

Expression of tongue width

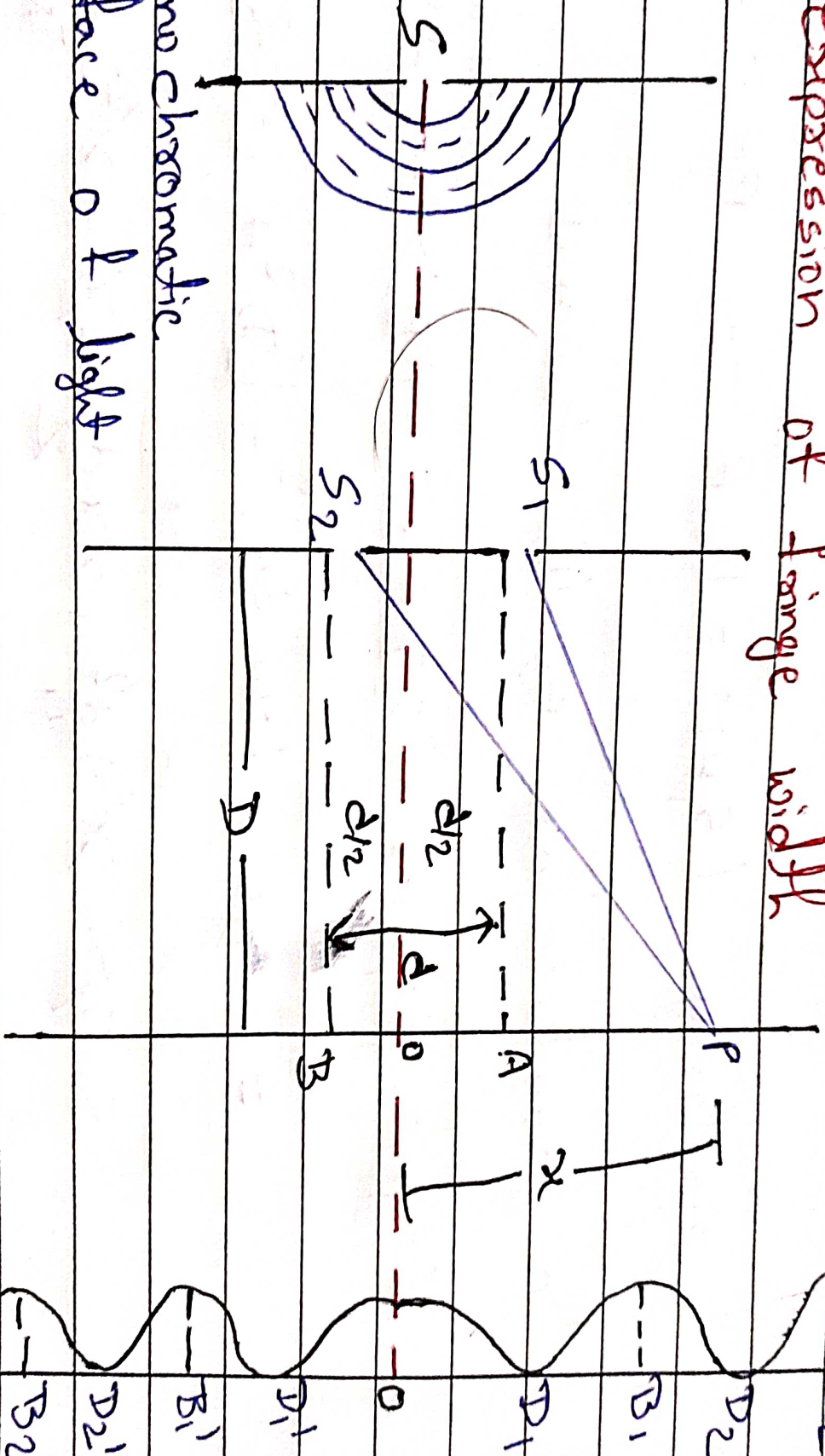


fig:- Young's Double slit experiment

Suppose a narrow slit 'S' is illuminated by a monochromatic light of wave length λ . S_1 and S_2 are two slits at equal distance from slit S. These two slits act as a monochromatic source of light. The two slits are separated by slits S_1 and S_2 line.

Let point P is the superimposing point ~~that~~ distance x from centre O. Then the nature interference at point P will be constructive or destructive. it will depends upon the path difference.

$$\text{Path Difference (P)} = S_2P - S_1P$$

In right angle triangle ΔS_2PB and S_1PA

$$(S_2P)^2 = (S_2B)^2 + (PB)^2 \quad \text{--- (I)}$$

$$\text{Similarly } (S_1P)^2 = (S_1A)^2 + (PA)^2 \quad \text{--- (II)}$$

On subtracting eq. (II) from (I)

$$(S_2P)^2 - (S_1P)^2 = (S_2B)^2 + (PB)^2 - (S_1A)^2 - (PA)^2$$

$$= D^2 + (x + \frac{d}{2})^2 - [D^2 + (x - \frac{d}{2})^2]$$

$$= D^2 + x^2 + \frac{d^2}{4} + x \cdot \frac{d}{2} - D^2 - x^2 - \frac{d^2}{4} + x \cdot \frac{d}{2}$$

$$= 2dx$$

$$(s_2P)^2 - (s_1P)^2 = 2dx$$

$$(s_2P + s_1P)(s_2P - s_1P) = 2dx$$

$$\therefore s_2P - s_1P = \frac{2dx}{s_2P + s_1P}$$

$$\text{In } \dots s_2P \approx s_1P = D$$

$$\therefore s_2P - s_1P = \frac{2dx}{D+D} = \frac{2dx}{2D} = \frac{dx}{D}$$

Position of bright fringe

As we know that bright constructive interference will occur when

$$P = n\lambda = \frac{x \cdot d}{D}$$

$$\therefore x = \frac{nD\lambda}{d}$$

Position of first fringe

$$x_0 = 0$$

$$x = \frac{0D\lambda}{d} = 0$$

Position of 2nd bright fringe

$$x_2 = \frac{2D\lambda}{d}$$



In general $x_n = \frac{n\lambda D}{d}$

As we know that for destructive interference
(Position of dark fringes)

The path differences is given by :-

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

For first dark fringe
put $n=1$

$$x_1 = \frac{\lambda D}{2d}$$

Similarly $x_2 = \frac{3\lambda}{2} \frac{D}{d}$

$$x_3 = \frac{5\lambda \cdot D}{2d}$$

$$x_4 = \frac{7 \cdot \lambda D}{2 \cdot d}$$

In general

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