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Lab 11. INTERFERENCE AND DIFFRACTION OF LIGHT

11.1. Materials

Two lasers of different wavelengths, diffraction grating, single-slit and double-slit masks, optical bench, screen, tape, cards or white paper, ruler, meter stick, sodium vapor lamp, air wedge and Newton's rings apparatus

11.2. Activities

A. Diffraction grating

1. Record the wave number (lines per unit distance) of the grating. Calculate the regular spacing between lines.
2. Place the diffraction grating between the laser and the white paper. Shine the laser on the grating. Adjust the distance to the screen so that both the central beam and a dot of diffracted light projects onto the screen. Measure the distance on the screen from the central beam to a side dot. Calculate the wavelength of the laser light.

Wavenumber	_____	Spacing	_____
Screen distance	_____	Distance to dot	_____
Diffraction angle	_____	Wavelength λ	_____

3. Repeat with a laser of a different wavelength. Use the same diffraction grating, so the wavenumber and spacing will be the same as before. You may need to adjust the screen distance.

Screen distance	_____	Distance to dot	_____
Diffraction angle	_____	Wavelength λ	_____

You will use these calculated wavelengths in the succeeding activities.

B. Single slit diffraction

1. Set up a projection screen. Place a single-slit mask slide about a meter ahead of the screen. Aim the laser so that its beam shines on one of the slits and projects its diffraction pattern on the white screen.
2. Observe the diffraction pattern of the widest slit. Then re-position the slide so that the laser bean strikes the next-widest slit. Observe the resulting diffraction pattern.
3. Continue with the narrower and narrower slits. How does the diffraction pattern change as the slit becomes narrower?

4. For a slit showing a clear pattern, record the positions of several of the dark bands in the pattern. Set $x = 0$ as the center of the diffraction pattern, and measure distances from there to the dark bands to the side. Enter your measurements in Table 1.
5. Calculate the angles corresponding to the measured distances, then determine the width of the slit.
6. Replace the laser with a laser of another wavelength. Carry out the same measurements and calculations for this laser.

Table 1. Single slit diffraction patterns

Screen distance L _____

First laser		λ = _____		Second laser		λ = _____	
m	x	θ	d	m	x	θ	d
1				1			
2				2			
3				3			

C. Double slit diffraction

1. Now place a mask with double slits in the laser beam. Compare and contrast the double slit diffraction pattern to the pattern from the single slit.

2. For a slit showing a clear pattern, record the positions of several of the bright bands in the pattern. Set $x = 0$ as the center of the diffraction pattern, and measure distances from there to the bright bands to the side. Enter your measurements in Table 2.
3. Calculate the spacing between the slits from the diffraction pattern.

Table 2. Double slit diffraction patterns

Screen distance L _____

First laser		λ = _____		Second laser		λ = _____	
m	x	θ	d	m	x	θ	d
1				1			
2				2			
3				3			

D. Air gaps

These are two different arrangements of glass plates with a thin air gap between them. You will observe them illuminated by a monochromatic light so that regions with different interference properties are easy to distinguish.

Air wedges

These are pairs of glass plates touching at one edge and with a thin spacer between them at the opposite edge.

1. You should see bright and dark bands along the plates. In what direction do the bands run?

2. Is the spacing between bands uniform, or does it vary along the plates?

Newton's rings

This apparatus comprises a plano-convex lens resting against a flat plate.

1. Describe the pattern of bright and dark bands.

2. Is the center of the pattern dark or bright?

3. Does the pattern change if you illuminate the apparatus from behind?

11.3. Additional questions

1. Are your estimates of the slit widths and spacings from the different diffraction patterns similar to each other?
2. Are your estimates of the slit widths and spacings from the different lasers similar to each other?