Physics 8.03
Vibrations and Waves

Lecture 9

Wave equation in 2D and 3D

Time-independent Fourier analysis

Last time: Boundary Conditions

- Reflection and transmission

$$r = \frac{v_2 - v_1}{v_2 + v_1} \text{ and } \tau = \frac{2v_2}{v_2 + v_1}$$

- Harmonic pulses → (traveling waves)

$$y(x,t) = y_0 \cos(kx \pm \omega t + \phi)$$

- Separable solutions → (standing waves)

$$y(x,t) = f(x)\cos(\omega t + \phi)$$

  - Boundaries [0, L] → Normal modes

$$y_n(x,t) = A_n \sin\left(\frac{n\pi}{L}x\right)\cos(\omega_n t + \phi)$$

- Energy carried by waves

$$\frac{dU}{dx} = \frac{1}{2}T\left(\frac{\partial y}{\partial x}\right)^2 \text{ and } \frac{dK}{dx} = \frac{1}{2}\mu\left(\frac{\partial y}{\partial t}\right)^2$$

- Wave equation in 2 and 3 dimensions
- Waves of arbitrary shapes
  - Fourier analysis