Conditions for Sustained Interference of Light waves

To obtain sustained (well-defined & observable) interference pattern the intensity must be maximum at points corresponding to constructive interference & zero at points of destructive interference.

For this purpose following conditions must be satisfied

1. The two interfering sources must have same frequency & they must be coherent {initial phase should remain constant}

2. The interfering wave must have equal amplitude.

3. The two interfering waves must be propogated along the same line.

4. The separation between the two sources must be as small as possible.

   otherwise, fringes of maximum and minimum intensity will lie so close together that, will not be separately visible.

5. The two sources must be narrow.

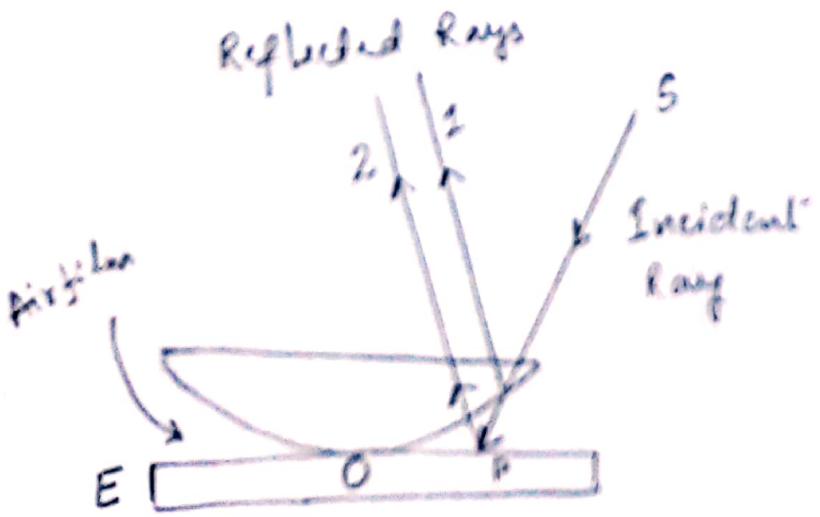
6. The interfering waves must be in same state of polarisation, if polarised.

Newton's Rings

The phenomenon of Newton's Rings is a special case of interference in an air film of variable thickness.

When a plano-convex lens of large focal length is placed in contact with plane glass plate, air film is developed between the lower surface of the lens and the upper surface of the plate. The thickness of film is very small at the centre (at pt. of contact). When monochromatic light falls normally on such film, we get alternately bright and dark circular rings when seen by reflected light.

The interference fringes or rings of equal thickness so formed were first discovered by Newton & hence are called as Newton's Rings



Newton's Rings are produced as a result of interference between the light waves reflected from the upper & lower surface of the air film.

In fig (1), '1' and '2' are the reflected interfering rays corresponding to an incident ray SP.

The effective path diff.^{n} between the interfering rays in reflected light is given as

$$\text{path diff} = 2\mu t \cos(r+\theta) - \lambda/2$$

where $\mu \rightarrow$ Refractive index of the film (air),

$t \rightarrow$ is thickness of film at point P

$r \rightarrow$ angle of refraction inside the film

$\theta \rightarrow$ angle of wedge.

Here $r = 0$ (for normal incidence)

θ is very small, so that $\cos(r+\theta) = \cos\theta = 1$,

$\therefore$ the effective path difference, is,

$$\boxed{\Delta = 2\mu t - \lambda/2}$$

(a) At the point of contact 'O' of lens and plate,

$t = 0$, $\therefore$ $\Delta = \lambda/2$.

This is the condition for minimum intensity.

Hence the central spot of the ring is dark

(b) The condition of Maximum Intensity [Bright Ring]

i.e. path difference should be even multiple of $\lambda/2$

$$\therefore \quad 2\mu t - \lambda/2 = 2m \cdot \lambda/2 \qquad m = 0, 1, 2, \cdots$$

$$2\mu t = (2m+1)\,\lambda/2 \qquad m = 0, 1, 2, 3, \cdots$$

(c) Condition of minimum Intensity (dark Ring)

i.e path difference should be odd multiple of $\lambda/2$

$$\therefore \quad 2\mu t - \lambda/2 = (2n-1)\lambda/2 \qquad n = 1, 2, 3, \ldots \text{etc.}$$

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

Newton's Rings are the circular rings having the common centre at the point of contact.