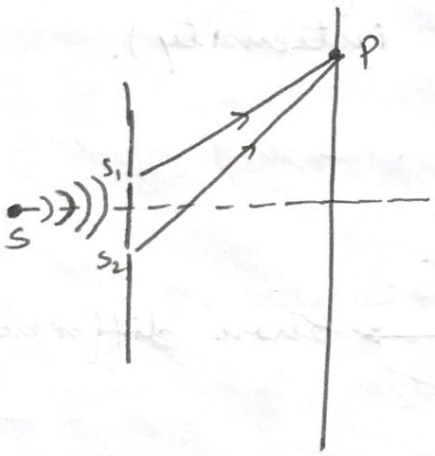
INTERFERENCE: When light waves of same frequency travels in a medium and cross each other, in the region of superposition, resultant intensity is modified, there are certain points where intensity becomes maximum, and corresponds to the constructive interference, while at certain points the intensity becomes minimum, such points corresponds to destructive interference.



Suppose a beam coming from S_1 having amplitude and displacement at point P due to their wave,

$$y_1 = a_1 \sin \omega t \quad \text{——①}$$

that due to wave coming from S_2,

$$y_2 = a_2 \sin(\omega t + \delta) \quad \text{——②}$$

According to the superposition principle,

$$y = y_1 + y_2 = a_1 \sin \omega t + a_2 \sin(\omega t + \delta)$$

$$= a_1 \sin \omega t + a_2 \sin \omega t \cos \delta + a_2 \cos \omega t \sin \delta$$

$$y = (a_1 + a_2 \cos \delta) \sin \omega t + a_2 \sin \delta \cos \omega t$$

let, $a_1 + a_2 \cos \delta = A \cos \phi$

$$a_2 \sin \delta = A \sin \phi$$

$$y = A\cos\phi \sin\omega t + A\sin\phi \cos\omega t$$

$$y = A\sin(\omega t + \phi)$$

$$A^2 = a_2^2 \sin^2\delta + a_1^2 + a_2^2\cos^2\delta + 2a_1a_2\cos\delta$$

$$A^2 = a_1^2 + a_2^2 + 2a_1a_2\cos\delta$$

Constructive Interference :

$$I = A^2 = a_1^2 + a_2^2 + 2a_1a_2\cos\delta \quad \text{——} (3)$$

For maxima, $\cos\delta = +1$.

$$I_{max} = a_1^2 + a_2^2 + 2a_1a_2 = (a_1+a_2)^2$$

or $I_{max} > a_1^2 + a_2^2$

$I_{max} > I_1 + I_2$ (sum of individual intensity).

If $\cos\delta = +1$.

$\delta = 2n\pi$

where, $n = 0, 1, 2 \ldots$

$\delta = 0, 2\pi, 4\pi, 6\pi$ ⟶ phase difference

$$\Delta\phi = \frac{2\pi}{\lambda}\cdot \Delta x$$

$\Delta\phi$ ↓ phase difference.

Δx ↓ path difference.

$$2n\pi = \frac{2\pi}{\lambda}\cdot \Delta x$$

$$\boxed{\Delta x = 2n\lambda/2}$$ ⟶ condition for maxima.

Destructive Interference:

$$I_{min} = a_1^2 + a_2^2 + -2a_1a_2$$

$$= (a_1 - a_2)^2$$

$\Rightarrow$ $I_{min} < a_1^2 + a_2^2$

$\Rightarrow$ $I_{min} < I_1 + I_2$

It is minimum if

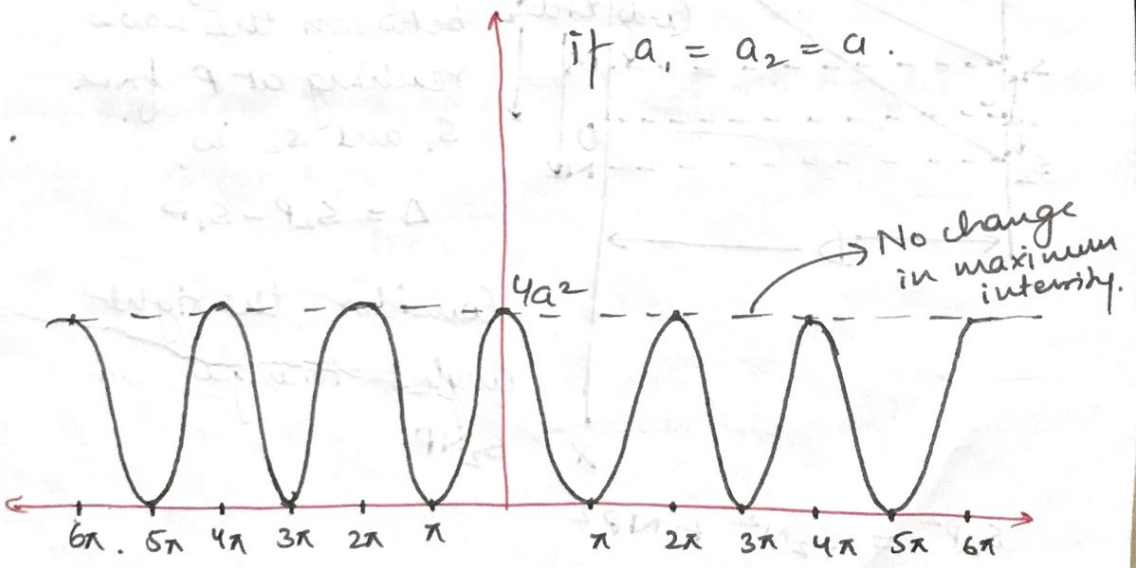
$\cos\delta = -1$.

$\delta = (2n+1)\pi$, $n = 0, 1, 2, \ldots$

$\delta = \pi, 3\pi, 5\pi \ldots$

$\Delta\phi = \frac{2\pi}{\lambda} \times \Delta x$

$$\boxed{\Delta x = (2n+1)\lambda/2}$$ → condition for minima.



Intensity distribution curve.

COHERENT SOURCES :

Two sources are said to be coherent if they emit continuous light waves of the same frequency or wavelength, same or nearly same amplitude, and having either a zero or constant phase difference.

Two independent sources can not be coherent because they can not maintain the requirement of constant phase difference between them."

Methods to obtain coherent sources :

1. **Division of Wavefront:** In this category, the coherent sources are obtained by dividing the wavefront, originating from a common source, by employing mirrors, biprisms or lenses.
eg. Fresnel's Biprism, Lloyd's mirrors etc.

2. **Division of Amplitude :** In this category, the amplitude of the incident beam of light is divided into two or more parts either by partial reflection or refraction.

These beams travel different paths and finally brought together to produce interference eg. Newton's Rings, Michelson's interferometer, Fabry-Perot interferometer etc.

Conditions for sustained interference:

1. The waves from two sources must be of same frequency.
2. Two light waves must be coherent.
3. ~~3.~~ The separation between the coherent sources (2d) must be small.
4. If the interfering waves are polarised, they must be in the same state of polarisation.