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
- Harmonic pulses (traveling waves)
- Separable solutions (standing waves)
- Boundaries \([0, L]\)
  - Normal modes
- Energy carried by waves

\[
r = \frac{v_2 - v_1}{v_2 + v_1} \quad \text{and} \quad \tau = \frac{2v_2}{v_2 + v_1}
\]

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

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

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

\[
\frac{dU}{dx} = \frac{1}{2} T \left(\frac{\partial y}{\partial x}\right)^2 \quad \text{and} \quad \frac{dK}{dx} = \frac{1}{2} \mu \left(\frac{\partial y}{\partial t}\right)^2
\]
- Wave equation in 2 and 3 dimensions
- Waves of arbitrary shapes
  - Fourier analysis