AUB
Physics Department

30 MAR 2017

Date: 30-3-2017

Grade: 10

Physics210L
Interference & Diffraction

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I. *Diffraction:*
Distance from slit to screen: L = 0.85 m.

$\lambda = \frac{y\,a}{m\,L}$

Locations of Intensity Minima

Slit width a =0.04 mm				
Order	Left of central maximum	Right of central maximum	Average = ½ (x_R-x_L)	Wavelength λ (nm)
m =1	-0.014	0.014	0.014	658
m =2	-0.028	0.028	0.028	658
m =3	-0.042	0.043	0.0425	667
Slit width a =0.08 mm				
Order	Left of central maximum	Right of central maximum	Average = ½ (x_R-x_L)	Wavelength λ (nm)
m =1	-7.315×10^{-3}	6.872×10^{-3}	6.6935×10^{-3}	629.9
m =2	-0.014	0.014	0.014	658
m =3	-0.021	0.021	0.021	658
Slit width a =0.16 mm				
Order	Left of central maximum	Right of central maximum	Average = ½ (x_R-x_L)	Wavelength λ (nm)
m =1	-3.325×10^{-3}	3.547×10^{-3}	3.436×10^{-3}	646.78
m =2	-6.65×10^{-3}	6.872×10^{-3}	6.761×10^{-3}	636.4
m =3	-0.01	0.01	0.01	627.0

$x = \frac{m\lambda L}{a}$

$\bar{\lambda} = \frac{\sum \lambda_i}{N}$, $N = 9$

$d_i = \lambda_i - \bar{\lambda}$

$\sigma = \sqrt{\frac{\sum d_i^2}{N-1}}$

$\alpha = \frac{\sigma}{\sqrt{N}} = \frac{\sigma}{3}$

a. Estimate the average value of λ (show a sample calculation) and its rms error. Compare to the literature value of the wavelength of laser and comment.

Average $\Rightarrow$ 649.228 nm

$\alpha = \frac{\sigma}{\sqrt{N}} = \frac{139}{\sqrt{8}} = 49.199$ nm $\Rightarrow \alpha = 5\times$ nm

$\lambda = (649 \pm 51)$ nm ✓ lit value = 650 nm

compare $(\lambda-\alpha, \lambda+\alpha)$ $(644, 654)$ nm our value is in the domain therefore our results are accurate. ✓

b. Describe qualitatively what you would see if you use a white light instead of a laser.

white light is not monochromatic (consists of seven colors each of a certain wavelength)

=> we will see diffraction pattern for each color seperately

=> white light appears in the middle

c. Based on your observations, what happens to the diffraction pattern as the aperture becomes larger.

Diffraction pattern becomes smaller

$$X = \frac{m \lambda L}{a}$$

II. *Interference*:

Distance from slit to screen: L = 0.85 m.

Separations between Adjacent Bright Fringes

Slit width a =0.04 mm, slit separation d =0.5 mm				
Fringe Order	Length	# of maxima	Y= distance between adjacent bright fringes	Wavelength λ (nm)
Central	0.029	25	1.16×10^{-3}	682.4
1st order right	0.015	12	1.25×10^{-3}	735.3
1st order left	0.015	12	1.25×10^{-3}	735.3
Slit width a =0.04 mm, slit separation d =0.25 mm				
Fringe Order	Length	# of maxima	Y= distance between adjacent bright fringes	Wavelength λ (nm)
Central	0.032	15	2.13×10^{-3}	626.5
1st order right	0.013	6	2.16×10^{-3}	635.3
1st order left	0.013	6	2.16×10^{-3}	635.3
Slit width a =0.08 mm, slit separation d =0.25 mm				
Fringe Order	Length	# of maxima	Y= distance between adjacent bright fringes	Wavelength λ (nm)
Central	0.015	7	2.14×10^{-3}	629.4
1st order right	6.654×10^{-3}	3	2.213×10^{-3}	652.4
1st order left	6.2×10^{-3}	3	2.066×10^{-3}	607.65
Slit width a =0.08 mm, slit separation d =0.5 mm				
Fringe Order	Length	# of maxima	Y= distance between adjacent bright fringes	Wavelength λ (nm)
Central	0.014	13	1.0769×10^{-3}	633.5
1st order right	7.488×10^{-3}	7	1.0697×10^{-3}	629.2
1st order left	7.472×10^{-3}	7	1.0674×10^{-3}	627.9

Estimate the wavelength of the laser and its rms error. Compare to the literature value and comment.

$x = \frac{\lambda L}{a} \Rightarrow \lambda = \frac{xa}{L}$

$\bar{\lambda} = 652.5125$ nm

$\alpha = \frac{\sigma}{\sqrt{N-1}} = 12.28$ nm

$\lambda = (653 \pm 12)$ nm

$\lambda = 650 \in (653 - 12, 653 + 12)$

$\lambda = 650$ nm $\in (641, 665)$

Then, the results are accurate

Questions

1. Explain how the slit width affects the value of X?

$X = \frac{\lambda L}{d}$; X doesn't depend on the width

So, the slit width doesn't affect the value of X. ✓

2. According to your results does the distance between maxima increase, decrease or stay the same when the slit separation is increased?

When the split seperation is increased, the distance between maxima decrease. ✓

3. By what percentage, would the separation between two adjacent fringes change if the experiment is performed using an Ar^+-laser emitting at 514 nm?

$X = \frac{Yd}{D}$ → what happen to sep

514

since λ ↓ from 650 to 514

the seperation would decrease

$$\frac{X_2 - X_1}{X_1} = \frac{\frac{Y_2 d_2}{D_1} - \frac{Y_1 d_1}{D_1}}{\frac{Y_1 d_1}{D_1}} = \frac{Y_2 - Y_1}{Y_1}$$

$\frac{650 - 514}{650} \times 100 = 20.92\%$

so Y deceases by 20.92% ✓