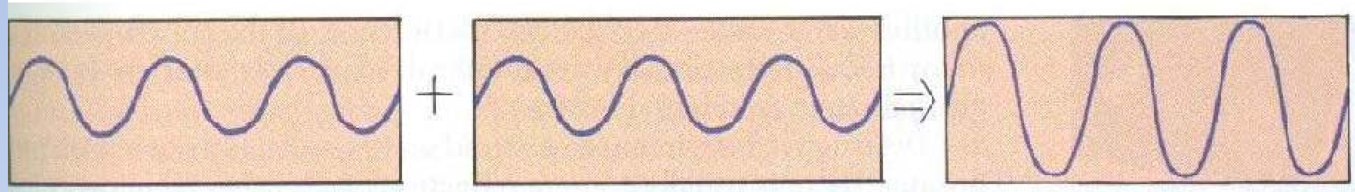
Themed: 03-01

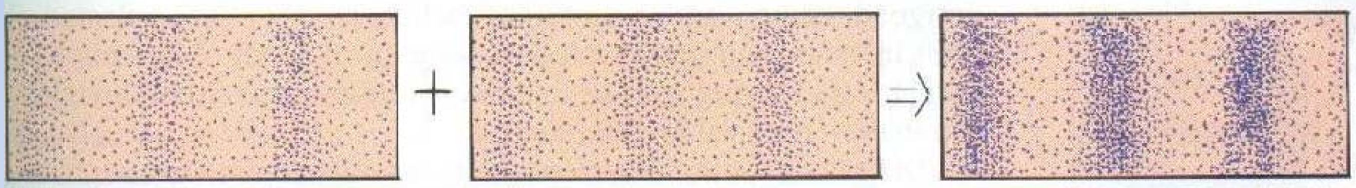
Using Western Musical Introduction and Fundamental Frequency

Review - What is sound?

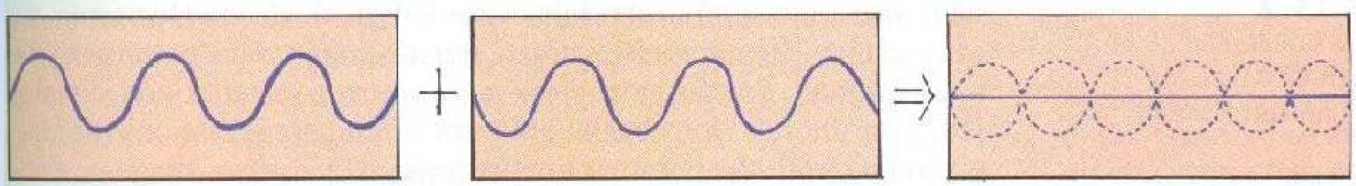
- Cyclic sound pressure variations
- Human ears are sensitive to it and human brains can rapidly process sound information sent to brain
- Sound (not noise) consists of standing waves



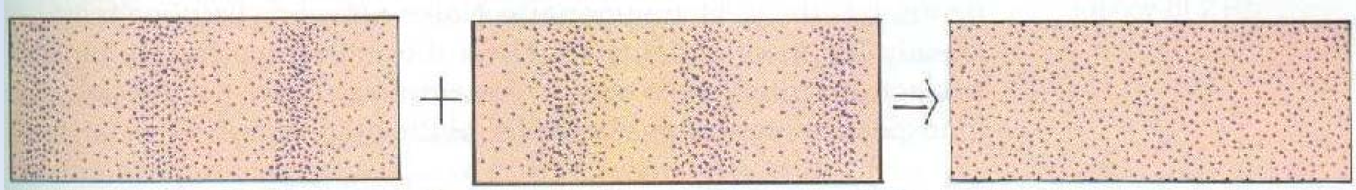
The superposition of two identical transverse waves in phase produces a wave of increased amplitude.



The superposition of two identical longitudinal waves in phase produces a wave of increased amplitude.



Two identical transverse waves that are out of phase destroy each other when they are superimposed.



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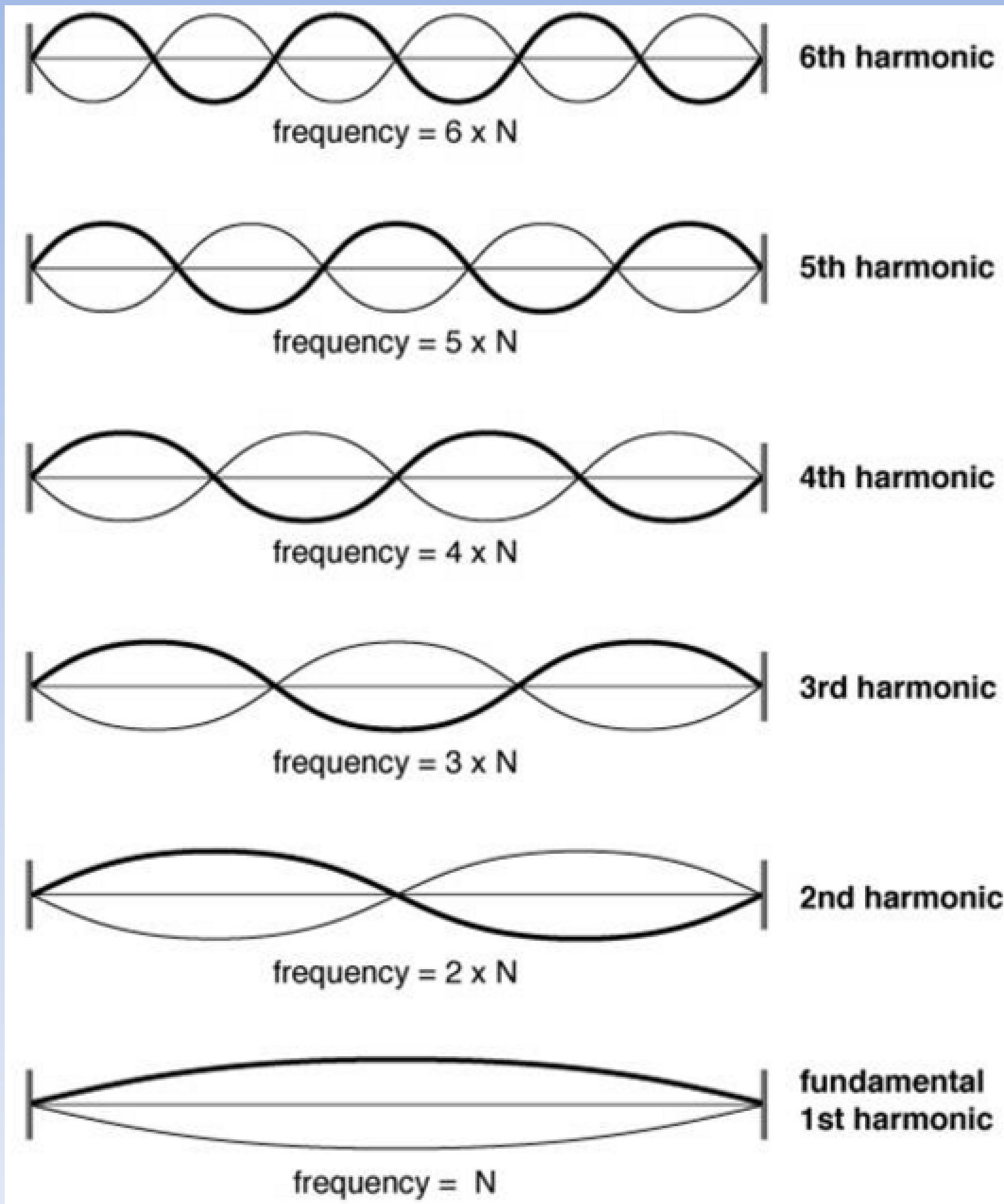
How sounds are made

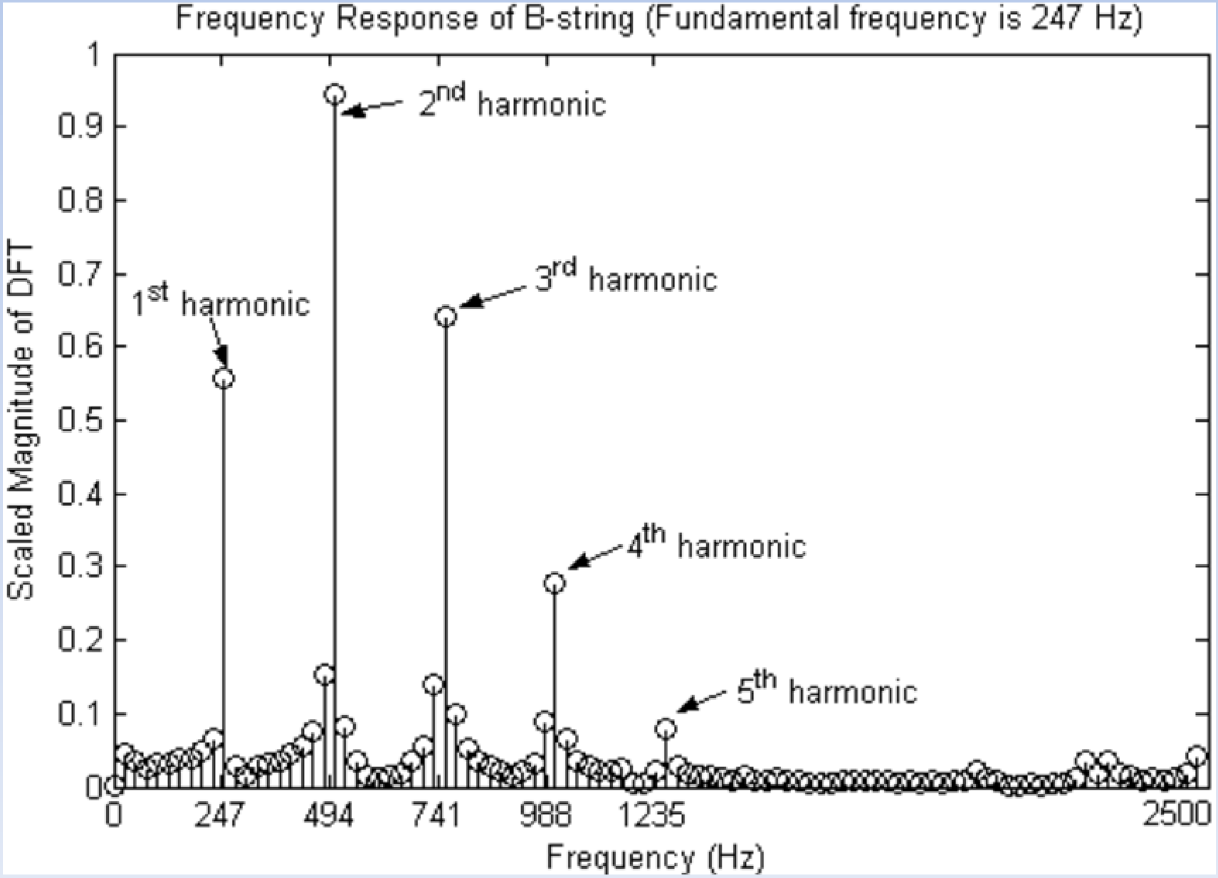
- Something vibrates at its natural frequency (larynx, guitar string, etc.)
- Guitar string attached to sound board, sound board vibrates air
- Air vibrates our ears
- Vibrations don't happen at just ONE of the natural frequencies
  - Sound energy is SHARED among several natural frequencies (harmonics)



Timbre

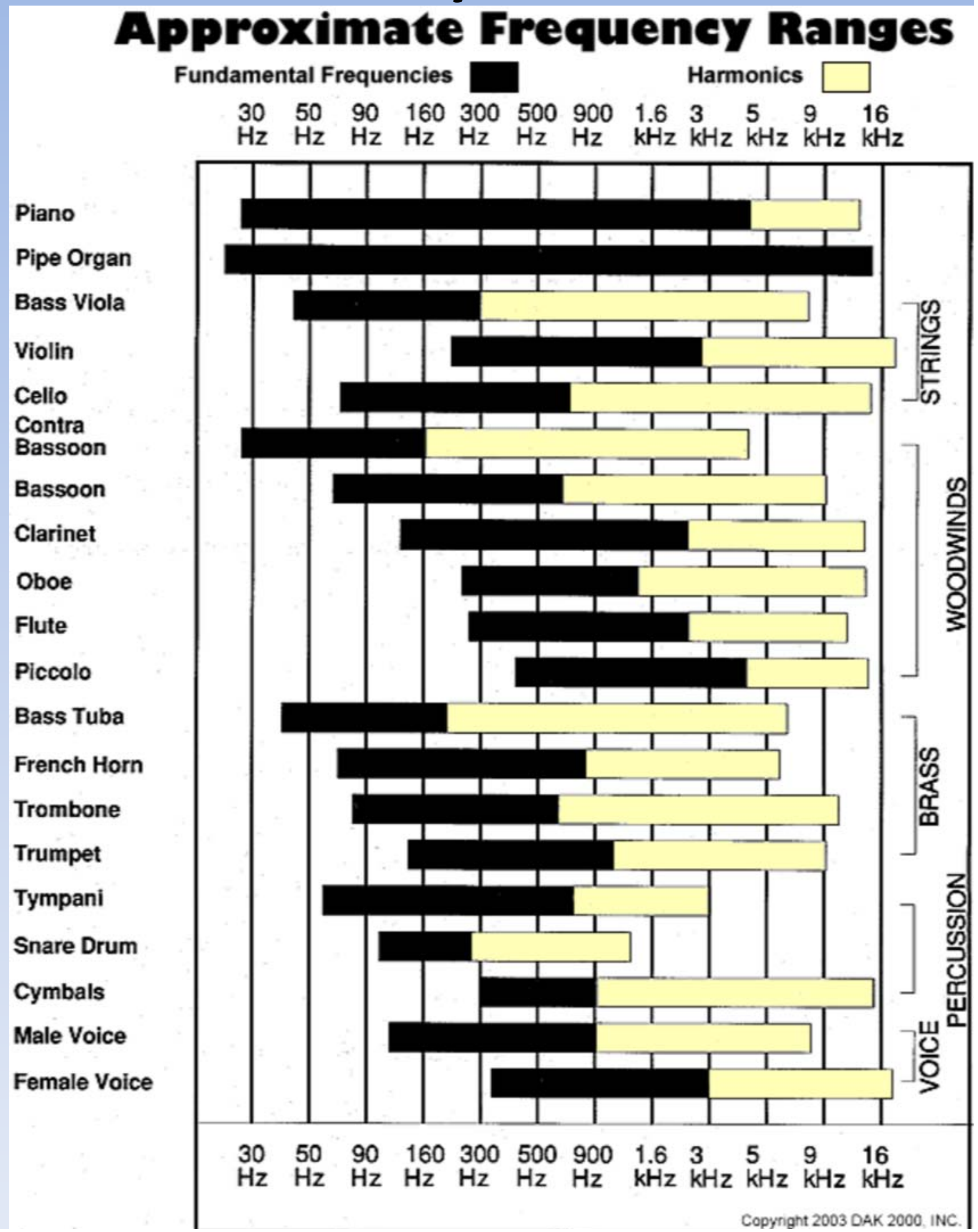
- The distribution of sound energies among the harmonics
- Notice: This is how sound energy is distributed for one note on a particular guitar
- Notice: This is NOT an Audacity type printout!

- Sound energies are shared among several harmonics
- This makes for rich sounds compared to a piano (more monotone)



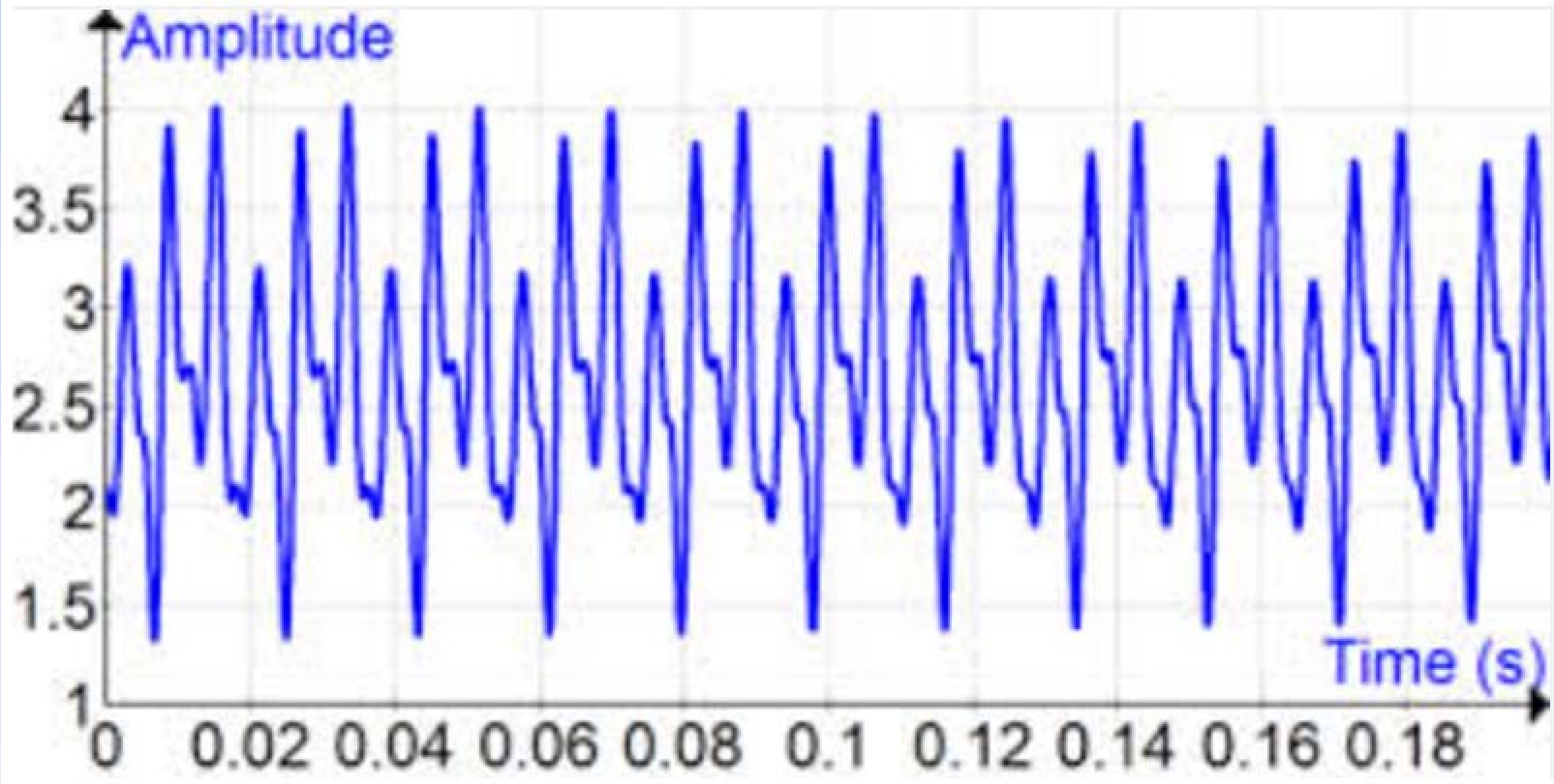
Timbre of Some Sound Systems

- Notice pipe organ is quite monotone
- Piano is pretty monotone
- Human voice is rich
- Bassoon and Tuba create rich sounds too



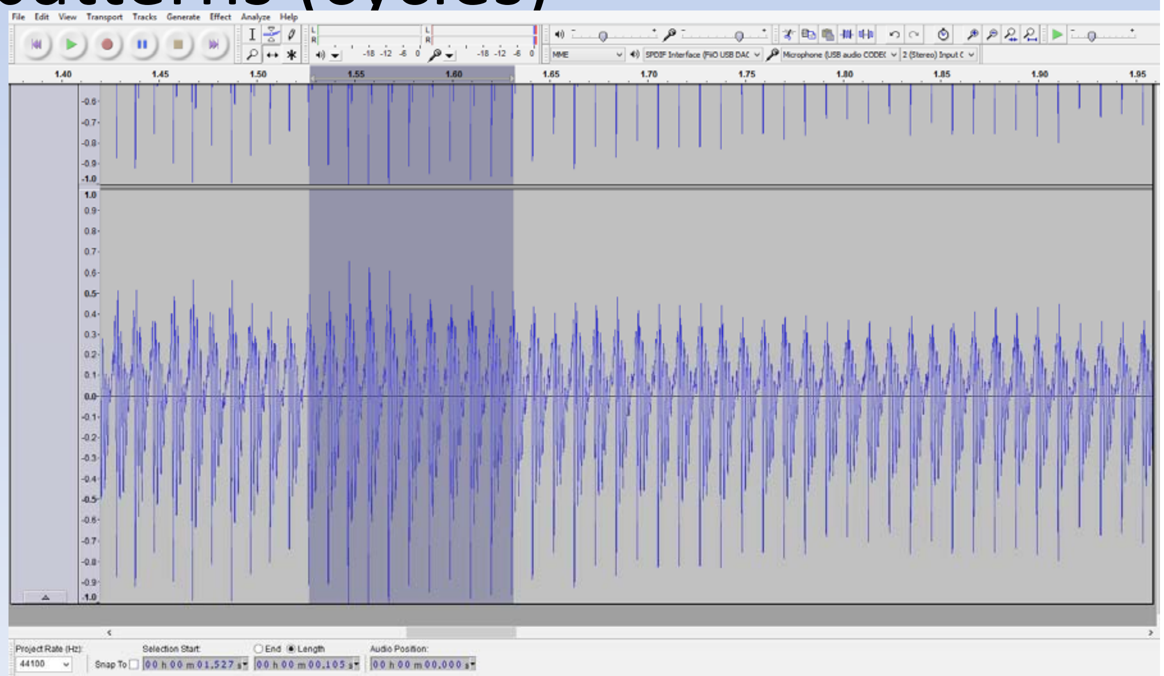
Can You Pick Out the Fundamental?

- Fundamental: Lowest frequency, often highest amplitude
- Can you find the fundamental frequency? (55 Hz)
- The "note" being played, IS the fundamental frequency
- Our next mission: Figure which note that is! (A_1)



Audacity Introduction

- Records air pressure variations (sound!)
- Y-axis is pressure/sound energy/amplitude
- X-axis is time
  - Look at sig figs in time measurements, this limits the precision of your frequency measurements
- Look for repeating patterns (cycles)
  - f = cyc/sec



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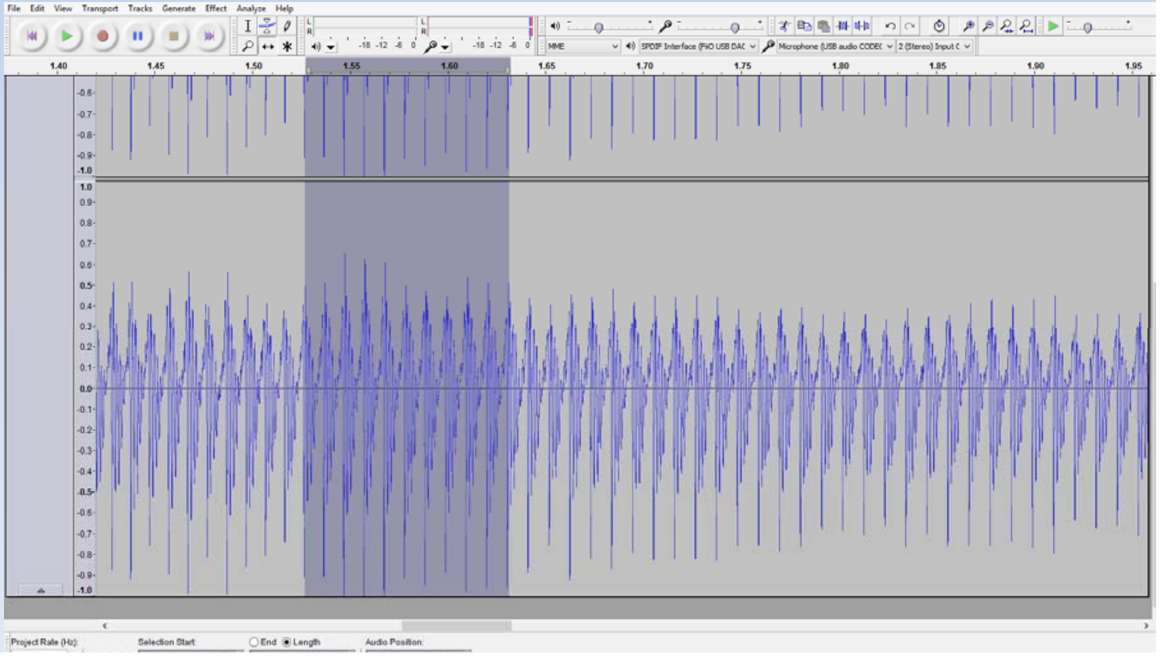
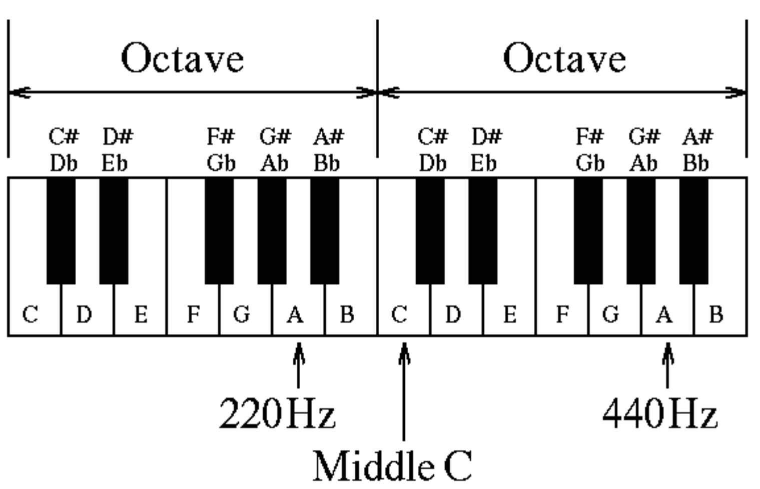


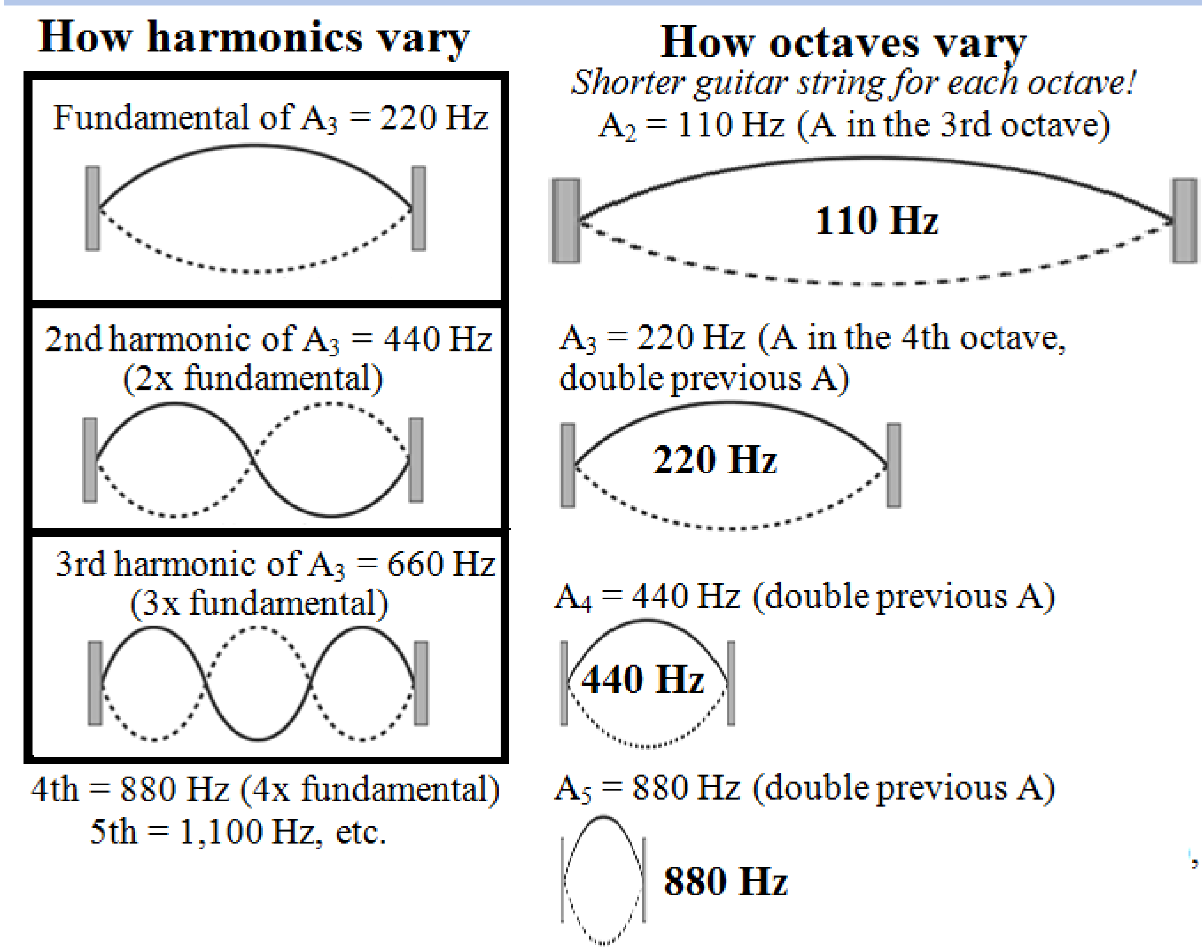
Western Musical System

- A_0 is 27.5 Hz (fundamental). Find these frequencies.
  - What is A_1? A_2? A_3?
  - What is the 3rd Harmonic of A_2? 4th Harmonic? (guitar)
- Each octave doubles the frequency
- Each octave: 12 notes (Keyboard: 7 white keys, 5 black keys)
- Each note about 6% higher f than previous note (5.946% higher)
- What is f for A_2? G_4#? A_3#?



Harmonics vs. Octaves

- Octaves ARE the fundamental (1^{st} harmonic)
  - Shorter guitar string
- Harmonics coexist on same string so not monotone
  - Harmonics produce timbre – rich sounds



Wave speed harmonics for closed-closed systems

- Closed-closed means nodes at both ends (slinky, guitar string, etc.)
- We don’t do math for other systems in this (tuning fork and metal pipe demos showed open-open systems)
- Note (including octave) determines fundamental frequency
- Count wavelengths in particular harmonic
- Use $v = f\lambda$ (three variables, I give you two, you use equation to find missing one!)