diffraction Grating

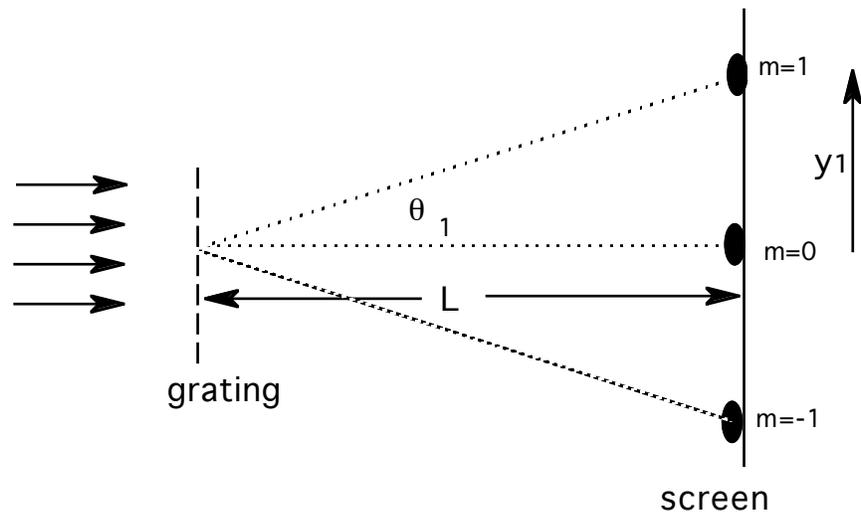
The objective is to find the wavelength of light from the interference pattern and from the given groove spacing of the grating.

The angular and linear positions of the bright spots are described by the relationships:

$$m\lambda = d \sin\theta_m \quad [\text{eqn. 1}]$$

$$y_m = L \tan\theta_m \quad [\text{eqn. 2}]$$

Unlike the double slit pattern where the angles were quite small, these spots are well separated and you should not use any small angle approximations.



1. Adjust the laser beam so it is perpendicular to the screen or wall as assumed by eqn. 2 (A mirror against the screen is useful for this.)
2. Adjust the grating so the pattern is symmetric, ie., $y_1=y_{-1}$. (This assures that the beam is perpendicular to the grating as required by eqn. 1.)
3. Measure the grating to screen distance L .
4. Measure the distance between the central spot and the next nearest neighbor, y_1 .
5. Find d (spacing between the grooves on the grating) from information on the grating or from your instructor. It is handy to express d in units of nm if you want to compute the wavelength in nm.
6. Compute the wavelength of the light from your knowledge of L , y , and d . (Do not use the eqn. 3 from the double slit experiment as it is based on the small angle approximation.)
7. Compare your computed value to the He Ne laser wavelength of 632.8 nm by stating the percent difference.