

WAVE OPTICS

Interference of waves of intensity I_1 and I_2 :

resultant intensity, $I = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos(\Delta\phi)$ where, $\Delta\phi =$ phase difference.

For Constructive Interference :

$$I_{\max} = (\sqrt{I_1} + \sqrt{I_2})^2$$

For Destructive interference :

$$I_{\min} = (\sqrt{I_1} - \sqrt{I_2})^2$$

If sources are incoherent

$$I = I_1 + I_2, \text{ at each point.}$$

YDSE :

Path difference, $\Delta p = S_2P - S_1P = d \sin \theta$

if $d \ll D \quad = \frac{dy}{D}$

if $y \ll D$

for maxima,

$$\Delta p = n\lambda \quad \Rightarrow \quad y = n\beta \quad n = 0, \pm 1, \pm 2, \dots$$

for minima

$$\Delta p = \begin{cases} (2n-1)\frac{\lambda}{2} & n = 1, 2, 3, \dots \\ (2n+1)\frac{\lambda}{2} & n = -1, -2, -3, \dots \end{cases}$$

$$\Rightarrow y = \begin{cases} (2n-1)\frac{\beta}{2} & n = 1, 2, 3, \dots \\ (2n+1)\frac{\beta}{2} & n = -1, -2, -3, \dots \end{cases}$$

where, fringe width $\beta = \frac{\lambda D}{d}$

Here, $\lambda =$ wavelength in medium.

Highest order maxima :

$$n_{\max} = \left[\frac{d}{\lambda} \right]$$

total number of maxima = $2n_{\max} + 1$

Highest order minima :

$$n_{\max} = \left[\frac{d}{\lambda} + \frac{1}{2} \right]$$

total number of minima = $2n_{\max}$.

Intensity on screen : $I = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos(\Delta\phi)$ where, $\Delta\phi = \frac{2\pi}{\lambda} \Delta p$

If $I_1 = I_2, I = 4I_1 \cos^2\left(\frac{\Delta\phi}{2}\right)$

YDSE with two wavelengths λ_1 & λ_2 :

The nearest point to central maxima where the bright fringes coincide:

$$y = n_1\beta_1 = n_2\beta_2 = \text{Lcm of } \beta_1 \text{ and } \beta_2$$

The nearest point to central maxima where the two dark fringes coincide,

$$y = (n_1 - \frac{1}{2})\beta_1 = (n_2 - \frac{1}{2})\beta_2$$

Optical path difference

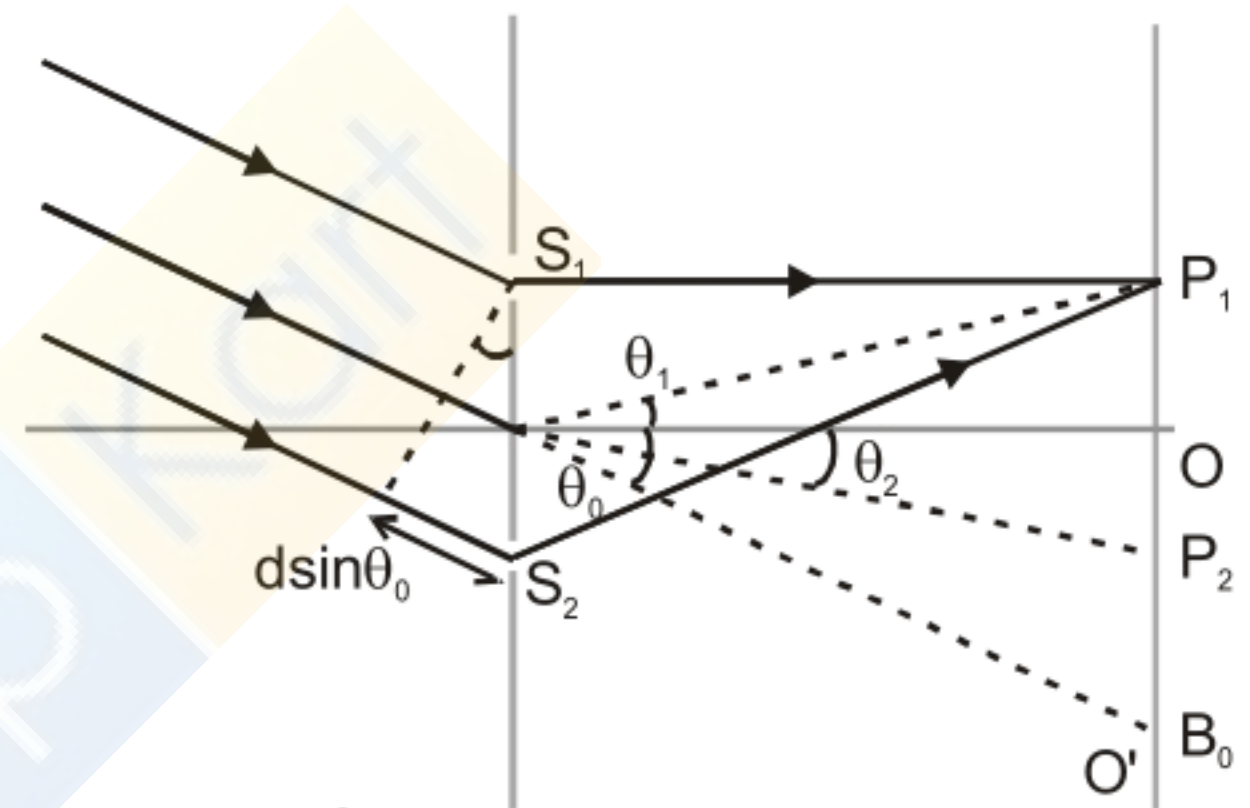
$$\Delta p_{\text{opt}} = \mu \Delta p$$

$$\Delta \phi = \frac{2\pi}{\lambda} \Delta p = \frac{2\pi}{\lambda_{\text{vacuum}}} \Delta p_{\text{opt.}}$$

$$\Delta = (\mu - 1) t. \frac{D}{d} = (\mu - 1) t \frac{B}{\lambda}.$$

YDSE WITH OBLIQUE INCIDENCE

In YDSE, ray is incident on the slit at an inclination of θ_0 to the axis of symmetry of the experimental set-up



We obtain central maxima at a point where, $\Delta p = 0$.

$$\text{or } \theta_2 = \theta_0.$$

This corresponds to the point O' in the diagram.

Hence we have path difference.

$$\Delta p = \begin{cases} d(\sin \theta_0 + \sin \theta) & \text{for points above } O \\ d(\sin \theta_0 - \sin \theta) & \text{for points between } O \text{ \& } O' \\ d(\sin \theta - \sin \theta_0) & \text{for points below } O' \end{cases} \dots (8.1)$$

THIN-FILM INTERFERENCE

for interference in reflected light $2\mu d$

$$= \begin{cases} n\lambda & \text{for destructive interference} \\ (n + \frac{1}{2})\lambda & \text{for constructive interference} \end{cases}$$

for interference in transmitted light $2\mu d$

$$= \begin{cases} n\lambda & \text{for constructive interference} \\ (n + \frac{1}{2})\lambda & \text{for destructive interference} \end{cases}$$

Polarisation

- $\mu = \tan \theta_p$.(brewster's angle)
 $\theta_p + \theta_r = 90^\circ$ (reflected and refracted rays are mutually perpendicular.)
- **Law of Malus.**
 $I = I_0 \cos^2 \theta$
 $I = KA^2 \cos^2 \theta$
- **Optical activity**

$$[\alpha]_{t,c}^{\lambda} = \frac{\theta}{L \times C}$$

θ = rotation in length L at concentration C.

Diffraction

- $a \sin \theta = (2m + 1) \lambda / 2$ for maxima. where $m = 1, 2, 3, \dots$
- $\sin \theta = \frac{m\lambda}{a}$, $m = \pm 1, \pm 2, \pm 3, \dots$ for minima.
- Linear width of central maxima = $\frac{2d\lambda}{a}$
- Angular width of central maxima = $\frac{2\lambda}{a}$
- $I = I_0 \left[\frac{\sin \beta / 2}{\beta / 2} \right]^2$ where $\beta = \frac{\pi a \sin \theta}{\lambda}$
- Resolving power .

$$R = \frac{\lambda}{\lambda_2 - \lambda_1} = \frac{\lambda}{\Delta\lambda}$$

where, $\lambda = \frac{\lambda_1 + \lambda_2}{2}$, $\Delta\lambda = \lambda_2 - \lambda_1$