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

For Destructive interference : $I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$

If sources are incoherent $I = I_1 + I_2$, at each point.

YDSE :

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

if $d << D$ $= \dfrac{dy}{D}$

if $y << D$

for maxima,

$\Delta p = n\lambda \Rightarrow y = n\beta$ $n = 0, \pm1, \pm2$ ....

for minima

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

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

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

Here, λ = wavelength in medium.

Highest order maxima : $n_{max} = \left[\dfrac{d}{\lambda}\right]$

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

Highest order minima : $n_{max} = \left[\dfrac{d}{\lambda} + \dfrac{1}{2}\right]$

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

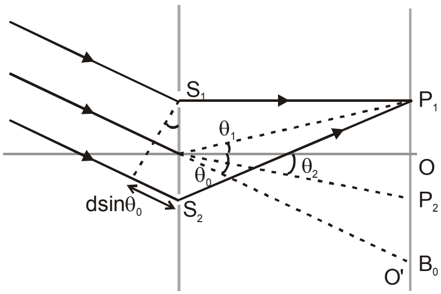
$$\Delta p_{opt} = \mu\Delta p$$

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

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

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, $\Delta p = 0$.

or $\theta_2 = \theta_0$.

This corresponds to the point O' in the diagram.

Hence we have path difference.

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

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

- μ = tan .(brewster's angle)

  $\theta\rho$ + θ_r = 90°(reflected and refracted rays are mutually perpendicular.)

- **Law of Malus.**

  $I = I_0 \cos^2$

  $I = KA^2 \cos^2$

- **Optical activity**

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

  θ = rotation in length L at concentration C.

Diffraction

- a sin θ = (2m + 1) /2 for maxima. where m = 1, 2, 3 ......

- $\sin\theta = \frac{m\lambda}{a}$, m = $\pm$ 1, $\pm$ 2, $\pm$ 3......... for minima.

- Linear width of central maxima = $\frac{2d\lambda}{a}$

- Angular width of central maxima = $\frac{2\lambda}{a}$

- $$I = I_0\left[\frac{\sin\beta/2}{\beta/2}\right]^2 \quad \text{where } \beta = \frac{\pi a \sin\theta}{\lambda}$$

- Resolving power .

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

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