1. Title Page

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Experiment 5 Interference / Experiment 6 Single Slit Diffraction

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1. Objective:

The objective of experiment 5 was to observe the interference of light waves as they pass through different apertures and trace their patterns. Then we analyze the patterns to observes the differences and determine what characteristics of the waves change from each pattern. The objective of experiment 6 was study the single slit diffraction of light and to be able to determine the wavelength of the light through the diffraction.

1. Procedure and Results:

In experiment 5 we placed the He-Ne laser on the lab table and placed a double slit slide in the holder directly in front of the laser. We then measured the distance (L) from the slide to the wall where we taped a piece of white paper to trace the patterns on. Then we adjusted the slide, so the laser would go through Pattern A, marked by A. We traced the pattern projected by A from the brightest maximum and to the right as far we could on the paper. Repeated the tracing for Pattern B, C, and D, moving the slide each time to the marked pattern. After the tracing was finished we measured the pattern A from the center of the central maximum to the center of each mth value for 1 through 5. These measurements are the Ym (mm), repeated this measuring process for pattern B as well. Similarly, in experiment 6, we used the same laser in the same distance from the paper taped to the wall. However, we used a slide with a single slit to create diffraction on the laser. We traced the pattern from its brightest fringe and to the right to the edge of the paper. Then we measured from the center of the brightest fringe to the center of the minima between the fringes for each mth value for 1 through 8. This measurement is Yp (mm).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| m | d (mm) | Ym (mm) | L (mm) | λ (mm) |
| 1 | 0.25 | 4.0 | 2000 | 5.0 \* 10^-4 |
| 2 | 0.25 | 9.0 | 2000 | 5.6 \* 10^-4 |
| 3 | 0.25 | 14 | 2000 | 5.8 \* 10^-4 |
| 4 | 0.25 | 20 | 2000 | 6.3 \* 10^-4 |
| 5 | 0.25 | 24 | 2000 | 6.0 \* 10^-4 |

Pattern A

|  |  |  |  |
| --- | --- | --- | --- |
| λex (mm) | λth (mm) | % Disc | Std. Dev. |
| 574 \* 10^-6 | 633\*10^-6 | 9.29% | 2.24 \* 10^-5 mm |

Using the measured values for m, Ym, L and Da, we calculated the wavelength for column 5. The formula used was λ = (d\*Ym)/(m\*L). So for m(1), the solution would look like λ = (0.25mm\*4.0mm)/(1\*2000mm) = 5.0 \* 10^-4mm.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| m | λex (mm) | Ym (mm) | L (mm) | Db (mm) |
| 1 | 574\*10^-6 | 3.0 | 2000 | .38 |
| 2 | 574\*10^-6 | 5.0 | 2000 | .46 |
| 3 | 574\*10^-6 | 8.0 | 2000 | .43 |
| 4 | 574\*10^-6 | 10 | 2000 | .46 |
| 5 | 574\*10^-6 | 13 | 2000 | .44 |

Pattern B

|  |  |  |  |
| --- | --- | --- | --- |
| Dex (mm) | Dth(mm) | % Disc | Std. Dev. |
| .43 | .50 | 13 | 1.5\*10^-2 mm |

Using the measured values for m, Ym, L and λ, we calculated the slit separation (Db) for pattern B for column 5. The formula used was Db = (m\*λ\*L)/(Ym). So for m(1), the solution would look like DB = (1\*(574\*10^-6mm)\*2000mm)/(3.0mm) = .38mm.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| m | a (mm) | Yp (mm) | L (mm) | λ (mm) |
| 1 | .16 | 9.0 | 2000 | 7.2 \* 10^-4 |
| 2 | .16 | 18 | 2000 | 7.2 \* 10^-4 |
| 3 | .16 | 25 | 2000 | 6.7 \* 10^-4 |
| 4 | .16 | 33 | 2000 | 6.6 \* 10^-4 |
| 5 | .16 | 40 | 2000 | 6.4 \* 10^-4 |
| 6 | .16 | 48 | 2000 | 6.4 \* 10^-4 |
| 7 | .16 | 56 | 2000 | 6.4 \* 10^-4 |
| 8 | .16 | 64 | 2000 | 6.4 \* 10^-4 |

|  |  |  |  |
| --- | --- | --- | --- |
| λex (mm) | λth (mm) | % Disc | Std. Dev. (mm) |
| 666 \* 10^-6 | 633 \* 10^-6 | 5.21% | 1.24 \* 10^-5 |

Experiment 6 Table

Using the measured values for Yp, L and a, we calculated the wavelength for column 5. The formula used was λ = (a\*Ym)/(m\*L). So for m(1), the solution would look like λ = (0.16mm\*9.0mm)/(1\*2000mm) = 7.2 \* 10^-4mm.

1. Discussion:

In experiment 5, we could successfully create and analyze interference patterns as a light wave is passed through a double slit slide. During this procedure we expected to be able to analyze when the light waves were in phase and amplifying each other as well as when they are out of phase and canceling each other. In fact, we noticed as the slit separation is increased the minimas come closer together. Patterns A and C, as well as patterns B and D, display this relationship when we compared their patterns. Patterns A and B have wider fringes and smaller minimas compared to patterns C and D. We also noticed that as the number of slits changes, in the slide, the pattern starts to display a greater distance between the fringes. Upon closer observations, there appeared to be dimmer fringes between the bright fringes. Always having the same patter, 2 less dim fringes then the number of slits in the pattern. For example on the pattern with 5 slits, there would be 3 dim fringes between each of the bright fringes. Then when we used the slide with ~600 lines/mm; the space between the fringes were exponentially further than the ones before. And using the same pattern we approximated that there was ~598 lines between each fringe. During the experiment we did run into a few factors that could cause uncertainties. The most prominent factors would be whether the slides were cleaned from any dirt that interferes. As well as our accuracy of placing the laser directly on the patterns.

Unlike experiment 5, experiment 6 we only used a slide with a single slit pattern in order to analyze diffraction patterns. Instead of the perfect rectangle shape being produced by the laser, passing through the rectangle slit, onto the paper; we saw a flared-out pattern on the paper. Made up of bright fringes separated by dark minimas very similar to the patterns we saw in experiment 5. We could correctly produce the patterns we had expected. We, then, compared the diffraction pattern of rectangular slits with circular openings. The rectangle slits produced a straight-line pattern of bright and dark fringes. While the circular pattern produces rings separated between by dark fringes. For the second part of the experiment we were measuring values to calculate the average wavelength in our pattern. We compared the average value with the theoretical value provided, and determined that the theoretical value did fall correctly into our experimental range with a discrepancy of only 5.21%. The possibilities of errors remained the same from experiment 5. The slides might have had interference produced by dirt or dust, as well as us not correctly lining the laser with the patterns on the slides.