Date 8/10/22

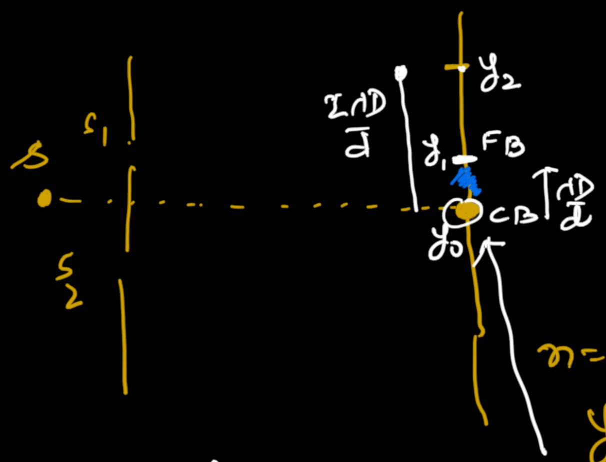
Physics

$$\frac{yd}{D} = n\lambda \quad \text{Maxima}$$

$$\frac{yd}{D} = (2n-1)\lambda/2 \quad \text{Minima}$$

Maxima

$$y = \frac{n\lambda D}{d}$$
→ position



$n=0$

$y_0 = 0$

$n=1$

$$y_1 = \frac{\lambda D}{d}$$

$n=2$

$$y_2 = \frac{2\lambda D}{d}$$

Position of Dark fringes

$$\frac{yd}{D} = (2n-1)\lambda/2$$

$$y = \frac{(2n-1)\lambda D}{2d}$$

$n=1$

$$y_1 = \frac{(2\times1-1)\lambda D}{2d}$$

$$y_1 = \frac{\lambda D}{2d}$$

Fringe width

Separation between two consecutive bright or dark fringe is known as fringe width.

$$\frac{yd}{D} = n\lambda \qquad y_n = \frac{n\lambda D}{d}$$

$$y_{n+1} = \frac{(n+1)\lambda D}{d}$$

$$\beta = y_{n+1} - y_n$$

$$= \frac{(n+1)\lambda D}{d} - \frac{n\lambda D}{d} = \frac{\lambda D}{d} ✓$$

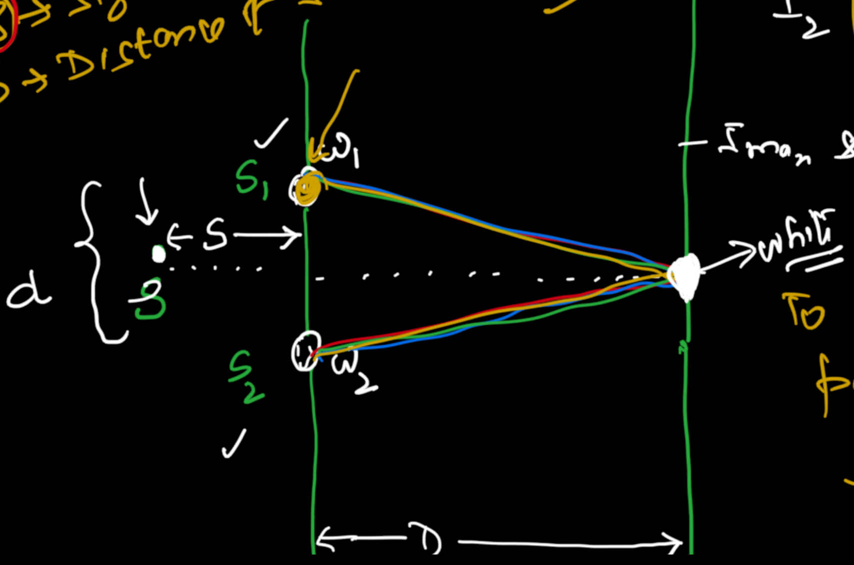
$\beta \rightarrow$ Fringe width.

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

$\frac{\beta}{D} \rightarrow$ Angular fringe width.

$\delta \rightarrow$ size of source

$S \rightarrow$ Distance of source from double slit.



$$\frac{I_1}{I_2} = \frac{\omega_1}{\omega_2} = \frac{a_1^2}{a_2^2}$$

I_{max} & I_{min}

$$\frac{I_{max}}{I_{min}} = \frac{(a_1+a_2)^2}{(a_1-a_2)^2}$$

To realize good Interference pattern on screen

$$\frac{\delta}{S} < \frac{\lambda}{d}$$

| Screen.

VEBGYOR

Prove that interference pattern follow energy conservation principle.

$I_{max} = (a_1 + a_2)^2$

$I_{min} = (a_1 - a_2)^2$

$I_{avg} = \frac{I_{max} + I_{min}}{2}$

$= \frac{(a_1 + a_2)^2 + (a_1 - a_2)^2}{2}$

$I_{avg.} = a_1^2 + a_2^2$

$I = I_1 + I_2$ Algebric

$= a_1^2 + a_2^2$

why $a_1 \simeq a_2$ to realize good interference pattern on screen?

let $a_1 = 49a$

$a_2 = a$

$I_{max} = (49a + a)^2 = 50^2 a^2$

$I_{min} = (49a - a)^2 = 48^2 a^2$

$\frac{I_{max}}{I_{m}} = \frac{50^2}{48^2}$

let

Case II $a_1 = a$ $a_2 = a$

$I_{max} = (a+a)^2 = 4a^2$

$I_{min} = (a-a)^2 = 0$

v.v.imp

why coherent sources are required to realize interference pattern?

$y_1 = a \cos \omega t$ — (i)

$y_2 = a \cos(\omega t + \phi)$ — (ii) $\longrightarrow$ $I_0 = ka^2$, $I_0 = ka^2$

$I \propto a^2$

Total algebraic sum

$2ka^2 = 2I_0$

Now we will go ahead with vector addition.

$\vec{y} = \vec{y_1} + \vec{y_2}$

$= a \cos \omega t + a \cos(\omega t + \phi)$

$\cos C + \cos D = 2 \cos \frac{C+D}{2} \cos \frac{C-D}{2}$

$y = 2a \cos \frac{\omega t + \omega t + \phi}{2} \cos \frac{(\omega t - \omega t - \phi)}{2}$

$y = 2a \cos(\omega t + \phi/2) \cos \frac{\phi}{2}$

$\cos(-\theta) = \cos \theta$

$y = 2a \cos \frac{\phi}{2} \cos(\omega t + \phi/2)$

$y = A \cos(\omega t + \theta)$

Resultant amplitude

$I \propto A^2$ $\quad$ $I \propto \left(2a \cos \phi/2\right)^2$

$I_R = k \times 4a^2 \cos^2 \phi/2$

$I_R = 4 I_0 \cos^2 \phi/2$

Ans

$I = 4I_0 \times \frac{1}{2} = 2I_0$ ✓✓

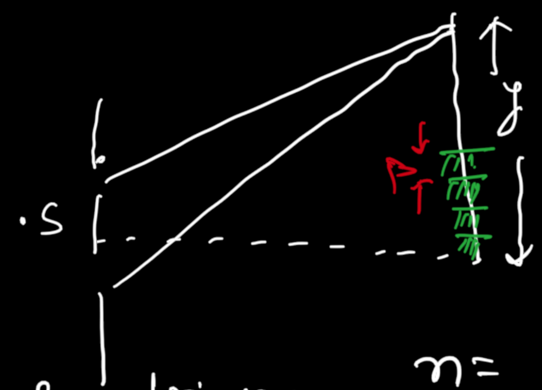
$\langle \cos^2 \frac{\phi}{2} \rangle = 1/2$

Condition for coinciding of the fringes:

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

$\beta \propto \lambda$

VIBGYOR



Number of fringes $n = \frac{\text{Total space } (y)}{\beta}$

bigger n

smaller wavelength $(n+1)$

$n\beta_L = (n+1)\beta_S$

$n \frac{\lambda_L \cancel{D}}{\cancel{d}} = (n+1)\frac{\lambda_S \cancel{D}}{\cancel{d}}$

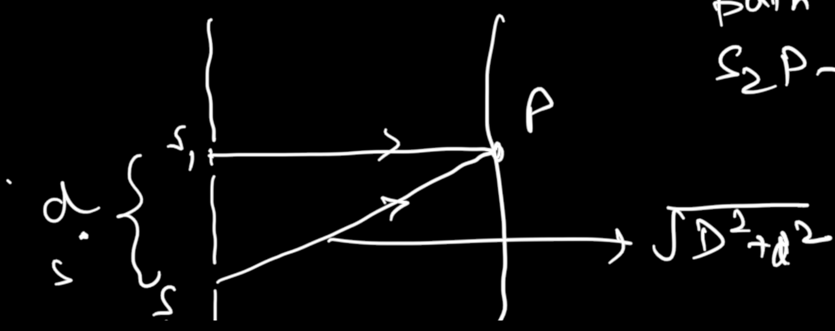
$\boxed{n\lambda_L = (n+1)\lambda_S}$

Q. Missing fringe just opposite to the slit.

Condition.

Path difference

$S_2P - S_1P$



$2 \;|\leftarrow D \longrightarrow|$ $\quad \sqrt{D^2+d^2} - D = \Delta x = (2n-1)\frac{\lambda}{2}$

$$(D^2+d^2)^{1/2} - D = (2n-1)\lambda/2$$

$$D\left\{1+\frac{d^2}{D^2}\right\}^{1/2} - D = (2n-1)\lambda/2$$

$$D\left\{1+\frac{1}{2}\frac{d^2}{D^2}\right\} - D = (2n-1)\frac{\lambda}{2}$$

$$\cancel{D} + \frac{1}{2}\frac{d^2}{D^{\cancel{2}}}\times\cancel{D} - \cancel{D} = (2n-1)\lambda/2$$

$$\frac{1}{\cancel{2}}\frac{d^2}{D} = (2n-1)\frac{\lambda}{\cancel{2}}$$

$$\boxed{\lambda = \frac{d^2}{D(2n-1)}}$$

What will happen to the fringe width if entire apparatus is immersed in liquid of refractive index μ.

$$\beta = \frac{\lambda_a D}{d} \qquad \beta' = \frac{\lambda'_m D}{d}$$

$$\beta/\beta' = \frac{\lambda_a}{\lambda'_m} = \mu$$

$$\boxed{\beta' = \frac{\beta}{u}}$$