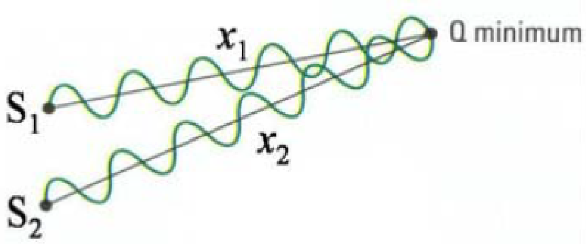
## ○ Path difference for destructive interference




❖ A dark fringe at Q if

$$\Delta\Phi = (2m+1)\pi$$

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

❖ At Q,

$$E_{1Q} = E_0 \sin(\omega t - kx_1)$$
$$E_{2Q} = E_0 \sin(\omega t - kx_2)$$

then

$$\Delta\Phi = (\omega t - kx_2) - (\omega t - kx_1)$$

$\Delta\Phi = k(x_1 - x_2)$ since $k = \dfrac{2\pi}{\lambda}$ and $(x_1 - x_2) = \Delta L$

$$\Delta\Phi = \frac{2\pi}{\lambda}\Delta L$$

❖ Therefore

$$(2m+1)\pi = \frac{2\pi}{\lambda}\Delta L$$

$$\boxed{\Delta L = \left(m + \frac{1}{2}\right)\lambda}$$

where $m = 0,1,2,\ldots..$

❖ Note

When

$m = 0$ ⇨ 1st dark fringe

$m = 1$ ⇨ 2nd dark fringe

$m = 2$ ⇨ 3rd dark fringe

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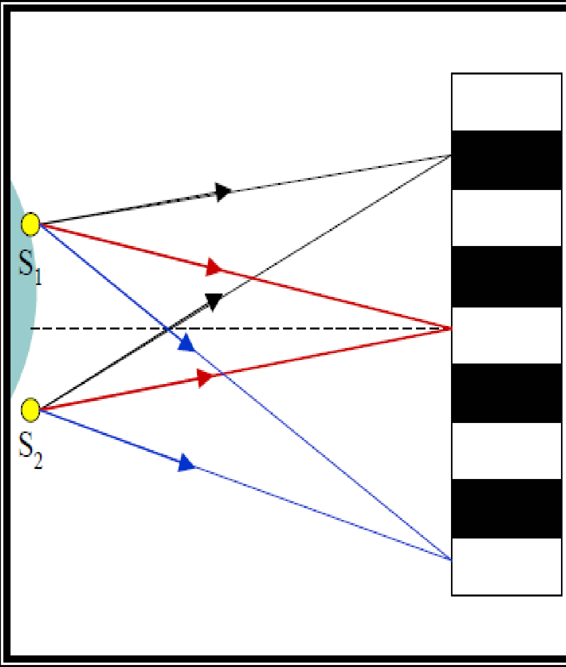
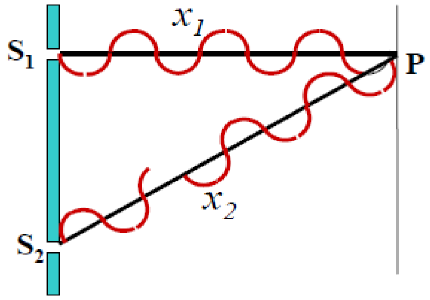



| | $\Delta\Phi$ | $m$ | $\Delta L$ |
|---|---|---|---|
| 2nd bright fringe | $4\pi$ | $2$ | $2\lambda$ |
| 2nd dark fringe | $3\pi$ | $1$ | $\frac{3}{2}\lambda$ |
| 1st bright fringe | $2\pi$ | $1$ | $\lambda$ |
| 1st dark fringe | $\pi$ | $0$ | $\frac{1}{2}\lambda$ |
| Central bright fringe | $0$ | $0$ | $0$ |
| 1st dark fringe | $\pi$ | $0$ | $\frac{1}{2}\lambda$ |
| 1st bright fringe | $2\pi$ | $1$ | $\lambda$ |
| 2nd dark fringe | $3\pi$ | $1$ | $\frac{3}{2}\lambda$ |
| 2nd bright fringe | $4\pi$ | $2$ | $2\lambda$ |

## 1.7. Interference of Two Coherent Sources in antiphase

- **Path difference for constructive interference**




- A bright fringe at P if

$\Delta\Phi = 2m\pi$ where $m = 1,2,...$

- At P,

$$E_{1P} = E_0 \sin(\omega t - kx_1)$$
$$E_{2P} = E_0 \sin(\omega t - kx_2 - \pi)$$

then

$$\Delta\Phi = (\omega t - kx_2 - \pi) - (\omega t - kx_1)$$

$\Delta\Phi = k(x_1 - x_2) - \pi$ since $k = \dfrac{2\pi}{\lambda}$ and

7 $\Delta\Phi = \left(\dfrac{2\pi}{\lambda}\Delta L\right) - \pi$ $(x_1 - x_2) = \Delta L$

- Therefore

$$2m\pi = \left(\frac{2\pi}{\lambda}\Delta L\right) - \pi$$

$$\Delta L = \left(m + \frac{1}{2}\right)\lambda$$

where $m = 0,1,2,.....$

- Note

When

$m = 0$ ⇨ 1st bright fringe

$m = 1$ ⇨ 2nd bright fringe

$m = 2$ ⇨ 3rd bright fringe

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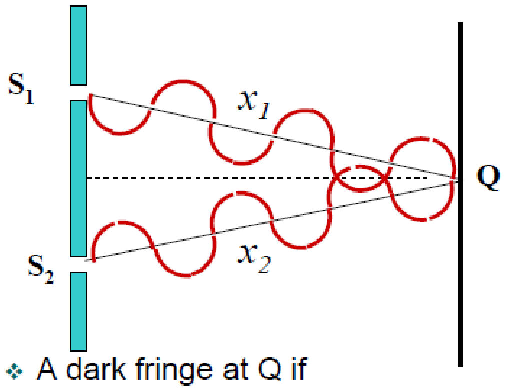
- **Path difference for destructive interference**




- A dark fringe at Q if

$\Delta\Phi = (2m+1)\pi$

where $m = 0,1,2,...$

- At Q, $E_{1Q} = E_0 \sin(\omega t - kx_1)$

$$E_{2Q} = E_0 \sin(\omega t - kx_2 + \pi)$$

then

$$\Delta\Phi = (\omega t - kx_2 + \pi) - (\omega t - kx_1)$$

$\Delta\Phi = k(x_1 - x_2) + \pi$ since $k = \dfrac{2\pi}{\lambda}$ and

$\Delta\Phi = \left(\dfrac{2\pi}{\lambda}\Delta L\right) + \pi$ $(x_1 - x_2) = \Delta L$

- Therefore

$$(2m+1)\pi = \left(\frac{2\pi}{\lambda}\Delta L\right) + \pi$$

$$\Delta L = m\lambda$$

where

$m = 0,1,2,.....$

- Note

When

$m = 0$ ⇨ Central dark fringe

$m = 1$ ⇨ 1st dark fringe

$m = 2$ ⇨ 2nd dark fringe

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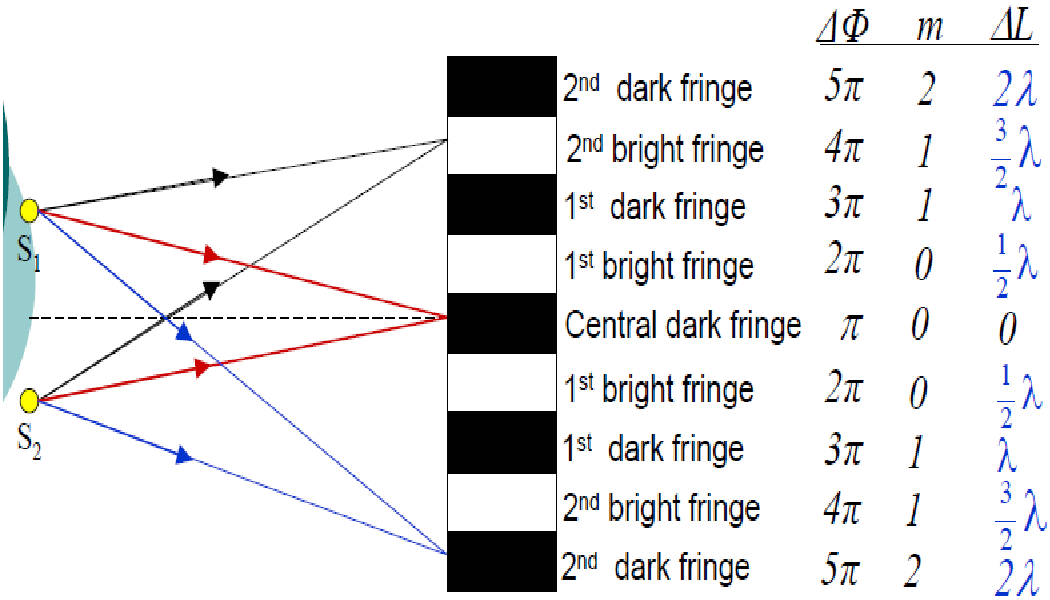
- **Interference pattern for two coherent sources in antiphase**




| 2 Coherent sources | Bright fringe | Dark fringe |
|---|---|---|
| **In phase** | $\Delta L = m\lambda$ <br> $m = 0,1,2,.....$ <br> $\Delta\Phi = 2m\pi$ <br> $m = 0,1,2,...$ | $\Delta L = \left(m + \frac{1}{2}\right)\lambda$ <br> $m = 0,1,2,.....$ <br> $\Delta\Phi = (2m+1)\pi$ <br> $m = 0,1,2,...$ |
| **Antiphase** | $\Delta L = \left(m + \frac{1}{2}\right)\lambda$ <br> $m = 0,1,2,.....$ <br> $\Delta\Phi = 2m\pi$ <br> $m = 1,2,...$ | $\Delta L = m\lambda$ <br> $m = 0,1,2,.....$ <br> $\Delta\Phi = (2m+1)\pi$ <br> $m = 0,1,2,...$ |