Waves

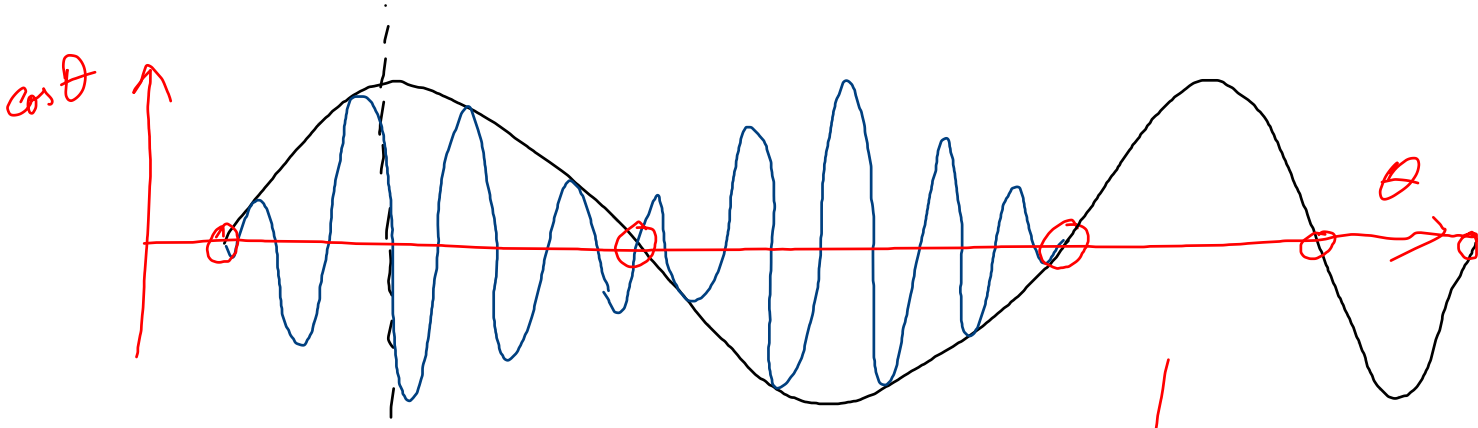
Superposition

Interference Stationary waves

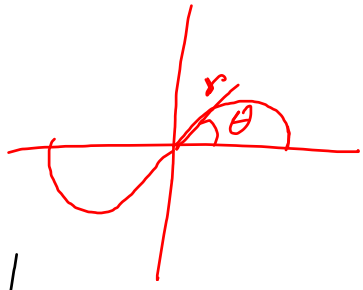
Slightly different frequency

$$\psi(x,t) = \psi_0 \sin(k_1 x - \omega_1 t) + \psi_0 \sin(k_2 x - \omega_2 t)$$

$$\psi = 2\psi_0 \cos\left[\frac{k_1 - k_2}{2} x - \frac{\omega_1 - \omega_2}{2} t\right] \sin\left[\frac{k_1 + k_2}{2} x - \frac{\omega_1 + \omega_2}{2} t\right]$$

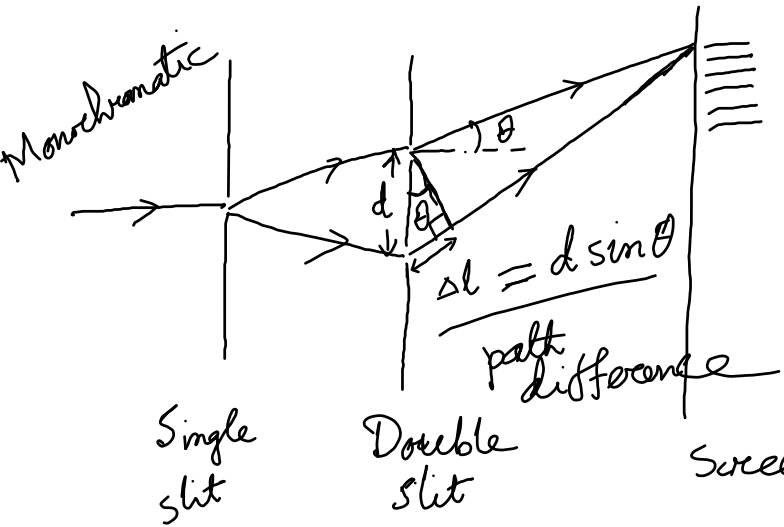


Angular Frequency $= \dfrac{\omega_1 + \omega_2}{2}$



Angular Beat frequency $\left| \dfrac{\omega_1 - \omega_2}{2} \right|$

Double-slit experiment



$$\psi_1 = \psi_0 \sin(kx - \omega t)$$

$$\psi_2 = \psi_0 \sin(kx - \omega t + \phi)$$

$$\psi = 2\psi_0 \cos\left(\frac{\phi}{2}\right) \sin\left(kx - \omega t + \phi/2\right)$$

$d \sin\theta = m\lambda$

Bright fringe

$m = 0, \pm 1, \pm 2, \cdots$ $d \sin\theta = \left(m + \frac{1}{2}\right)\lambda$

Dark fringe

Energy

$$\psi(x,t) = a\cos(\omega t - kx)$$

Kinetic energy $\frac{1}{2}mv^2$

$$v = \frac{\partial \psi}{\partial t}$$

$\rho_0 \delta x \rightarrow m$

$$\Delta E_k = \frac{1}{2}\rho_0 \delta x \left(\frac{\partial \psi}{\partial t}\right)^2$$

Per unit length $\mathcal{E}_k = \frac{1}{2}\rho_0 a^2\omega^2 \sin^2(\omega t - kx)$

time - averaged

$$\langle A \rangle \quad \frac{\int_0^T A \, dt}{\int_0^T dt}$$

$$\langle \mathcal{E}_k \rangle_t = \frac{1}{4} \rho_0 a^2 \omega^2$$