

The Wave Equation

For any function, f that satisfies the wave equation:

$f(x - vt)$ describes a wave moving in the positive x direction.

$f(x + vt)$ describes a wave moving in the negative x direction.

What is the origin of these functional forms?

They are solutions to a wave equation:

$$\frac{\partial^2 f}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 f}{\partial t^2}$$

The harmonic wave, $f = \cos(kx \pm \omega t)$, satisfies the wave equation.
(You can verify this.)

Examples of wave equations:

Sound waves: $\frac{d^2 p}{dx^2} = \frac{1}{v^2} \frac{d^2 p}{dt^2}$ p is pressure

Electromagnetic waves: $\frac{d^2 E_x}{dz^2} = \frac{1}{c^2} \frac{d^2 E_x}{dt^2}$ Also $E_y B_x$ and B_y
See P212, lecture 22, slide 17

The appendix has a discussion of traveling wave math.

You will do some problems in discussion.