Newton’s Ring Experiment
Lecture 8

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Experimental arrangement of Newton's Ring Experiment:

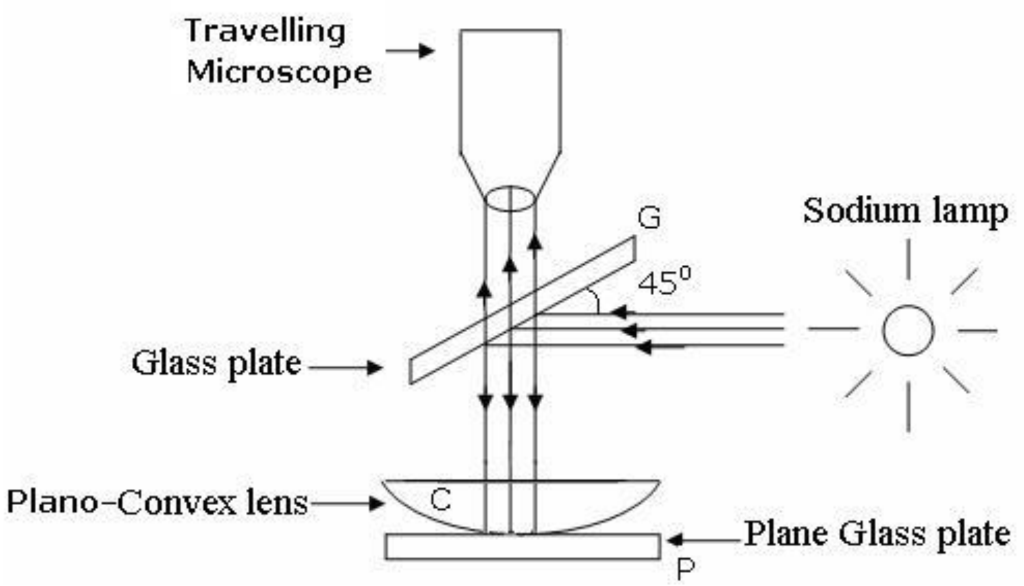

Fig 1

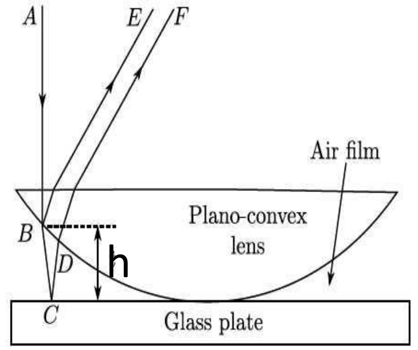

Figure 6.2: Schematic diagram of the light rays in Newton's ring

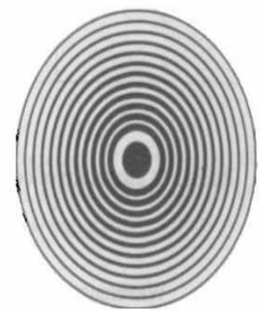

Figure 6.3: Newton's ring

Fig 2

Theory: In Newton's ring experiment the formation of rings are due to the superposition of the two waves, one reflecting from the upper surface of the thin film produced between the plano convex lens and plane glass plate and another reflecting from the lower surface of the film backed by denser glass medium.

So the path difference between these two reflecting waves is

$$2nh \pm \frac{\lambda}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where h is the thickness of the film at point B (fig2) and n refractive index of the film.

For constructive interference

$$2nh \pm \frac{\lambda}{2} = \text{even multiple of } \lambda/2$$

$$2nh = \text{odd multiple of } \lambda/2$$

$$= (2m+1)\,\lambda/2 \quad ....(2)$$

where m= 0,1,2,3,.........

Similarly for destructive interference

$$2nh = 2m\lambda/2 \quad ....(3)$$

$$= \text{even multiple of } \lambda/2$$

The loci of points of equal thickness h, will produce a circular fringe. If for mth order fringe the radius of the circular fringe ring is r_m and R be the radius of curvature of the lens then from geometry we can write

$$(R-h)^2 + r_m^2 = R^2$$

Since $R \gg h$, so we can write $\quad r_m{}^2 = 2Rh \quad ....(4)$

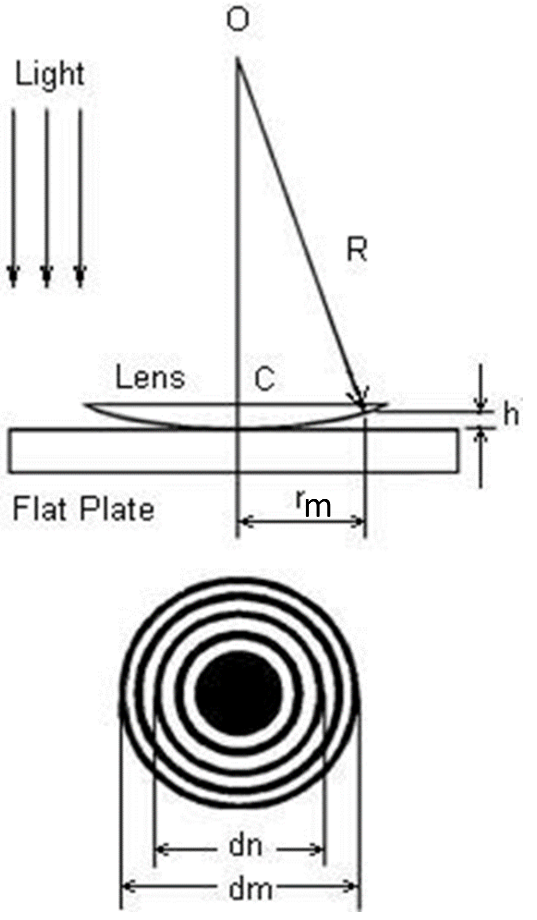

Fig 3

Now for constructive interference putting the value of equation (2) in (4)we get

$$r_m{}^2 = \frac{(2m+1)\lambda R}{2n} \quad \text{.....................................(5)}$$

Similarly for the mth dark fringe

$$r_m{}^2 = \frac{2m\lambda R}{2n} \quad \text{.....................................(6)}$$

Above equations show that the radii of the bright rings are proportional to square root of the odd natural numbers and that of the dark rings are proportional to square root of the natural numbers.

If D_m be the diameter of the mth bright ring then

$$Dm^2 = \frac{2(2m+1)\lambda R}{n} \quad \text{............... (7)} \quad [\therefore Dm^2 = (2r_m)^2]$$

For dark ring diameter

$$D_m{}^2 = \frac{4m\lambda R}{n} \quad \text{.......................(8)}$$

The difference of diameter of (m+1) th and mth order dark ring is

$$D_{m+1} - D_m = \sqrt{\frac{4\lambda R}{n}}\left[\sqrt{m+1} - \sqrt{m}\right]$$

This shows that as order number increases the difference of the diameter decreases so the rings gradually becomes narrower.

Fringe width: The separation between two successive bright or dark fringe is fringe width. For two successive dark rings we have

$$D_{m+1}^2 - D_m^2 = \frac{4\lambda R}{n}$$

$$D_{m+1} - D_m = \frac{4\lambda R}{n(D_{m+1}+D_m)}$$

As $D_{m+1}+D_m \approx 2D_m$, so fringe width

$$\beta = \frac{D_{m+1}-D_m}{2} = \frac{4\lambda R}{2n.2D_m}$$

$$\beta = \frac{\lambda R}{nD_m} \qquad \text{..(9)}$$

Thus fringe width decreases as the diameter increases.

At the point of contact of the lens and the glass plate h=0, so condition of destructive interference will be satisfied there for m=0 which shows that central fringe at the point of contact is dark.

THANK YOU