

WAVE OPTICS

WAVE FRONT

- Wave front is a locus of particles having same phase.
- Direction of propagation of wave is perpendicular to wave front.
- Every particle of a wave front acts as a new source and is known as secondary wavelet.

Coherent source

If the phase difference due to two source at a particle point remains constant with time, then the two sources are considered as coherent source

INTERFERENCE

$$A_{\text{net}}^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$$

$$I_{\text{net}} = I_1 + I_2 + 2\sqrt{I_1I_2}\cos\phi$$

For constructive interference

$$I_{\text{net}} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$$

For destructive interference

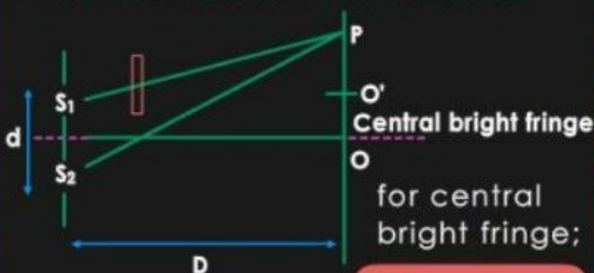
$$I_{\text{net}} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$$

FRINGE WIDTH

It is the distance between two maxima of successive order on one side of the central maxima. This is also equal to the distance between two successive minima.

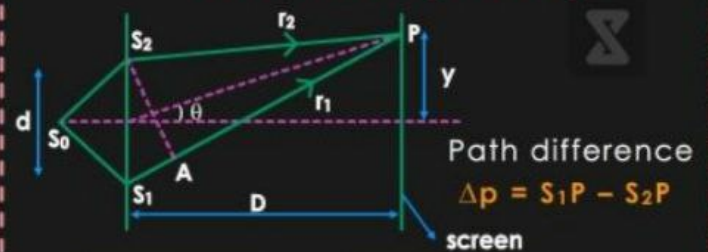
$$\beta = \frac{\lambda D}{d}$$

DISPLACEMENT OF FRINGE



$$\Rightarrow \frac{y d}{D} = t(\mu - 1)$$

YOUNG'S DOUBLE SLIT EXPERIMENT (Y.D.S.E)



$$\sqrt{\left(y + \frac{d}{2}\right)^2 + D^2} - \sqrt{\left(y - \frac{d}{2}\right)^2 + D^2} \quad \dots(1)$$

Approximation I :

For $D \gg d$, We can approximate rays \vec{r}_1 and \vec{r}_2 as being approximately parallel, at angle θ to the principle axis.

$$\text{Now, } S_1P - S_2P = S_1A = S_1S_2 \sin\theta$$

$$\Rightarrow \text{Path difference} = d \sin\theta \quad \dots(2)$$

Approximation II :

Further if θ is small, i.e.

$$y \ll D, \sin\theta \approx \tan\theta = \frac{y}{D}$$

$$\text{and hence, path difference} = \frac{dy}{D} \quad \dots(3)$$

for maxima

$$\Delta p = \frac{dy}{D} = n\lambda$$

for minima

$$\Delta p = \pm \frac{\lambda}{2}, \pm \frac{3\lambda}{2}, \pm \frac{5\lambda}{2}$$