Name

Physics 110

Lab #7: Transverse Standing Waves

1 Introduction

When an object travels it carries along energy and momentum, because it has mass. In a traveling wave energy and momentum are made to travel in space, in the absence of the transmission of any mass. This is because in wave motion it is the 'disturbance' that moves. But like objects (particles), waves exhibit many physical phenomena such as transmission, reflection, energy loss, etc. They also exhibit phenomenon very different from particles. One of these is that of interference: two waves that travel in opposite directions pass through each other so that at every point in space the net disturbance is an effective sum of their individual disturbances.

In this laboratory an example of standing waves, waves created when two traveling waves interfere in just the right way ('resonance') to produce a stationary pattern of nodes (places of zero wave disturbance) and antinodes (places of maximal disturbance).

For the one dimensional systems we will study in this lab, a simple relation exists connecting the distance between successive nodes, the frequency of the driving mechanism, and the speed of wave propagation in the medium of interest:

$$v_{wave} = f\lambda$$

where v_{wave} is the wave propagation speed, λ is the wavelength of the standing wave (which equals twice the distance between successive nodes; why?), and f is the (resonant) frequency of the standing wave.

2 Transverse waves on a String

- 1. Measure the mass and length of the string, removing all knots.
- 2. Set up the string with a 200g mass hung over the pulley and measure and record the length of the string between the two fixed nodes (that at the pulley and that at the mechanical oscillator). Carefully adjust the frequency of the driver so that resonances are formed with 1 to at least 7 loops. Record the frequencies (make two measurements at each resonance and report the average) and sketch the loop structure in each case. Are the resonant frequencies equally spaced?

3. Determine how to plot your resonant frequency and λ data so that a linear plot results, with slope equal to v_{wave} . Make and attach your plot and record v_{wave} .

4. The wave velocity can also be found from the equation

$$v_{wave} = \sqrt{\frac{F_T}{\mu}}$$

where T is the tension in the string and μ is the linear mass density of the string (= mass/length). Use your values of the mass and length to determine μ and then compute a velocity using this equation:

5. Write a paragraph, comparing your two values of the velocity. Identify systematic effects which might account for a difference.