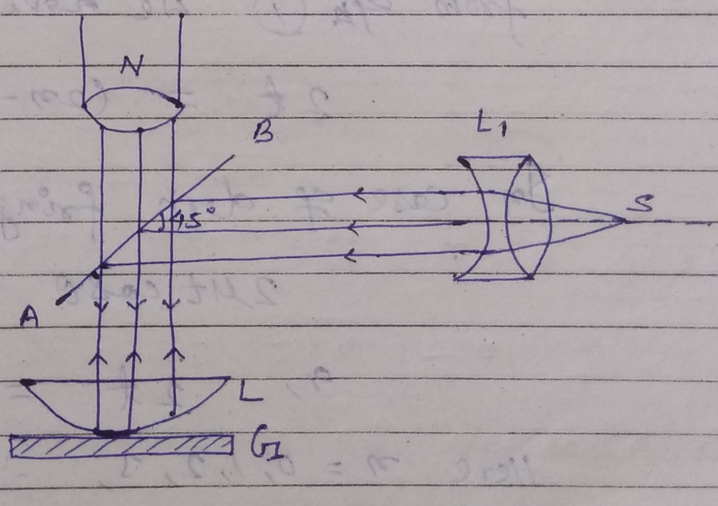
Newton's rings:

Whenever a plano-convex lens of large focal length is kept on a plane glass plate, a thin film of air is enclosed between the lower surface of the air film is very small at the point of touch and gradually increases from the centre outwards. The fringes produced with monochromatic light are circular in shape. The fringes are concentric circles, uniform in thickness and with the point of contact as the centre. When it is observed with white light, the fringes are coloured; with monochromatic light, bright and dark circular fringes are produced in the air film. The arrangement for obtaining Newton's ring has been shown in fig.



In above fig: S = monochromatic light Source kept at the focus of lens.

L_1 = Lens

B = glass plate inclined at 45°.

L = Plano convex lens of large focal length.

G_1 = Plane glass Plate.

Theory of Newton's Ring : (By reflected Light)

Let us consider the radius of curvature of the lens is 'R' and the air film of thickness t is at a distance 'r' from the point of contact. We are considering the case in which interference is taking place to reflected light so for bright ring.

$$2\mu t \cos\theta = (2n-1)\frac{\lambda}{2} \quad \text{--- (1)}$$

Here $n = 1, 2, 3, \ldots$ etc.

Here θ is very small $\therefore \cos\theta = 1$

and for air $\mu = 1$

from eqn (1) we have

$$2t = (2n-1)\frac{\lambda}{2} \quad \text{--- (2)}$$

In case of dark fringe or ring

$$2\mu t \cos\theta = n\lambda$$

$$(\because \cos\theta = 1, \mu = 1)$$

or, $$2t = n\lambda \quad \text{---- (3)}$$

Here $n = 0, 1, 2, 3, \ldots$

As we know that $t = \frac{r^2}{2R}$

Putting the value of 't' in eqn (2) & (3) we get:

$$r^2 = \frac{(2n-1)\lambda R}{2} \quad \text{— (4)}$$

$$\therefore r = \sqrt{\frac{(2n-1)\lambda R}{2}} \quad \text{---} \quad (5)$$

For dark ~~fring~~ rings

$$r = \sqrt{n\lambda R} \quad \text{———} \quad (6)$$

If $n=0$, then the radius of the dark ring is zero and the radius of bright ring is $\sqrt{\frac{\lambda R}{2}}$.
So, centre is dark. Alternately dark and bright rings are produced.

The radius of dark ring is proportional to $\sqrt{n}$, $\sqrt{\lambda}$ & $\sqrt{R}$.

Similarly, radius of the bright rings is proportional to $\sqrt{\frac{2n-1}{2}}$, $\sqrt{\lambda}$ & $\sqrt{R}$.

Let diameter of the dark ring,

$$D = 2r = 2\sqrt{n\lambda R} \quad \text{---} \quad (7)$$

for the central dark ring $n=0$

$$\therefore D = 2\sqrt{2\lambda R} = 0$$

It corresponds to the centre of Newton's Rings.

For dark ring (first ring),

$n = 1$

$$\therefore D_1 = 2\sqrt{\lambda R}$$

for nth dark ring $D_n = 2\sqrt{n\lambda R}$.

The fringe width decreases with the order of the fringe and the fringes get closer with increase in their order.

For bright rings

$$r_n = \sqrt{\frac{(2n-1)R\lambda}{2}}$$

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