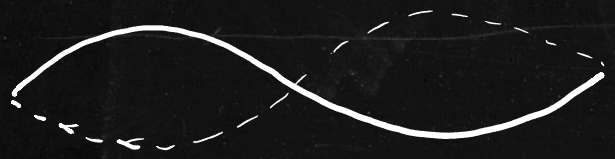
Wave

- Mechanical Wave
- Electromagnetic Wave — Light
- Matter Wave

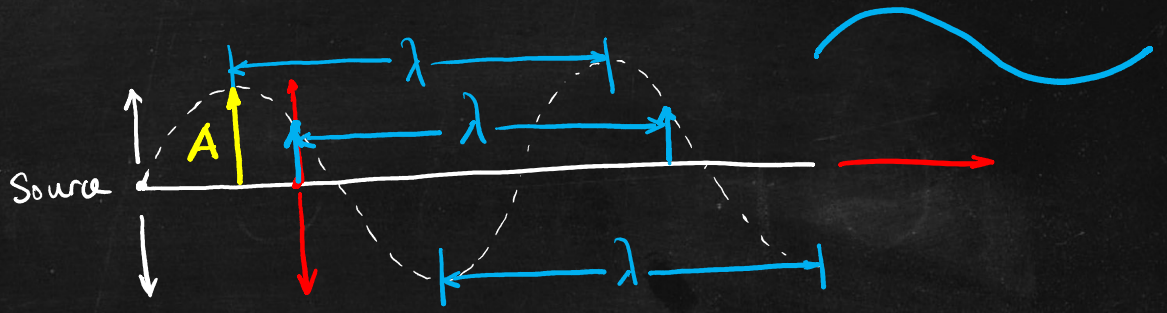
- transverse wave 横波
- longitudinal wave 纵波

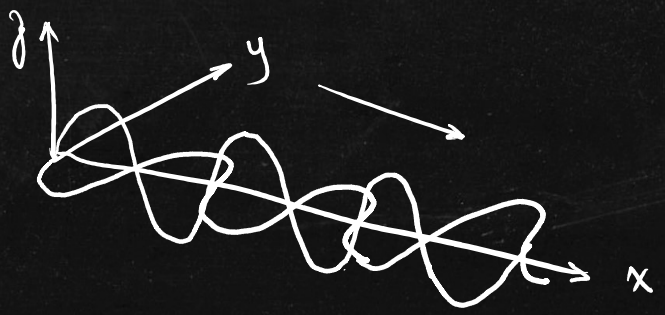
- Standing wave 驻波
- travelling wave 行波



Source 波源　　Observer 观察者

Medium 介质



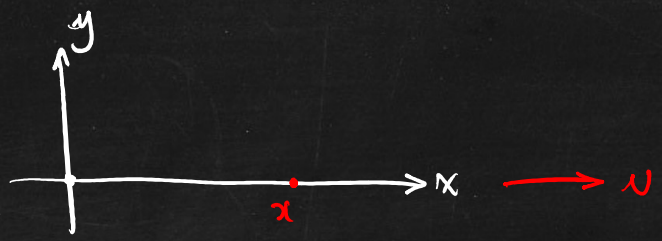


$$v = \frac{\lambda}{T} = \lambda f$$

Mechanical Wave:

$y = A\cos\omega t$ (Source)

$y = A\cos(kx - \omega t)$ wave function



wave number: $k = \frac{2\pi}{\lambda}$

$y = A\cos(k(-x) - \omega t) = A\cos(kx + \omega t)$

$\frac{\partial y}{\partial x} = A \cdot k \cdot (-\sin(kx - \omega t)) = -Ak\sin(kx - \omega t)$ $\quad \frac{\partial^2 y}{\partial x^2} = -Ak^2\cos(kx - \omega t)$

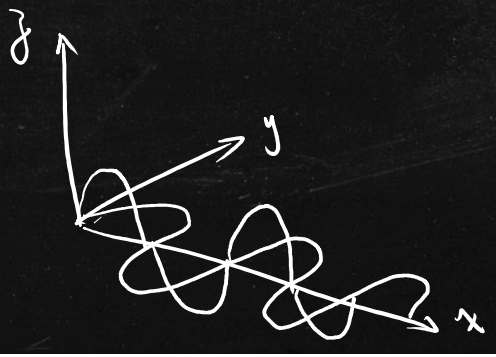
$\frac{\partial y}{\partial t} = A \cdot (-\omega) \cdot (-\sin(kx - \omega t)) = A\omega\sin(kx - \omega t)$ $\quad \frac{\partial^2 y}{\partial t^2} = -A\omega^2\cos(kx - \omega t)$

$$\frac{\frac{\partial^2 y}{\partial x^2}}{\frac{\partial^2 y}{\partial t^2}} = \frac{k^2}{\omega^2} = \left(\frac{k}{\omega}\right)^2 = \left(\frac{2\pi}{\lambda\omega}\right)^2 = \left(\frac{1}{\lambda}\right)^2 = \frac{1}{v^2}$$

$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\cdot\frac{\partial^2 y}{\partial t^2}$$ (wave equation)

$$\frac{\partial^2 E_y(x,t)}{\partial x^2} = \underbrace{\varepsilon_0\mu_0}_{\frac{1}{c^2}}\frac{\partial^2 E_y(x,t)}{\partial t^2}$$

$$\frac{1}{\sqrt{\varepsilon_0\cdot\mu_0}} = c$$



$$\frac{\partial^2 y}{\partial x^2} = \frac{\rho}{B}\frac{\partial^2 y}{\partial t^2} = \frac{1}{\left(\sqrt{\frac{B}{\rho}}\right)^2}\cdot\frac{\partial^2 y}{\partial t^2} \qquad \text{(Fluid)}$$

$v = \sqrt{\frac{B}{\rho}}$ $\quad B$ – Bulk Modulus $\quad \rho$ – density

$v = \sqrt{\frac{Y}{\rho}}$ $\quad Y$ – Young's Modulus

$$\frac{\partial^2 y}{\partial x^2} = \frac{\mu}{F}\cdot\frac{\partial^2 y}{\partial t^2} = \frac{1}{\left(\sqrt{\frac{F}{\mu}}\right)^2}\cdot\frac{\partial^2 y}{\partial t^2}$$

$v = \sqrt{\frac{F}{\mu}}$

F – Tension

μ – mass per unit length