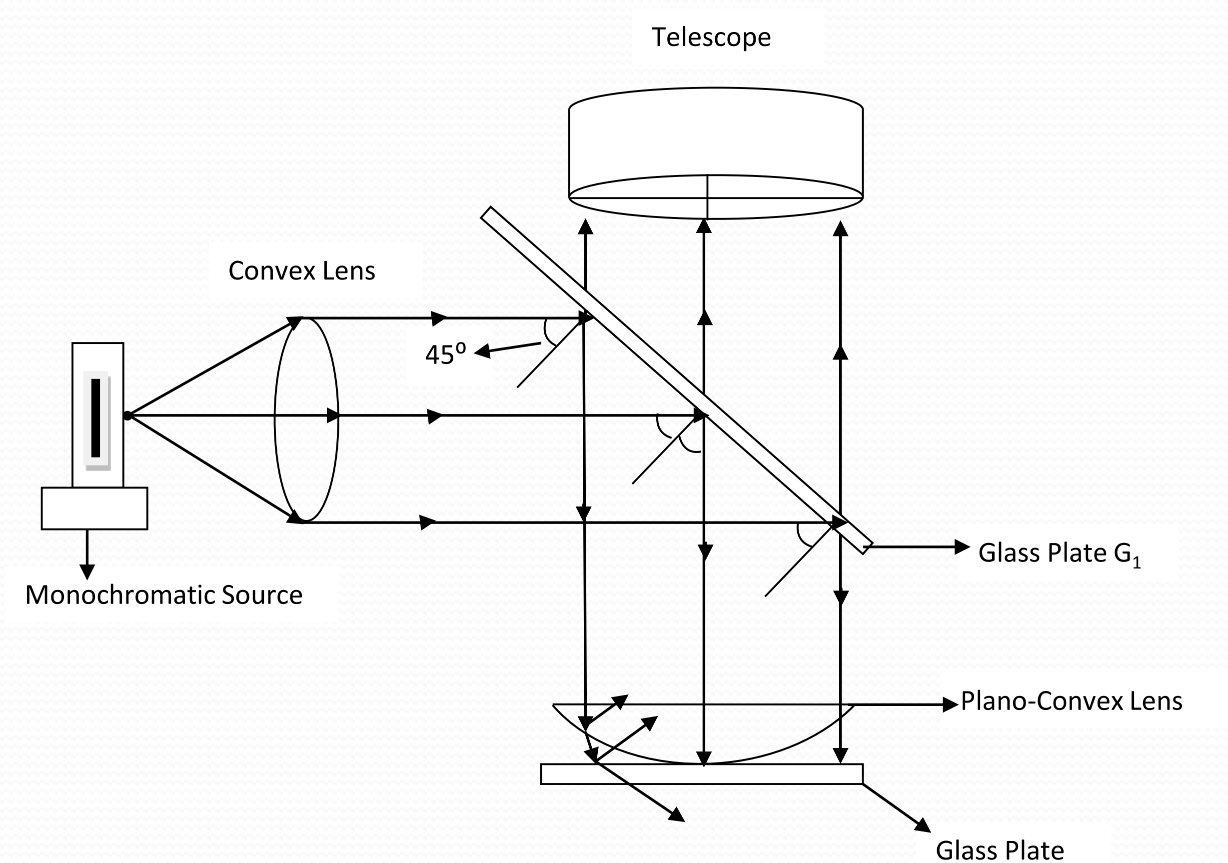
NEWTON'S RING

- Newton's ring in case of Reflected light.
- Newton's ring in case of Transmitted light.
- Condition for maxima.
- Condition for Minima.
- Diameter of dark and bright rings.
- Determination of wavelength of light.
- Determination of refractive index of a liquid.

When a Plano convex lens with its convex surface placed on a glass plate an air film of increasing thickness is formed between the Plano convex lens and glass plate. The thickness at the point of contact is zero.



If **S** be the source of monochromatic light. When light from the source (S) is allowed to fall on a convex lens, then it render's a parallel beam of light .This parallel beam of light is allowed to fall on plane glass plate. That is placed at an angle to the direction of incident beam of light. Then the glass plate reflects the incident beam of light normally towards the air film enclosed between the Plano convex lens and the glass plate.

First of all this light is allowed to fall on a plane surface of Plano convex lens. Then a part of this light is reflected and a part of light is transmitted, then this transmitted light is allowed to fall on a curve surface of Plano convex lens .Then a part of this transmitted light is reflected and comes out in the form of ray no. 1 and a part of light is transmitted, after that this transmitted light is allowed to fall on a plane glass late then a part of light is reflected and comes out in the form of ray no. 2 and a part of light is transmitted and comes out in the form of ray no. 3.

Thus at a particular constant thickness interference take place due to the reflected ray no. 1 and 2.

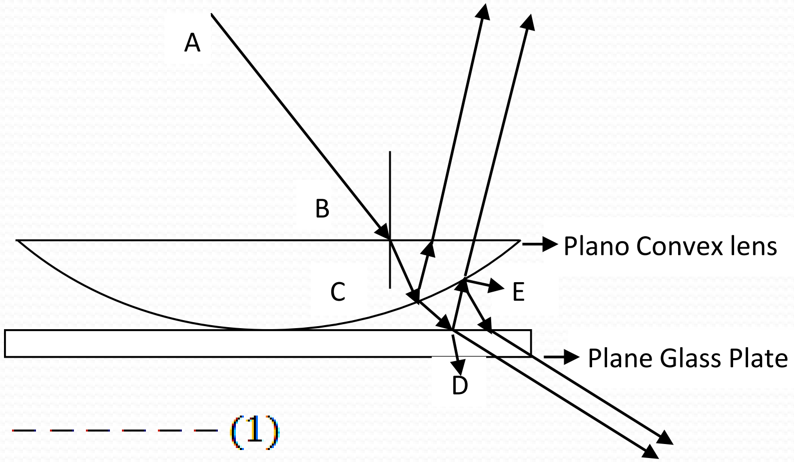
Due to convexity of the Plano convex lens and at the particular constant thickness the radii or foci are constant so that the interference pattern is take place in the form of concentric ring.

Diameter of ring in case of reflected light:-

When a Plano convex lens placed on a glass plate then air film of increasing thickness is formed between both of them. But at the point of contact thickness of air film is zero. Let us suppose that a beam of monochromatic light (AB) is allowed to fall in the plane surface of a Plano convex then a part of this light is refracted along BC, when this refracted beam is allowed to fall on the curve surface of a Plano convex lens at a point **C**. Then a part of this BC ray will be reflected and comes out in form of ray no.**1** and a part of this **BC** ray will be transmitted along **CD**. Then transmitted light is allowed to fall on the plane glass plate. Then a part of **CD** will be reflected and comes out in the form of ray no.**2** and a part of ray will transmitted and comes out in the form of ray no.**3**

When these two reflected ray no. **1** and **2** are superimpose on each other then interference take place in the form of concentric ring.

Thus interference pattern is either dark or bright depend upon path difference between the two reflected rays. Thus the path difference between two reflected ray will be:-



$$2\mu t\cos(r+\alpha)+\frac{\lambda}{2}\text{-----------------}(1)$$

But in our experiment rays are incident normally thus for normal incidence

$Angle\ of\ refraction\ (r)=0\quad For\ air\ film\ (\mu)=1\quad if\ wedge\ is\ small\ then\ angle\ \alpha=small$

$then\ the\ value\ of\ (r+\alpha)\ almost\ zero\quad if\ (r+\alpha)=0\ then\quad cos\ (r+\alpha)=\cos 0=1$

$Putting\ value\ of\ \cos(r+\alpha)=1\ \ Putting\ value\ of\ \cos(r+\alpha)=1$

$then\ the\ path\ difference\ between\ both\ of\ the\ reflected\ ray\ will\ be:-$

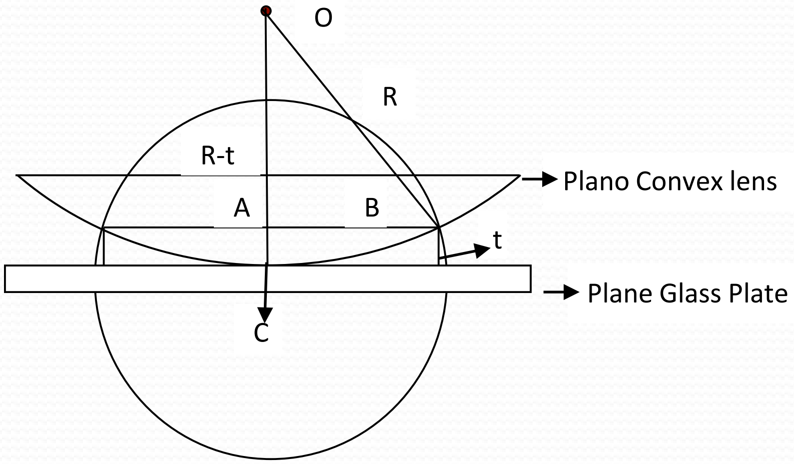
$$2t+\frac{\lambda}{2}\text{-----------------------}(2)$$

But at the point of contact thickness of air film is zero so that when **t=0** then path difference between the two reflected ray is which is condition of the minima so' that at the point of contact in case of reflected light interference pattern will be dark.

Diameter of dark or bright ring

A

Plano convex lens that is a part of sphere whose radius of curvature **(R)** placed on a glass plate then air film of increasing thickness is formed between both of them. So at particular constant thickness **(t)** interference take place in the form of concentric ring. And suppose that is n^{th} ring whose radius is r_n. And $\mathbf{n^{th}}$ ring will appear dark or bright depend upon path difference between the two reflected rays that is



Now consider right triangle **OAB** in this triangle

$OC = R, OA = (R - t)$ because $AC = t, AB = r_n$

Applying Pythagoras theorem in this triangle

$OB^2 = OA^2 + AB^2 \quad R^2 = (R-t)^2 + r_n^2 \quad => R^2 = R^2 + t^2 - 2Rt + r_n^2$

$=> 0 = t^2 - 2Rt + r_n^2$ ------------------ (2)

In the Fig $(AC = t)$ *which is very small as compared to* $(OC = R)$ *or* $(AB = r_n)$

So that t^2 *in eq.* (2) *can be neglated then we get* $0 = -2Rt + r_n^2$

$$=> r_n^2 = 2Rt \quad => t = \frac{r_n^2}{2R} - - - - - - - - - - - - - - -(3)$$

Putting value of (t) in Eq.(1) we get

$$\frac{r_n^2}{R} + \frac{\lambda}{2} -(4)$$

This is path difference between the reflected ray (1) and (2)

So that nth ring will appear bright only when path difference $= n\lambda$

$$\frac{r_n^2}{R} + \frac{\lambda}{2} = n\lambda - - - - - - - - - - - - - - - (5)$$

And n^{th} *ring will appear dark only when path difference* $= \frac{(2n+1)\lambda}{2}$

$$\frac{r_n^2}{R} + \frac{\lambda}{2} = \frac{(2n+1)\lambda}{2} - - - - - - - - - - - - - - - - - - (6)$$

Now n^{th} *ring will appear bright only when*

$$\frac{r_n^2}{R} + \frac{\lambda}{2} = n\lambda \qquad \frac{r_n^2}{R} = n\lambda - \frac{\lambda}{2} \qquad \frac{r_n^2}{R} = \frac{(2n-1)\lambda}{2} \qquad r_n^2 = \frac{(2n-1)\lambda R}{2} - - - - - - - - (7)$$

Where r_n *is the radius of* n^{th} *ring So diameter of* n^{th} *ring bright ring will be* $D_n = 2\,r_n$

$=> r_n = \frac{D_n}{2}$ *Putting value of* r_n *in Eq (7)* $\frac{D_n^2}{4} = \frac{(2n-1)\lambda R}{2}$

$$D_n^2 = 2(2n-1)\lambda R \qquad D_n = \sqrt{(2(2n-1)\lambda R}$$

Thus diameter of n^{th} bright ring comes out to be $D_n = \sqrt{(2(2n-1)\lambda R}$

$Now\ n^{th} ring\ will\ appear\ bright\ only\ when$ $\frac{r_n^2}{R} + \frac{\lambda}{2} = \frac{(2n+1)\lambda}{2}$

$\frac{r_n^2}{R} = \frac{(2n+1)\lambda}{2} - \frac{\lambda}{2}$ $\frac{r_n^2}{R} = n\lambda$ $r_n^2 = n\lambda R - - - - - - - - (7)$

$Where\ r_n\ is\ the\ radius\ of\ n^{th}\ ring.$ $So\ diameter\ of\ n^{th}\ ring\ dark\ ring\ will\ be\ D_n = 2\,r_n$

$=> r_n = \frac{D_n}{2}$ $Putting\ value\ of\ r_n\ in\ Eq\ (7)$

$$\frac{D_n^2}{4} = n\lambda R$$

$$D_n^2 = 4n\lambda R$$

Thus diameter of n^{th} dark ring comes out to be

$$D_n = \sqrt{4n\lambda R}$$