29 February 2024

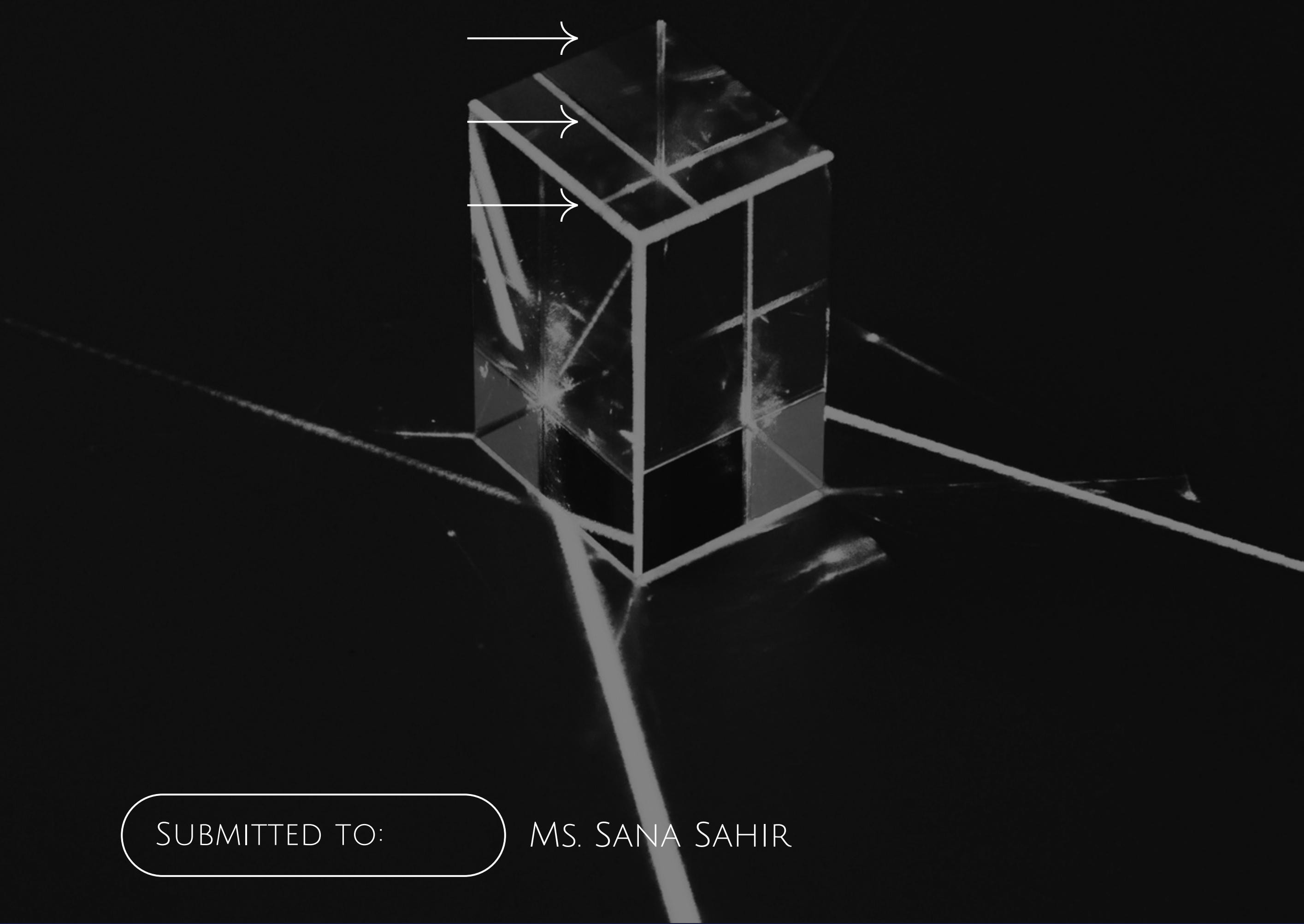
Winter 2024

experiment 8

Interference & Diffraction

University of Wollongong in Dubai

SUBMITTED BY:



SUBMITTED TO: MS. SANA SAHIR

PHYS143
Physics for Engineers

Purpose

To explore the diffraction of light through a variety of apertures.

Hypothesis Statement

As the light from the laser strikes the positioned DVD/CD at an angle, it is expected to see the laser light being diffracted and produce diffraction spots on the sheet of paper. The distance between each diffraction spot will depend on the spacing between the data tracks.

Materials

- Compact Disc (CD)
- Digital Versatile Disc (DVD)
- Laser Pointer
- Ruler
- Screen
- Protractor

Procedure

1. Set up the laser, CD/DVD and a screen as shown in Figure 1.
2. Place the CD/DVD at an angle of 45 degrees.
3. Shine the laser at the CD/DVD.
4. Measure the distance of laser beam above paper (*l*) and distance between diffraction spots (*w*).

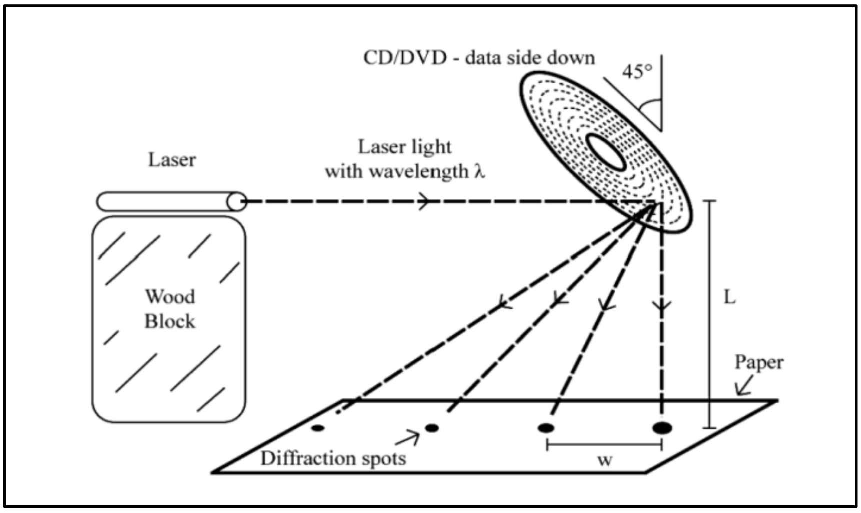


Figure 1: Experimental set-up; side view

Data

CD Track Spacing

L = 15.5 cm
w = 13.4 cm
λ = 650 nm

d = Distance between CD tracks
= $\frac{\lambda L}{w} = \frac{650 \times 10^{-9} \times 15.5 \times 10^{-2}}{13.4 \times 10^{-2}}$
= 7.5187×10^{-7} m
= 7.5187×10^{-4} mm

Number of CD tracks per mm = $\frac{1}{d}$
= 1330

DVD Track Spacing

L = 15.5 cm
w = 47.2 cm
λ = 650 nm

d = Distance between DVD tracks
= $\frac{\lambda L}{w} = \frac{650 \times 10^{-9} \times 15.5 \times 10^{-2}}{47.2 \times 10^{-2}}$
= 2.1345×10^{-7} m
= 2.1345×10^{-4} mm

Number of DVD tracks per mm = $\frac{1}{d}$
= 4685

Observations

Upon observation of the experiment, when the laser pointer was illuminated, the DVD reflected more than 3 dots, while the CD reflected 2 dots on the screen. This means that there are more tracks per mm in a DVD, which was proved to be correct by the calculations, as the DVD stores more data compared with the CD.

Conclusion

1. What was the purpose of this lab?
The purpose of this lab was to explore the diffraction of light through a variety of apertures.

2. How does the lab we performed relate to what we are studying in class?
The lab we performed demonstrates the wave nature of light and is relevant to topics discussed in class related to diffraction patterns, Interference as well as practical application of the concepts.

3. Give a brief recap of the procedure used.
Set up a laser, CD/DVD, and screen, position CD/DVD at 45 degrees, shine the laser at CD/DVD and measure laser beam distance above paper and diffraction spots.

4. What problems did you have during the lab? Did you have to modify your procedure?
The problems we faced in the lab were alignment issues and inaccurate measurements. Sometimes the laser beam, screen and apertures were not aligned correctly which led to blurry or misaligned diffraction patterns. However, after properly aligning them we got an accurate diffraction pattern.

5. Do your results make sense? What are the sources of error?
Yes, the results do make sense. After performing the experiment multiple times under the same conditions, we got consistent results which proved that the results are accurate. Sources of error include alignment errors, screen distortions, and limited light intensity from the laser.

6. What did you learn from this lab?
From this lab we could confirm the wave nature of light due to the observed diffraction patterns. We also understood diffraction phenomena and how the size and shape of apertures influence the diffraction patterns.

7. If you were to repeat this lab in the future, how would you modify or improve the procedure?
If we were to repeat this lab in the future, we would improve the procedure by stabilizing the laser and fixing the CD to a supporting mechanism with accurate angles to get more precise measurements.

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Purpose

To learn how interference can be used to measure small distances very accurately.

Hypothesis Statement

As the laser light hits the strand of hair, it is expected that the laser will diffract around the strand of hair and create an interference pattern of dark and bright fringes on the screen. The distances between the fringes can be measured to determine the width of the hair strand.

Materials

- Laser Pointer
- Ruler
- Screen
- Strand of Human Hair

Procedure

1. Setup the laser beam to shine on the screen at a distance of around 1 m as shown in Figure 2.
2. Ensure that the long side of the rectangle is horizontal on the white screen.
3. Take a human hair (preferably dark) and intercept the laser beam with it.
4. Place the hair horizontally in front of the laser beam.
5. Measure the spacing between the bands. The width of the hair d should be given by $d = \frac{\lambda L}{w}$

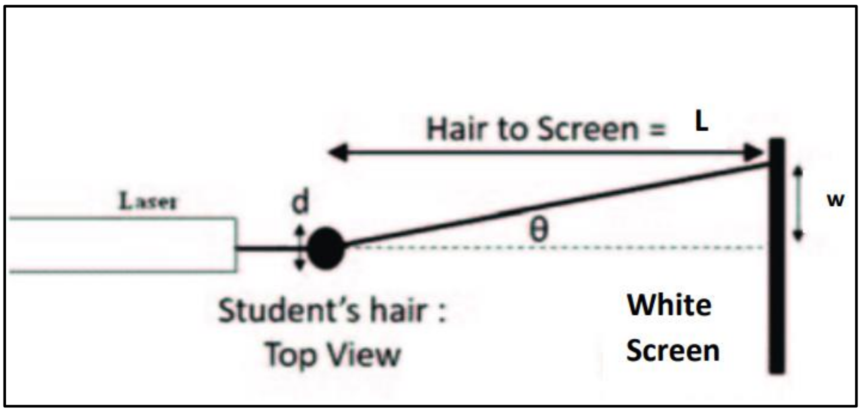

Figure 2: Experimental set-up; top view

Data

L = 0.9m λ = 650 nm w = 3.5 mm

$$d = \frac{\lambda L}{w} = \frac{650 \times 10^{-9} \times 0.9}{3.5 \times 10^{-3}} = 167.14\ \mu m$$

Observations

The average thickness of a human strand of hair ranges from 17 to 181 μm, and the experiment conducted satisfies this criterion, as the thickness of the hair calculated falls within the range. This experiment has measured the thickness of hair to be within the range using the formula above, where *d* refers to hair thickness, *λ* is the wavelength, *L* is the distance between the laser and beam and w is the space between the bands. Hence, light interference by the laser was used to accurately measure the thickness of a human strand of hair.

Conclusion

1. **What was the purpose of this lab?**

The purpose of this lab was to learn how interference can be used to measure small distances very accurately.

2. **How does the lab we performed relate to what we are studying in class?**

The lab we performed is directly connected to concepts discussed in class such as path and phase difference, wave nature of light as well as interference.

3. **Give a brief recap of the procedure used.**

Set up a laser beam at a distance of 1 m, align the long side horizontally on the white screen, and place a dark human hair in front of the beam, measuring the spacing between bands.

4. **What problems did you have during the lab? Did you have to modify your procedure?**

The main problem that we had during the lab was the alignment of the hair strand. Since the hair strand is very thin it was quite difficult to align it perfectly. However, with team effort and thorough observation we aligned it properly and got the required result.

5. **Do your results make sense? What are the sources of error?**

Yes, the results do make sense. Sources of error include, reading errors, misalignment and optical aberrations.

6. **What did you learn from this lab?**

Understanding the fundamentals of interference and how it's used in precise measurement methods is made possible by this experiment. It also shows how interference patterns change with small adjustments and how these changes can be used to measure small distances accurately.

7. **If you were to repeat this lab in the future, how would you modify or improve the procedure?**

If the lab were to be repeated in the future, the procedure can be enhanced by ensuring the room is dark as it makes it easier to see the diffraction patterns. We would also make use of some mechanism to stabilize the laser to ensure that it does not move while taking measurements.

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