2.4: Other Wave Functions

Tutorial 2.4: Other Wave Functions

So far all the waves we have encountered were described mathematically by sine and cosine functions. In general however, any function of x and t which has these variables in the form $x - vt$ will be a traveling wave with speed v. Notice that our sine wave function can also be written in this form: $y(x,t) = A\sin(k(x - vt) + \varphi)$ where as before $v = \omega/k$. This simulation will allow us to investigate other functions which are also waves.

Other Wave Functions

Questions:

Exercise 2.4.1

The initial equation shown is called a Gaussian function (or bell curve). Experiment by changing the constants in the equation (click 'reset' each time, change the function and hit enter or return).

a. What does the number in front of the exponent do?
b. What does the number in front of the variable t do?
c. What does the number after the plus sign do?
d. What does the first number in the parentheses after 'exp' do?
e. Identify which of these numbers is amplitude, speed, width, and initial location.

Exercise 2.4.2

Reload the initial wave and experiment with the signs in the equation.

a. What happens if you change the minus sign between the x and the $-3 * t$ to a plus sign?
b. What happens if you change the other minus sign in front of the 2 to a plus sign? (Think about what function you are dealing with here- does the result make sense?)
c. What happens if you place a minus sign in front of the original function?

Exercise 2.4.3

For $y(x,t)$ delete the original function, type (or copy and paste) the function $2.0/((x - 3.0 * t) \wedge 2 + 1)$ into the function window and run the simulation. Experiment by changing the numbers (reset each time to set the new values and hit enter to load the new function). In this case a single number still governs the speed but amplitude and width both depend on two numbers. Which number is the speed? Which two numbers determine the width and amplitude?

Exercise 2.4.4

Create your own traveling wave. The only requirement is that x, t and speed appear in the equation with the relationship $(x - vt)$. You may have to adjust parameters to be visible in the screen. What is your equation and what did you learn from this exercise?

Exercise 2.4.5

For $y(x,t)$ delete the original function, type (or copy and paste) the function $1 * \exp(-3 * (x - 2 * t + 5) \wedge 2) + 2 * \exp(-2 * (x + 1.2 * t - 5) \wedge 2)$ and run the simulation. This is a collision of two Gausian pulses traveling in opposite directions. What happens when they collide? How is does the amplitude at the moment they overlap compare to the amplitude of the two separate pulses (use the 'pause' and 'step' buttons to confirm your answer)?

Exercise 2.4.6

Reload the previous case of a collision but change one pulse to have a negative amplitude. What happens in this case? How is does the amplitude at the moment they overlap compare to the amplitude of the two separate pulses?

Exercise 2.4.7

Explain the connection between superposition (Chapter 2.1) and the answer to the previous two questions. Give a general definition of superposition based on your observations.
