EXPERIMENT NO.1

NEWTON'S RINGS EXPERIMENT

OBJECT:
To determine the wavelength of Monochromatic (sodium) light by Newton's Ring Method.

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

FORMULA USED:
The wavelength (l) of monochromatic light source is given by

$$\lambda = \frac{D_{n+p}^2 - D_n^2}{4pR}$$

D_{n+p}	=	Diameter of the $(n+p)^{th}$ ring.
D_n	=	Diameter of the $(n)^{th}$ ring.
p	=	An integer number
R	=	Radius of curvature of the curved surface of the Plano-convex lens.

THEORY:
The Newton's rings are formed by interference between the rays of light reflected from the top and bottom surfaces of the air film formed between the bottom of the Plano-convex lens and the glass plate. The effective path difference between these interfering rays is given as

$$d = 2\mu\, t\, Cos\, r + \frac{\lambda}{2} \qquad (1)$$

Where μ is the refractive index of the air film (for air $\mu = 1$); t is thickness of the air film, r is the angle of reflectance and λ is the wavelength of the light.

In the interference pattern, the diameter of the n^{th} bright ring is given by

$$D^2{}_n = 2(2\,n-1)\,\lambda\, R \qquad (2)$$

Where, R is the radius of curvature of the Plano-convex lens. If D_{n+p} be the diameter of $(n+p)^{th}$ bright ring, then

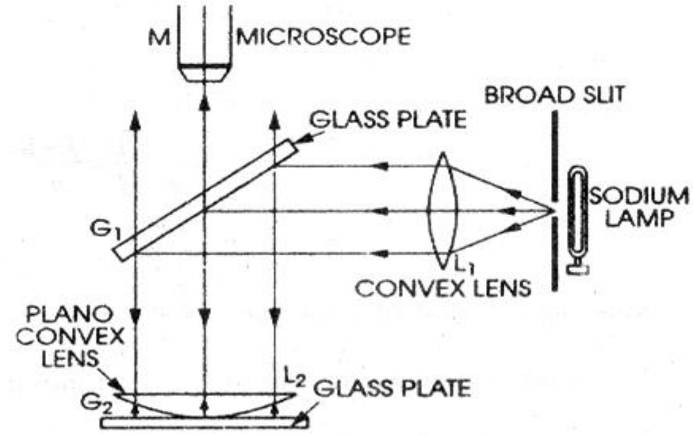

Figure.1 Experimental Arrangement of Newton's Rings Experiment

$$D^2_{n+p} \;=\; 2[2(n+p)-1]\lambda\, R$$

Subtracting equation (1) from (2), we get

$$D^2_{n+p} - D^2_{n} \;= 4p\lambda\, R$$

or

$$\lambda = \frac{D^2_{n+p} - D^2_n}{4pR}\ \mathrm{A}^0 \tag{3}$$

Equation (3) is used to determine the wavelength of monochromatic light.

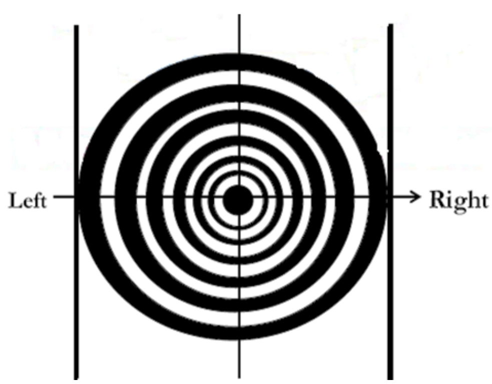

Figure.2 Movement of Cross wire

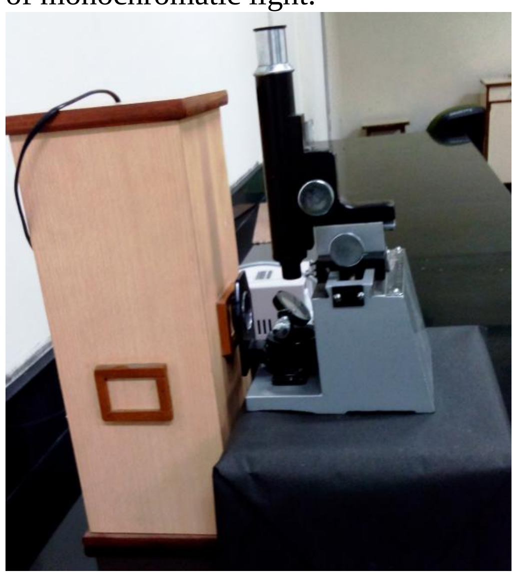

Figure.3. Experimental setup of Newton' Rings Experiment in the Lab

PROCEDURE:

1. Make the experimental arrangement as shown in figure (1) and allow the beam of light to pass through the convex lens L_1.

2. Adjust the partially silvered glass plate at 45^{o} so that beam of light gets reflected and falls normally on the Plano-convex lens.
3. Focus the microscope till sharp circular dark and bright rings are observed. If the rings are not in the field of view, adjust the microscope horizontally/vertically to view the rings .If the rings are not well illuminated, adjust the inclination of the glass plate.
4. According to the theory the centre of the ring should be dark but sometimes it appears white. This is due to the presence of the dust particles between the glass plate and Plano-convex lens .In this case the Plano-convex lens should be cleaned.
5. Bring the cross-wire at central ring and move it slowly towards left(or right) with the help of knob provided at right hand side of the base of the microscope till you reach at 25^{th} ring.
6. Rotate the knob in the opposite direction (right or left) and set the cross-wire tangential to the 20^{th} bright ring.
7. Take the reading of microscope on the main scale (M.S) and circular scale (C.S).
8. Similarly move further and take observations when the cross-wire is tangential to the 19^{th},18^{t},17^{th} ,……….,5^{th} ring.
9. Move the cross wire further along the same direction so that it becomes tangential to the 5^{th} bright ring on the other side of the central ring.
10. Take the observation up to 20^{th} bright ring.

OBSERVATIONS:

(1) Least count of the microscope = ……………………………..mm.
(2) Radius of curvature (R) of Plano- convex lens = ………….. mm.

No. of rings	**Microscope- reading on the**						$D_n = (a-b)$ **(mm)**	$D^2{}_n$ **(mm^2)**	$D^2{}_{n+p} - D^2{}_n$	**Mean** $D^2{}_{n+p} - D^2{}_n$	p
	Left hand side			**Right hand side**							
	M.S (mm)	**C.S**	**Total (mm) (a)**	**M.S (mm)**	**C.S**	**Total (mm) (b)**					
20											
19											
18											
17											
16											
15											
14											
…											
…											
5											

CALCULATIONS:

The wavelength of monochromatic light (Sodium lamp) is determined as

$$\lambda = \frac{D_{n+p}^2 - D_n^2}{4pR} = \text{………………..mm} = \text{………….. } A^0$$

RESULT:

(A) Standard result:
Wavelength of sodium light = 5893 A^0.

(B) Experimental result = -------- A^0.

(C) % Error = ----------------.

PRECAUTIONS:

1. The glass plate and lens should be cleaned.
2. The microscope eyepiece must be properly focused on its cross-wire.
3. Microscope should be given motion only along one-direction to avoid back-lash error.
4. The radius of curvature of the surface of the lens in contact with the glass plate should be measured accurately.
5. A lens of large radius of curvature should be used.

REFERENCES:

1. Optics by Brij Lal and Subramaniyam.
2. Optics by A.K.Ghatak

VIVA-VOCE

1. What do you understand by the interference of light?
2. What are essential conditions for obtaining interference of light?
3. What do you understand by coherent sources?
4. Is it possible to observe interference pattern by having two independent sources such as two candles?
5. Why should be two sources be monochromatic?
6. Why are the Newton's rings circular?
7. Why is central ring dark?
8. Where are these rings formed?
9. What will happen when a little water is introduced in between the Plano - convex lens and the plate?
10. How does the diameter of rings change on the introduction of liquid?