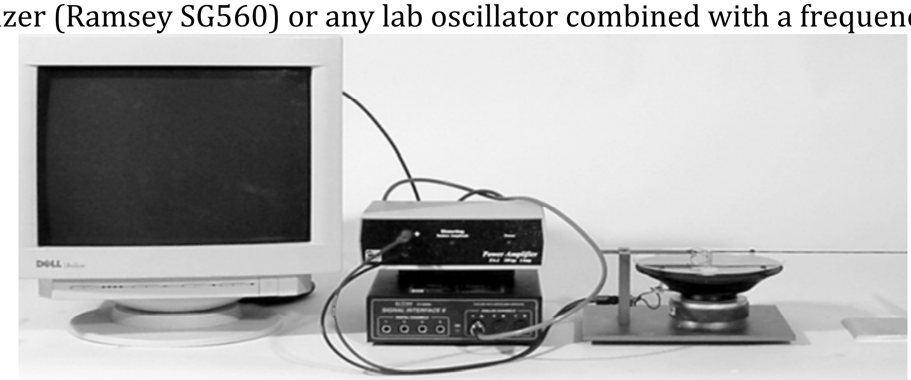
Lab 8
Strings

Purpose: Understand that the vibration modes of a string require the superposition of waves traveling on opposite direction. Using a Slinky, find that the period of the fundamental oscillaion equals the roundtrip time of a pulse on the string.

1. *Exercises with Slinky*: we found that it is helpful for students to work first with a slinky because the processes are slower and more obvious. Students sitting on the floor use a stop watch to time slinky oscillations for the first, second and third modes. They compare the period of the fundamental mode to the round trip travel time of a pulse on the slinky. They should reach the conclusion that excitation of the fundamental requires the hand to be moved in step with the reflected wave of the previous hand motion. For the experiment students need to be reminded to keep the distance (i.e. the length of the slinky) constant so as to keep the same tension. They should also understand why the fundamental of a half-length slinky is the same as the second mode of the full length slinky by one student moving the hand to the node of the full length slinky.

2. *Vibration of a Nylon string*:

Equipment: At one end, the string is attached to a bracket, at the other end it runs over a pulley clamped to the edge of the lab table, with a weight (e.g. 0.3 kg) attached to provide the string tension. Rather than the ill-defined boundary condition at the pulley, the string runs over a second braket to define the vibrating length (about 1.2 m). The string is a black (more visible than white) string of mass 0.3 g/m.
The string is driven by a electromechanical transducer near one end. Commercial transducers are fine but use of a loudspeaker coupled to the string is less expensive. As a driver, we use either a computer with Pasco DataStudio, or a digital frequency synthesizer (Ramsey SG560) or any lab oscillator combined with a frequency meter.



Experiments:

1. Find the mode frequencies for the first six mode–are they equally spaced? Enter results in a table and number the modes. For each mode, count the number of NODES by inspecting the vibrating string. How is the mode number and the number of nodes related?
2. Make a sketch of the shape of the string for the different modes. Based on these drawings, where would you pluck a guitar string to best excite e.g. the third mode?
   Which modes are excited when the pluck a guitar string 1/3rd from one end? 1.5th from one end? Which mode would be completely absent in either of these cases.
3. Changing the length of the string: move the bridge to change the length e.g. to 2/3rd or 1/2 of the original length. Find the mode frequencies. How is length related to mode frequency?
4. If time permits: change string tension.
5. Compare measured fundamental frequency to string formula (we state mass/meter in the lab notes but we also provide a scale and a spool of Nylon string for enterprising students to check the mass per unit length).