EXPERIMENT 6

LIGHT WAVE INTERFERENCE – NEWTONIAN RINGS

PURPOSE

- To study the principles of light interferometry
- To evaluate the wavelength of light from Newtonian rings

APPARATUS

Metallographic microscope with measuring stage, light source, interference optical filters, rectangular glass plate, plano-convex lens, dial indicator.

DESCRIPTION OF THE EXPERIMENT

A system of characteristic rings is generated in an air gap between a flat glass plate and a plano-convex lens through interference of the light in a gap.
Monochromatic light produced by source with optical filter passes through the beam splitter of the microscope and strikes the plano-convex lens perpendicularly - Fig.1.
Portion of the light is reflected back at the inner boundary surface of the lens while that portion which enters the air spherical wedge is reflected at the glass plate surface (experiencing additional phase shift).
Both light beams superpose with each other and due to the phase shift at certain distances from the centre of the system give dark interference fringes of circular shape (so called Newtonian rings) that could be observed in the microscopic ocular - Fig.2.
The diameter - ***d -*** of the ring depends both on lens curvature ***- R-*** and the wavelength -λ- of incident light:

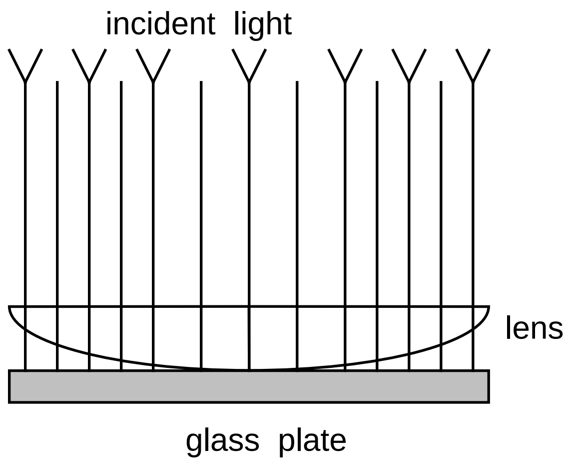
$$d_k = \sqrt{4kR\lambda} \qquad (1)$$

From the Eq. 1. one can calculate the wavelength of the light.:

$$\lambda = \frac{d_k^2 - d_l^2}{4 \cdot R \cdot (k - l)} \qquad (2)$$

k, l - ring number 0,1,2.....

k=0 corresponds to the central dark spot, while ***k>0*** to the subsequent dark rings.
Therefore from observation of the interference images one can evaluate the wavelength of the used light. Additional data about the plano-convex lens is required.



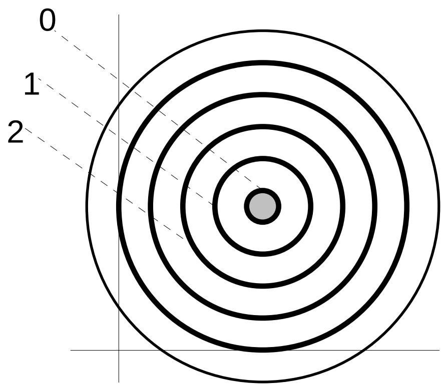


Figure 1. Figure 2.

MEASUREMENTS

1. Place the rectangular glass plate with plane - convex lens on it on the microscopic stage.
2. Install the dial gauge on the measuring stage of the microscope.
3. Adjust the objective and ocular until a sharp image of interference fringes is observed .
4. Centre observed rings at the midpoint of the visual field.
5. Record the diameter of several successive rings.
   i. with the adjusting knob move the microscopic stage until cross-hair line is tangent to a certain interference ring (numbered - k-).
   Record the stage position - a_{1k}
   ii. move the stage until cross-hair line is tangent to the opposite side of the same ring.
   Record the second position a_{2k}.
6. Repeat the measurement for at least 6 different rings.
7. Change the optical filter and repeat the procedure 3-6 with the new optical filter.
8. Complete the data sheet.

CALCULATIONS AND PRESENTATION OF RESULTS

1. For each filter separately calculate diameters - d_k of all observed interference rings from Eq.3.:

$$d_k = |a_{1k} - a_{2k}| \qquad (3)$$

2. From the eq.2. calculate series of wavelength values meeting the condition:

$$|k - l| > 1$$

radius value of the lens curvature should be receive from the laboratory directions
Complete the data sheet.

3. For each optical filter calculate the mean value of the wavelength - $\overline{\lambda}$. Record the corresponding optical filter colours.

ANALYSIS AND INTERPRETATION

1. Determine the accuracy of the - λ - measurement, i.e. :
   i. calculate the 95% confidence interval -$\Delta\lambda$ - use Student's distribution method with corresponding correction factor ***t*** (see part II - Lab. Data Analysis).
   ii. compare obtained results of λ with the filters data. Discuss the sources of errors.
2. Present the result in a form:

$$\lambda = \overline{\lambda} + \Delta\lambda$$

DATA TABLE

number of the ring ***k, l***	stage position ***a_1 [m]***	stage position ***a_2 [m]***	diameter of the ring ***d [m]***

REQUIREMENTS

1. Light interference conditions.
2. Forming the interference images in thin films (the air wedge., Newtonian rings).