

Custom Problem 26: Final Slinky “Experiments”

(a) “Tone quality” of a slinky

The tone quality of a musical instrument depends on what harmonics are excited. (For example, as discussed in class the even harmonics are missing for a clarinet, only v , $3v$, $5v$, etc. are present.) Locate the center of your slinky when it is suspended as it Experiment 2. Excite the slinky by giving it a sudden push at the center with your hand. Try different degrees of abruptness. You should soon be able to see that the even harmonics are always missing and the more impulsive your excitation, the larger the number of (odd) modes you excite. Can you devise a way to excite only the *even* modes?

(b) Slinky Polarization

Find a partner. You and your partner hold the opposite ends of the slinky.

- i. Let each of you shake the slink in a clockwise circular rotation (from his or her own point of view.) If this doesn't convince you that linear polarization is the superposition of opposite circular polarizations then nothing will.
- ii. With each person using a book as a straightedge to guide his or her hand, let one partner shake linear polarization at 45 degrees to the horizontal, and let the other shape linear polarization at 90 degrees to the first. (The 45 degrees is to prevent gravity from giving a big asymmetry.) One of you count out loud “1, 2, 3, 4, 1, 2, 3, 4, ...” four beats to a cycle, with “one” coming at a reproducible phase in the motion of his or her hand. The other shakes in phase, or 180 degrees out of phase, or 90 degrees out of phase. It takes some concentration not to be distracted by what you see.
- iii. With the far end fixed to something (your partner can go home now), shake out a circularly polarized wave packet of one or two turns. Verify that it conserves angular momentum upon reflection. Verify that if the angular momentum is along the propagation direction, the shape is of a left-handed screw, and that the handedness reverses upon reflection.