**Interference and Diffraction (O-4)**

**ABSTRACT:** This experiment studied the diffraction and interference of light waves that encounter narrow slits and small apertures and it measured the wavelength of monochromatic light from a laser. From the patterns and the distribution of light after it has passed through various apertures, certain relations are derived with respect to wavelength such as and where d is the length of the slit and a is the length to the first darkness and brightness respectively in single and double slit. The experimental data and expressions are found to be parallel with the actual He-Ne laser (red) wavelength (650nm ±72nm versus 630nm with a 3.17% error in a single slit experiment).

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**INTRODUCTION**:

Diffraction of light waves is a natural phenomenon and is the slight bending of light as it passes through or around the edge of an object. The amount of diffraction depends on the size of the wavelength of light relative to the size of the opening. If the opening is much larger than the light's wavelength, the bending will be almost unnoticeable. However, if the opening is really small, even as small as the wavelength or equal, the amount of bending is considerable and experimentally observable. If there are more than one aperture in one object the light waves from each will overlap behind the object, and this is called interference. Some of the light waves will interfere constructively, where some will cause destructive interference in certain locations. This experiment highlights distribution of light after passing through various apertures.

**PROCEDURE**:

The experiment consists of three main parts: Single slit diffraction, double slit diffraction and more diffraction. In the procedure A, the He-Ne laser should be placed at one end of the optical bench. The slide of single slits should be placed in front of the laser, to a distance where the laser is broad enough to illuminate the entire slit. After setting this distance and adjusting the slit position, a viewing screen must be positioned at the other end of the bench. This will be used for observation. By trying out different slits on the slide, the distribution of light is observed. Then, for the width of the central bright spot an expression should be derived, including the distance from the slit to the viewing screen, the width of the slit and the wavelength of the laser’s light. With the four different slits on the slide, four different trials are conducted and the width of the central bright spot is recorded and the results are averaged and uncertainty estimated. This is to predict the real wavelength of the laser’s light.

Similar to procedure-A, the two slit aperture slide must be placed between the laser and the screen and the patterns should be observed. To predict the location of the various bright spots above the central maximum, an expression must be derived. Following the expression, three trials should be performed with three sets of double slits to compare them with the theoretical value.

Finally in the procedure C, multiple slits are used to observe different patterns. This will be compared to the geometry of the previous aperture patterns. The patterns will be sketched.

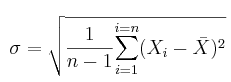
**RESULTS AND ANALYSIS:**

The derivations of the aforementioned expressions are as follows:

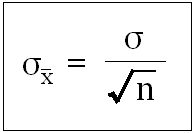
The wavelength result from procedure A is:

Note: The table is attached.

0.00065 mm ± 7.22892E-05 mm. This is obtained by taking the average first and getting the standard deviation. Standard deviation is nothing more than how each individual result varies from the arithmetic mean value. Standard deviation is obtained using the following formula:



However, this is not a proper plus or minus value to put on an average. Standard deviation of the mean is found by:



This value gives us the exact uncertainty. Same procedure is followed to come to the procedure B’s uncertainty. The experimental wavelength is the following:

0.00065mm±4.67911E-05 mm

**CONCLUSION**:

Our measurements of the wavelength are, within the experimental error, very close to the actual wavelength of He-Ne laser (630nm). This confirmed the accuracy of the relations that we derived based on aperture size and setup. Slight difference about 20nm is due to experimental error such as miscalculating the width of the central bright spot. These measurements have to be extremely precise and tend not to be very doable with naked eye since the fine boundaries of light are difficult to differentiate.