Waves and Fields (PHYS 195): Week 8

Spring 2021 v1.7

Intro:

After we finish the Doppler shift for sound and light we will start on the theory of static fields studying gravitational, electric, and magnetic fields.

Reading:

- Friday: HRW 17.7 and HRW 37. 5
- Monday: HRW 13.5 on Gravitation and HRW 21.1
- Wednesday : HRW 21.2-3, 22.1 - 3

Physics Topics:

- Doppler effect non-relativistic and relativistic
- Gravitational fields
- Electric fields
- Field Lines

Problems: Due Tuesday March 30 at 11:59 on gradescope code ZR34XK

(1) Short questions on the derivation of the wave equation for sound:
   (a) What does $D(x,t)$ represent?
   (b) What gives the elastic restoring force for the bit of air of length Δx?
   (c) For these sound waves, what is waving?
   (d) What is the polarization?
   (e) What is the phase velocity of these sound waves?

(2) *The power of voice*
   (a) At 50 cm the intensity from a person speaking in normal conversation is about 65 dB. Estimate the power output in sound. For simplicity assume that the sound spreads evenly over a sphere centered on the person.
   (b) How many people would be required to produce a total volume of 75 dB in ordinary conversation?

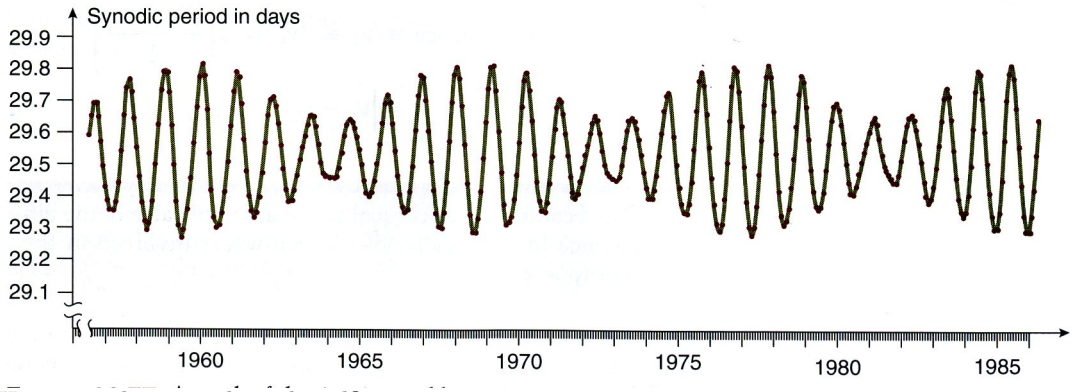
(3) Similar as in lab last week, a small speaker is driven by a function generator with a frequency that varies from 1000.0 Hz to 2000.0 Hz. It is next to an air-filled, cylindrical pipe with open ends and a length of 45.7 cm.
   (a) At how many frequencies does the sound from the speaker set up resonances in the pipe?
   (b) What are the lowest and highest resonant frequencies in this range?

(4) Two loudspeakers are placed 3.00 m apart. The two sources emit sound at single note at 440 Hz and are in phase. A microphone is placed 3.20 m from a point midway between the two speakers, where an intensity maximum is recorded.
   (a) How far must the microphone be moved, parallel to the line between the speakers, to find the first intensity minimum?
   (b) Suppose the speakers are reconnected so that the 440 Hz sounds are out of phase ($\Delta\phi = \pi$). At what positions are the intensity maximum and minimum now?

(5) HRW 17.21

(6) HRW 17.53

(7) The following plot shows data and a fit on the variation in the time between full moons. This "synodic period" (the period of the phases on the moon) is, on average, about 29.53 days. The *variation* as a function of year is shown.



(a) How is such a signal produced?
(b) What are the periods of the two oscillations that, once added together, would give this plot? (One of these will be roughly equal to a year.)
(c) Sketch a phasor diagram that would give this pattern. In your solutions we'll be looking for an accurate representation of the largest amplitude, smallest amplitude, and the relative angle, which will be a function of year.

(8) HRW 17.56

(9) Two violinists play the same note (and thus frequency) at opposite ends of a long hall. They emit sound waves in phase at a single frequency at 282 Hz.
(a) What do you hear as you walk down the corridor at 1.40 m/s?
(b) What is the frequency of variation in volume?

Lab:

Coulomb's Law!

A look ahead...

We move onto to electric potentials see HRW 24.