Experiment 5

Newton's rings

Aim:
To determine the wavelength of sodium light by Newton's ring.

Apparatus Required:
A plano-convex lens of large radius of curvature, optical arrangement for Newton's rings, plane glass plate, sodium lamp and travelling microscope.

Theory:
The optical arrangement for Newton's ring is shown in fig.1. Light from a monochromatic source (sodium lamp) is allowed to fall on the convex lens through a broad slit which renders it into a nearly parallel beam. Now it falls on a glass plate inclined at an angle 45° to the vertical, thus the parallel beam is reflected from the lower surface. Due to the air film formed by a glass plate and a plano convex lens of large radius of curvature, interference fringes are formed which are observed directly through a travelling microscope. The rings are concentric circles.

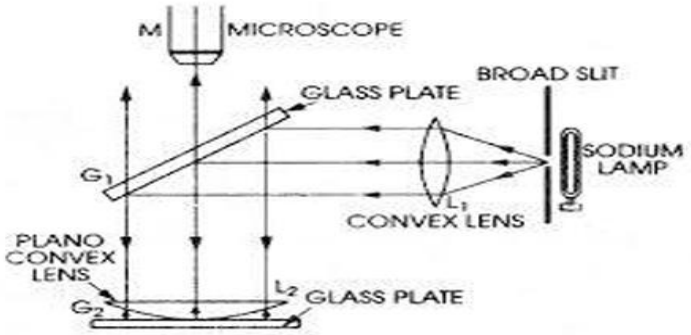


Figure 1

A ray AB incident normally on the system gets partially reflected at the bottom curved surface of the lens (Ray 1) and part of the transmitted ray is partially reflected (Ray 2) from the top surface of the plane glass plate. The rays 1 and 2 are derived from the same incident ray by division of amplitude and therefore are coherent. Ray 2 undergoes a phase change of p upon reflection since it is reflected from air-to-glass boundary.

The condition for constructive and destructive interferences are given as;

for normal incidence cos **r = 1** and for air film μ = **1.**

$$2t = (2m+1)\frac{\lambda}{2}$$ **constructive interference**

$$2t = m\lambda$$ **destructive interference**

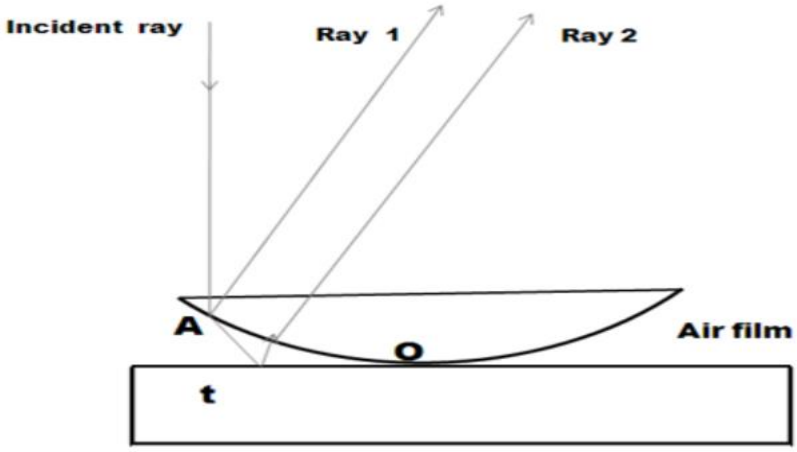


Figure.2

Central dark spot: At the point of contact of the lens with the glass plate the thickness of the air film is very small compared to the wavelength of light therefore the path difference introduced between the interfering waves is zero. Consequently, the interfering waves at the center are opposite in phase and interfere destructively. Thus, a dark spot is produced. **Circular fringes with equal thickness:** Each maximum or minimum are a locus of constant film thickness. Since the locus of points having the same thickness fall on a circle having its center at the point of contact, the fringes are circular. **Fringes are localized:** Though the system is illuminated with a parallel beam of light, the reflected rays are not parallel. They interfere nearer to the top surface of the air film and appear to diverge from there when viewed from the top. The fringes are seen near the upper surface of the film and hence are said to be localized in the film.

1. **Radii of the mth dark rings:** $r_m = \sqrt{m\lambda R}$.

2. **Radii of the mth bright ring:** $r_m = \sqrt{(2m+1)R\frac{\lambda}{2}}$

3. **The wavelength of monochromatic light can be determined** as,

$$\lambda = \frac{1}{4R}\frac{D^2{}_n}{n}$$

When R: a radius of curvature of the lens.

r: The radius of the fringe.

D_n: the diameter of the of the fringe(D=2r).

Procedure

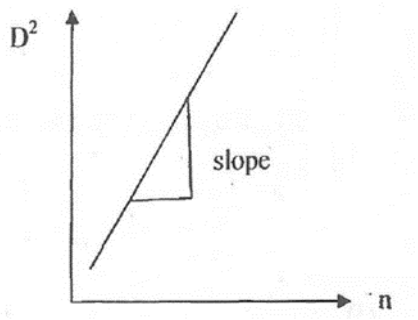
1. Arrange the instruments as shown in the adjacent figure. Clean durable surfaces with transparent paper, avoiding fingerprints.
2. Place the glass slide at a 45-degree angle to the horizon so that the light source is perpendicular to the lens.
3. Place the lens (focal length = 100 cm) below the objective lens of the moving head microscope. Using the microscope, adjust the focal lengths so that the circular dark apertures are visible.

4. The microscope hairs intersect at the center of the rings where n = 0, then the counting of dark lines (n = 1, 2, 3,…..) towards the right first, then towards the left second, and during this, the two readings (D_R) for the left are recorded.

Reading and majerment:

Table of Reading:

n	D_R	D_L	$D_n=D_R-D_L$	Dn^2
1				
2				
3				
4				
5				
6				



1. Draw the graph relation between (D^2_n) and (n) then find the slope.

2. Find the wave length (λ) of the used light which transmits from the laser by using the Eq, taking in your consideration that lens radius is (R= 12.141mm).

Question:

1-Why the fringes are circled and not parallel lines?

2- What will happen if a plane mirror is placed in place of a glass plate in Newton's rings experiment?

3-If white light is used in place of monochromatic light, how are Newton's rings affected?

4-Why is the center of circular fringes dark?