Wroclaw University of Science and Technology

GENERAL PHYSICS
LABORATORY REPORT

Theme of class: DETERMINATION OF RADIUS OF CURVATURE OF THE LENS AND THE WAVELENGTH OF LIGHT USING THE NEWTON'S RINGS

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1 Introduction

1.1 Theory

A well-known optical experiment uses Newton's rings to determine the wavelength of light and the radius of curvature of a lens. When a convex lens is put on a flat glass surface and illuminated by a monochromatic light source, Newton's rings are created. Concentric bright and dark circles with bright rings denoting constructive interference and dark rings denoting destructive interference make up the interference pattern created by the reflected light. The wavelength of the light can also be estimated by knowing the refractive index of the medium between the lens and the flat glass surface as well as the radius of curvature of the lens. This experiment is widely used in the field of optics and provides a practical demonstration of interference phenomena and its applications in optics.

1.2 Equipment

The equipment used in this experiment included:

- Microscope with compound table and mounted lens
- Sodium-vapour lamp with power supply

2 Experiment

2.1 Investigation of Newton's rings

The laboratory experiment aims to observe Newton's rings using a microscope and sodium lamp.

The experiment involves several steps including turning on the sodium lamp and aligning the beamsplitter plate at a 45 angle to illuminate the field observed in the microscope ocular.

Then, aligning the microscope tube in the optical axis of the setup using the micrometre screws of the compound table.

Next, adjusting the height of the microscope tube to obtain a sharp image of Newton's rings and correcting the brightness of the image by adjusting the beamsplitter angle.

The centre of the crosswires is adjusted at the centre of the rings pattern.

Moving the microscope to the left of the chosen dark ring, the crosswire is tangentially adjusted in the middle of it, and the micrometre screw aleft reading is noted down.

This step is repeated five times.

The microscope is then moved to the right of the same dark ring, and the crosswire is tangentially adjusted in the middle of it, noting down the reading of micrometre screw aright.

	K=5		K=4	
	Akl [mm]	Akr [mm]	Akl [mm]	Akr [mm]
1	14.95	18.56	14.69	18.39
2	14.94	18.55	14.68	18.37
3	14.93	18.57	14.7	18.35
4	14.96	18.43	14.74	18.4
5	14.96	18.54	14.73	18.41
Xm	14.95	18.53	14.71	18.38
	K=5		K=4	
	Ua(Akl) [mm]	Ua(Akr [mm])	Ua(Akl [mm])	Ua(Akr [mm])
	0.024	0.102	0.047	0.044

Table 1: 510nm

	K=5		K=4	
	Akl [mm]	Akr [mm]	Akl [mm]	Akr [mm]
1	14.33	18.78	14.57	18.55
2	14.32	18.76	14.54	18.57
3	14.35	18.74	14.55	18.53
4	14.31	18.79	14.56	18.54
5	14.34	18.75	14.58	18.59
Xm	14.33	18.76	14.56	18.56
	K=5		K=4	
	Ua(Akl) [mm]	Ua(Akr [mm])	Ua(Akl [mm])	Ua(Akr [mm])
	0.029	0.038	0.029	0.044

Table 2: 577nm

λ	u(λ)	k	r	u(r)	R	Uc(R)	R mean	u(R mean)
[nm]	[nm]		[mm]	[mm]	[m]	[m]	[m]	[m]
510	1	5	1.79	0.0524	1.26	0.17	1.51	0.375
510	1	4	1.835	0.0322	1.66	0.17		
577	1	5	2.215	0.024	1.71	0.12		
577	1	4	2.015	0.0264	1.76	0.15		

Table 3: Result table

Calculations

lab 81.

Uncertainties

$\Delta pa = 0.01$ mm

$$\overline{a_{kL}} = \frac{14.95 + 14.94 + 14.93 + 14.96 + 14.96}{5} = 14.95 \text{ mm}$$

$$\overline{a_{kR}} = \frac{18.56 + 18.55 + 18.57 + 18.43 + 18.54}{5} = 18.53 \text{ mm}$$

$$u_A(a_{kl}) = \sqrt{\frac{\sum_{i=1}^{5}(\overline{a_{kL}} - a_{kLi})^2}{5(5-1)}} \approx 0.024 \text{mm}$$

$$u_A(a_{kr}) = \sqrt{\frac{\sum_{i=1}^{5}(\overline{a_{kr}} - a_{kri})^2}{5(5-1)}} \approx 0.102 \text{ mm}$$

$$= \frac{10^{-3} \cdot 10^{-3}}{10^{-9}} + \frac{10^{-3} \cdot 10^{-3}}{10^{-9}} =$$

$$= \frac{10^{-6}}{10^{-9}} = 10^{3}$$

$$u_c(R) = \sqrt{\left(\frac{2r \cdot u(r)}{k \cdot \lambda}\right)^2 + \left(\frac{-r^2 \cdot u(\lambda)}{k \cdot \lambda^2}\right)^2} = 0.00015 \text{km} = 0.15 \text{ m}$$

$$u(r) = \sqrt{\left(\frac{\partial r}{\partial a_{kL}} \cdot u(a_{kL})\right)^2 + \left(\frac{\partial r}{\partial a_{kr}} \cdot u(a_{kr})\right)^2} =$$

$$= \sqrt{(0.5 \cdot u(\overset{14.95}{a_{kL}}))^2 + (-0.5 \cdot u(\overset{18.53}{a_{kR}}))^2} = 0.0524 \text{ mm}$$

mm mm

$\mu m + \mu m = \mu m = (10^{-6})^{\frac{1}{2}} = 10^{-3}$

$$u_c(\bar{R}) = \sqrt{\frac{\sum_{i=1}^{4}(\bar{R} - R)}{4(4-1)}} = 0.0045 \text{m}$$

$$R = \frac{\bar{r}^2}{k\lambda} = \frac{1.79^2}{5 \cdot 510} = 0.00126 \text{ km} = 1.26 \text{ m}$$

$$\frac{mm^2}{nm} = \frac{(10^{-3})^2}{10^{-9}} = \frac{10^{-6}}{10^{-9}} = 10^{3} = \text{km}$$

Figure 1: Uncertainties and calculations

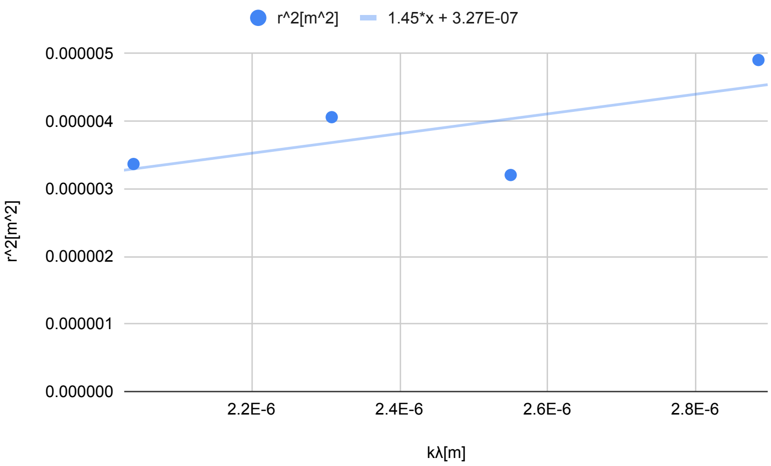

Figure 2: graph of the squares of the determined ring's radii r^2 vs the product of sodium light wavelength

R[m]	u(R)[m]
1.45	0.4277

3 Conclusion

In this experiment, we investigated Newton's rings and used it to determine the radius of curvature of a lens. By measuring the diameters of the interference rings and using the above formulas, we calculated the radius of curvature to be around 1.5 [m]. The accuracy of this measurement depends on the precision of our measurements of the interference ring diameters and the wavelength of the light. This experiment demonstrates the principles of interference in optics and provides a practical application for determining the properties of lenses.