THEORY OF INTERFERENCE FRINGES

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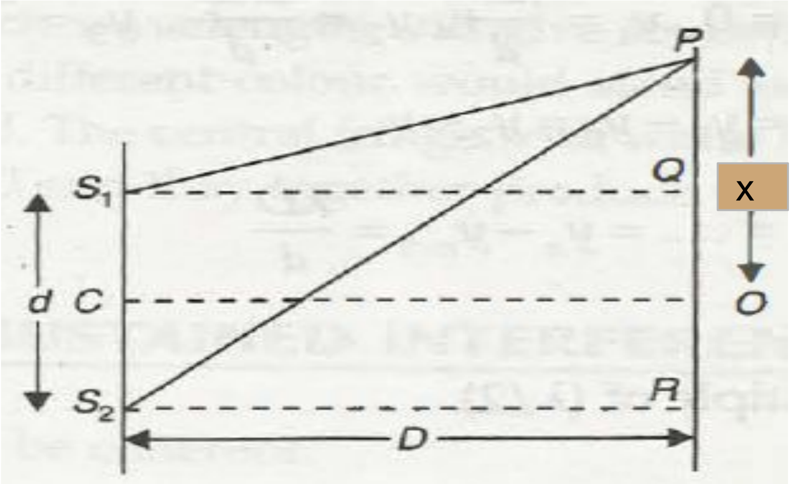
Consider a narrow monochromatic source S and two pin hole holes S_1 & S_2 act as two coherent sources separated by a distance 'd' . The point 'O' is equidistant from S_1 & S_2 .

∴ The path difference between the two waves is zero. Thus the point 'O' has maximum intensity.



Consider a point ‘P’ at a distance ‘x’ from ‘O’ . The wave reaches the point ‘P’ from S_1 & S_2 as shown in figure above.

The path difference between the waves coming from S_1 & S_2 is …

Path difference $= S_2P - S_1P = xd / D$

Phase difference: $(2\pi / \lambda)$. path difference

$= (2\pi / \lambda) . (S_2P - S_1P)$

$$\delta = (2\pi / \lambda) . (xd / D)$$

❖ **Condition for bright fringe :** The point 'P' is bright when the path difference is equal to integral multiple of λ .

$$\therefore \quad \mathbf{x_n d / D = n \lambda} \qquad \text{where } n = 0,1,2,3\text{.........}$$

$$\mathbf{x_n = n \lambda D / d}$$

The distance between any consecutive bright fringes = $x_2 - x_1$

$$= 2\lambda D / d - \lambda D / d$$

$$x_2 - x_1 = \lambda D / d$$

❖ **Condition for dark fringe :** The point 'P' is bright when the path difference is equal to odd multiple of half of wavelength .

$$\therefore \quad \mathbf{x_n\, d / D \;=\; (2n+1)\, \lambda / 2} \qquad \text{where } n = 0,1,2,3\ldots\ldots$$

$$\mathbf{x_n \;=\; (2n+1 / 2) \,.\, (\lambda D / d)}$$

The distance between any consecutive dark fringes = $x_2 - x_1$

$$= 2.5\, \lambda D / d - 1.5\, \lambda D / d$$

$$x_2 - x_1 = \lambda D / d$$

❖ **Fringe width :**

The distance between any consecutive bright or dark fringes is known as fringe width or band width ($\boldsymbol{\beta}$) .

$$\beta = \lambda D / d$$

⇒ $\boldsymbol{\beta}$ is proportional to $\boldsymbol{\lambda}$ **,** the distance between the screen and the source (D) and inversely proportional to the distance between the coherent sources .