Physics 223

Experiment 1: Traveling Waves on a String

November 14, 2014

As you learned last semester, wave phenomena are an integral part of our physical world. Thus, a thorough knowledge of wave behavior is essential in understanding many physical systems. In this experiment you will measure the properties of transverse waves traveling on an elsatic cord. A taut string can support traveling waves whose velocity depends on the tension, T , in the string and the linear mass density, μ , of the string as follows:

$$v = \sqrt{\frac{T}{\mu}}. \tag{1}$$

For any wave, the velocity can be expressed as $v = f\lambda$ where f is the frequency of the wave. This velocity is difficult to measure directly but may be determined by measuring the properties of the standing waves on the string. Standing waves are a superposition of two waves traveling in opposite directions on the string and may be excited directly by applying a suitable driving force.

When a string is stretched between two fixed points, its fundamental mode of vibration will consist of a single segment with nodes on each end. If the string is driven at this fundamental frequency, a standing wave is formed. Standing waves also occur if the string is driven at any integer multiple of the fundamental frequency. These higher frequencies are called the harmonics. For a given harmonic, the wavelength is

$$\lambda = \frac{2L}{n} \tag{2}$$

where L is the length of the stretched string and $n = 1, 2, 3, ...$ is the number of segments in the string (see Figure 1). Notice that n also corresponds to the number of antinodes in the standing wave. Using Equation 2, we can determine the velocity of the wave as

$$v = \frac{2Lf}{n} \tag{3}$$

To excite standing waves in the string (in this case an elastic cord) we will use a mechanical oscillator. By changing the frequency of the signal driving the oscillator it is possible to excite various standing wave modes in the wire.

Using the apparatus provided, design and carry out an experiment to verify the relationship of traveling wave speed, v, to tension, T, in the wire as described in Equation 1. Note that μ is not constant as the cord is streched, so devise a way of calculating the linear mass density for different tensions.

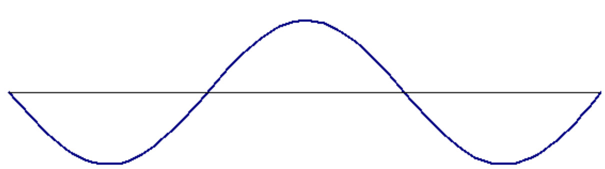

Figure 1: Standing wave on a string for n=3