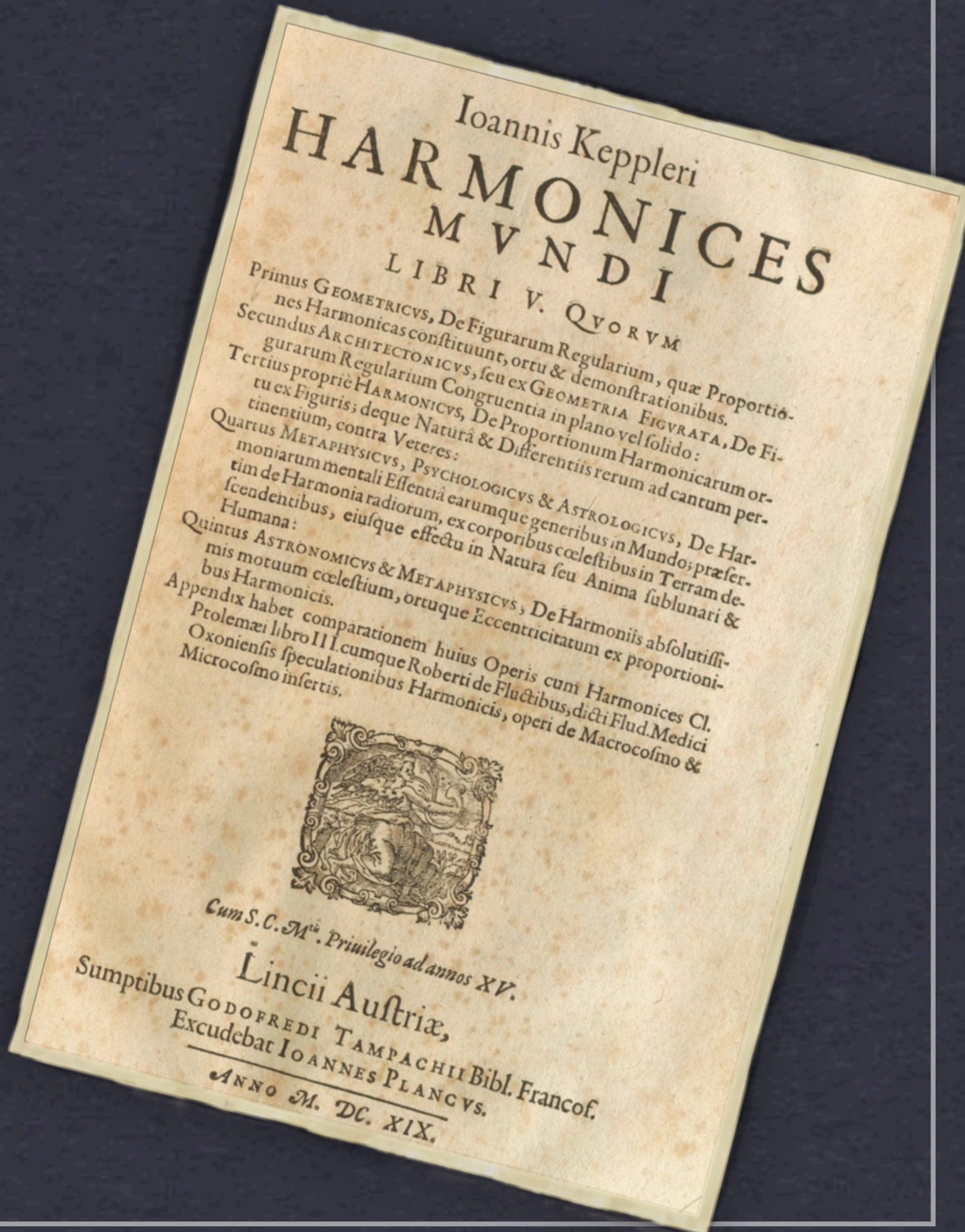
Harmonics

2012 Lecture



Ioannis Keppleri

HARMONICES MVNDI

LIBRI V. QVORVM

Primus GEOMETRICVS, De Figurarum Regularium, quæ Proportiones Harmonicas constituunt, ortu & demonstrationibus.

Secundus ARCHITECTONICVS, seu ex GEOMETRIA FIGVRATA, De Figurarum Regularium Congruentia in plano vel solido:

Tertius propriè HARMONICVS, De Proportionum Harmonicarum ortu ex Figuris; deque Naturâ & Differentiis rerum ad cantum pertinentium, contra Veteres:

Quartus METAPHYSICVS, PSYCHOLOGICVS & ASTROLOGICVS, De Harmoniarum mentali Essentiâ earumque generibus in Mundo; præsertim de Harmonia radiorum, ex corporibus cœlestibus in Terram descendentibus, eiusque effectu in Natura seu Anima sublunari & Humana:

Quintus ASTRONOMICVS & METAPHYSICVS, De Harmoniis absolutissimis motuum cœlestium, ortuque Eccentricitatum ex proportionibus Harmonicis.

Appendix habet comparationem huius Operis cum Harmonices Cl. Ptolemæi libro III. cumque Roberti de Fluctibus, dicti Flud. Medici Oxoniensis speculationibus Harmonicis, operi de Macrocosmo & Microcosmo insertis.

Cum S. C. Mtis. Priuilegio ad annos XV.

Lincii Austriæ,

Sumptibus GODOFREDI TAMPACHII Bibl. Francof.

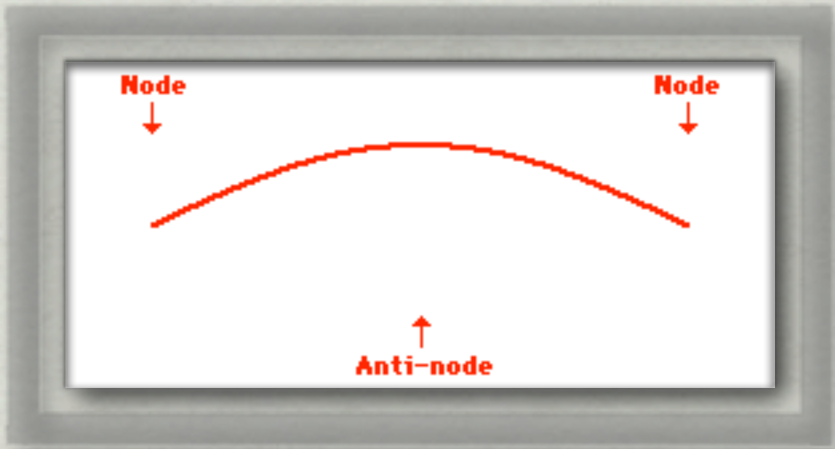
Excudebat IOANNES PLANCVS.

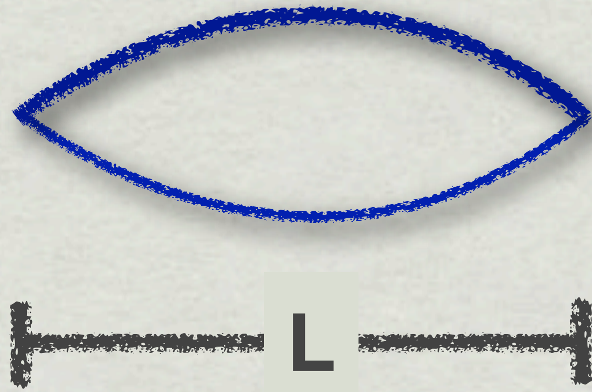
ANNO M. DC. XIX.

Harmonics

- From Wikipedia 1/24/2011
- The tight relation between overtones and harmonics in music often leads to their being used synonymously in a strictly musical context, but they are counted differently leading to some possible confusion. Harmonics are not overtones, when it comes to counting. Even numbered harmonics are odd numbered overtones and vice versa.
  In many musical instruments, it is possible to play the upper harmonics without the fundamental note being present. In a simple case (e.g., recorder) this has the effect of making the note go up in pitch by an octave; but in more complex cases many other pitch variations are obtained. In some cases it also changes the timbre of the note. This is part of the normal method of obtaining higher notes in wind instruments, where it is called overblowing. The extended technique of playing multiphonics also produces harmonics. On string instruments it is possible to produce very pure sounding notes, called harmonics or flageolets by string players, which have an eerie quality, as well as being high in pitch. Harmonics may be used to check at a unison the tuning of strings that are not tuned to the unison. For example, lightly fingering the node found half way down the highest string of a cello produces the same pitch as lightly fingering the node 1/3 of the way down the second highest string. For the human voice see Overtone singing, which uses harmonics.
- The fundamental frequency is the reciprocal of the period of the periodic phenomenon.

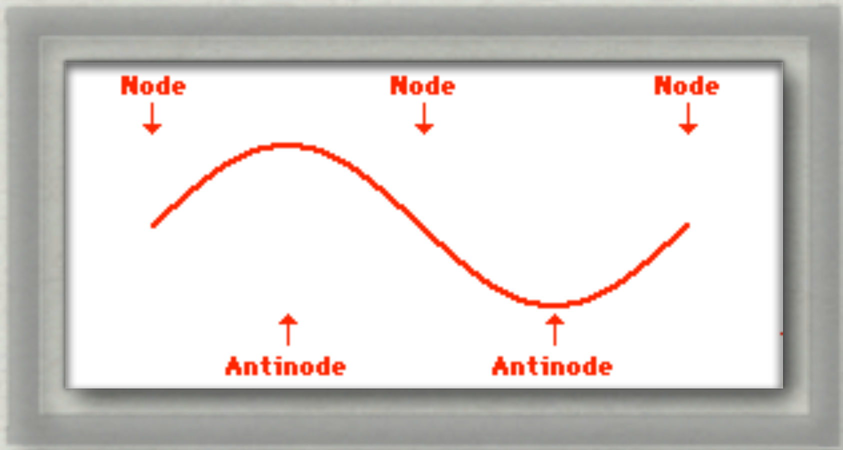
Standing waves on a string

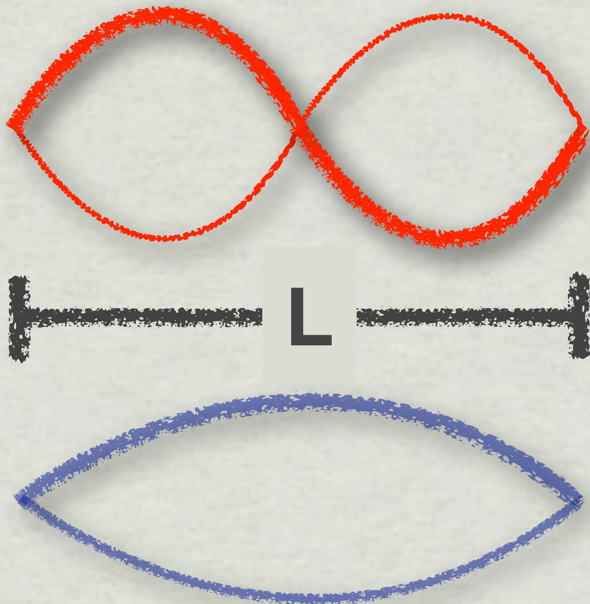




- Fundamental Frequency
- First Harmonic
- Wavelength $\lambda = (2/1)\ L$

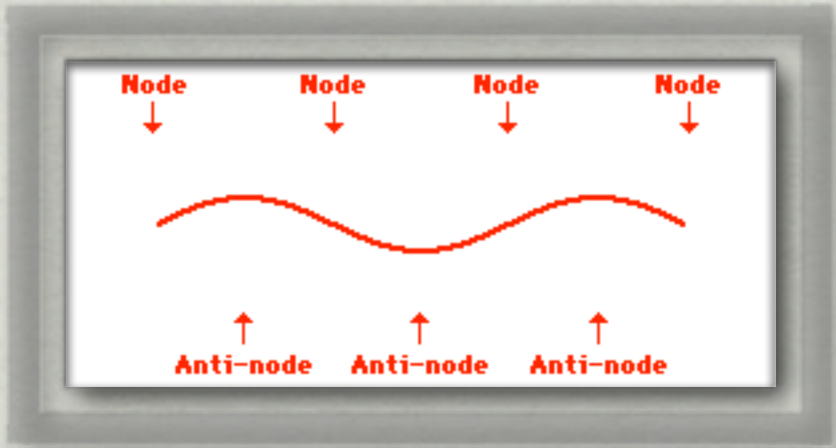
Standing waves on a string

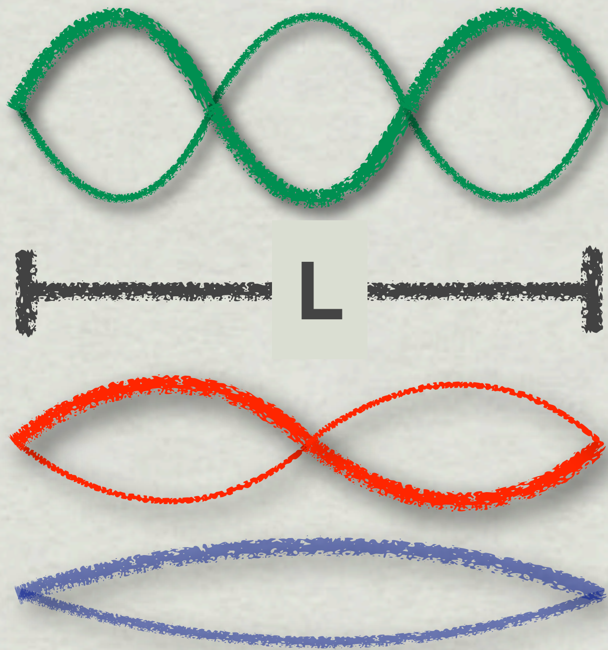




- First Overtone
- Second Harmonic
- Wavelength $\lambda = (2/2)\ L$

Standing waves on a string

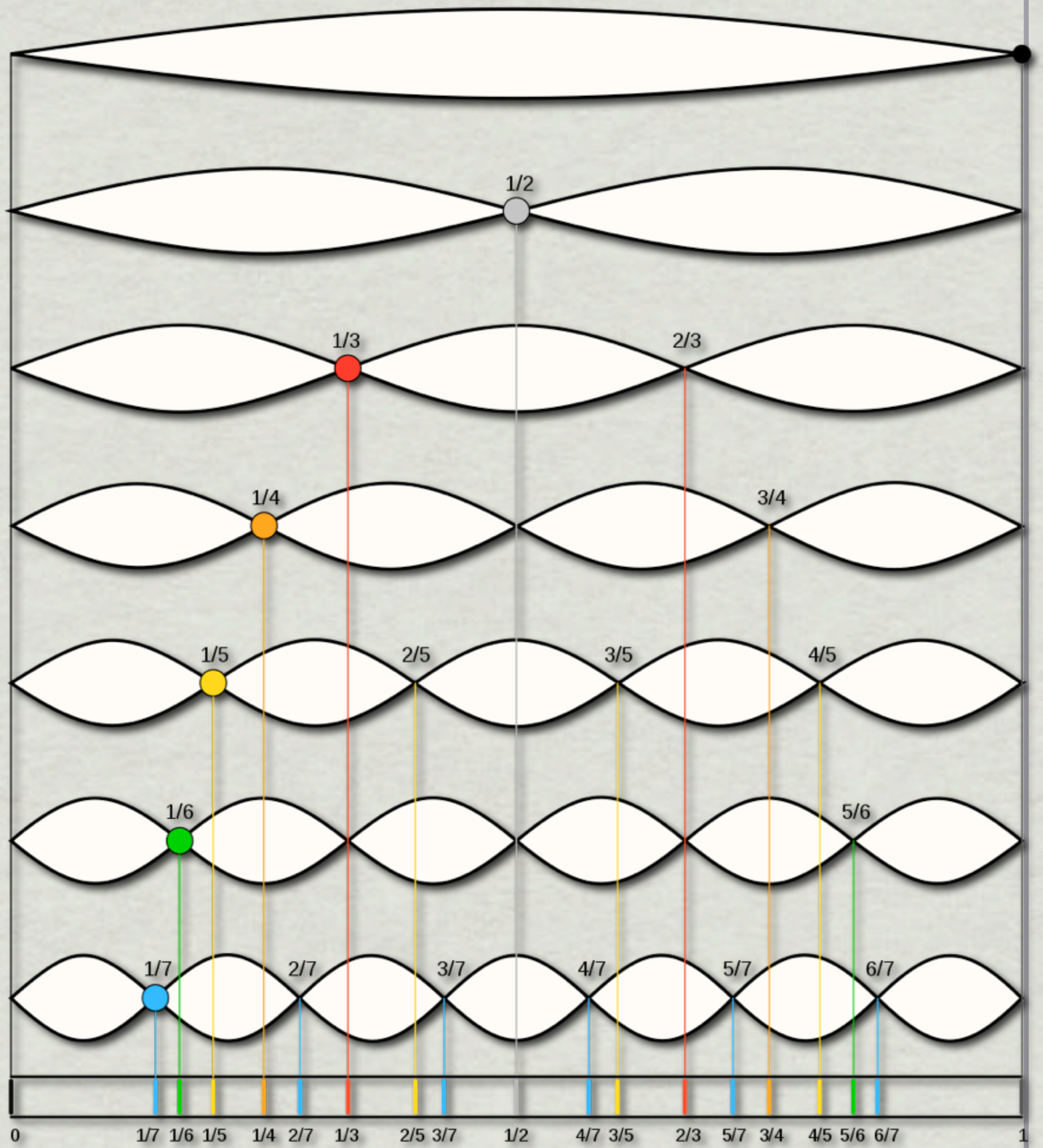




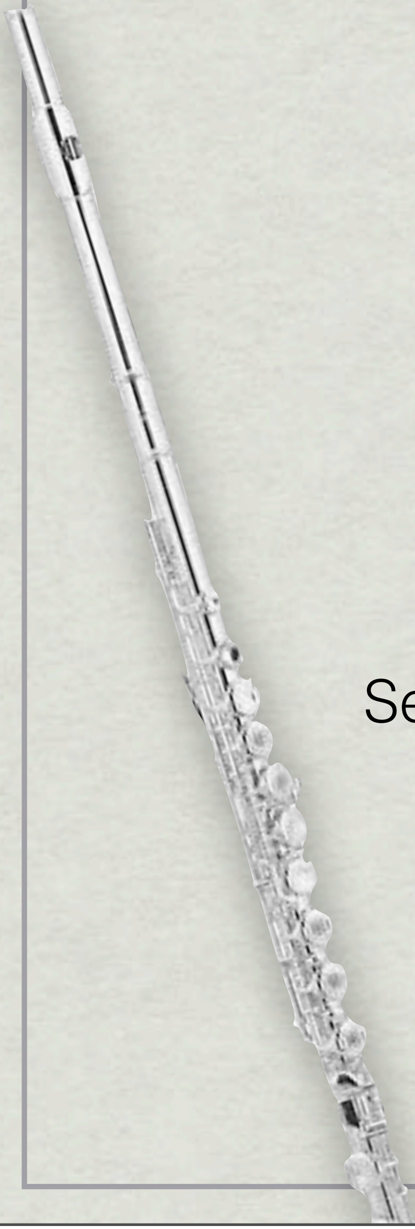
- Second Overtone
- Third Harmonic
- Wavelength $\lambda = (2/3)\ L$

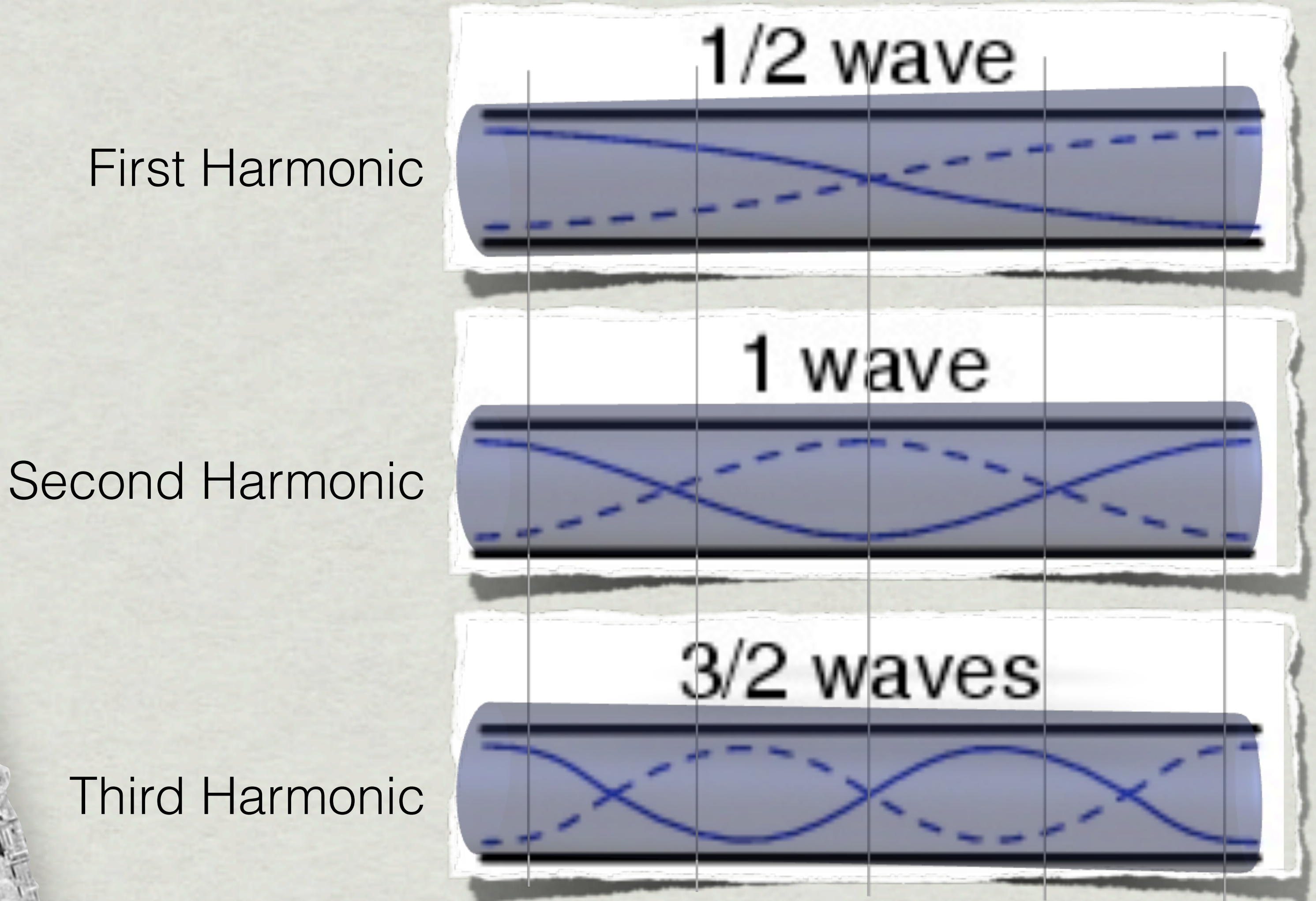
And so on...

* Each harmonic follows the same pattern
* $\lambda = (2/n)\ L$

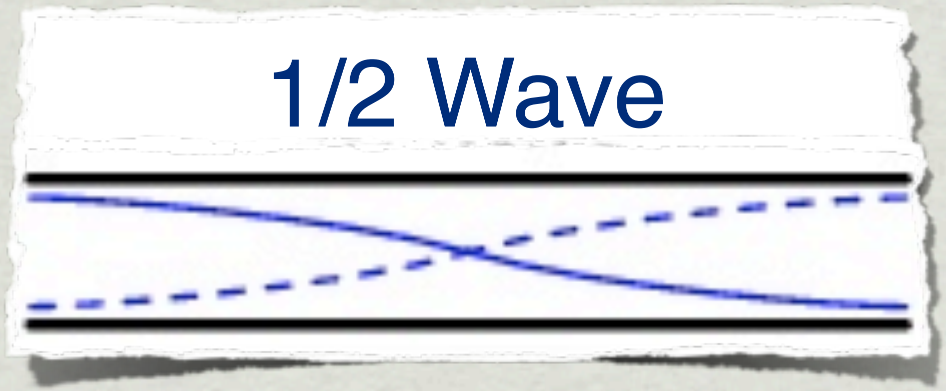


Standing waves in an open tube





Standing waves in an open tube

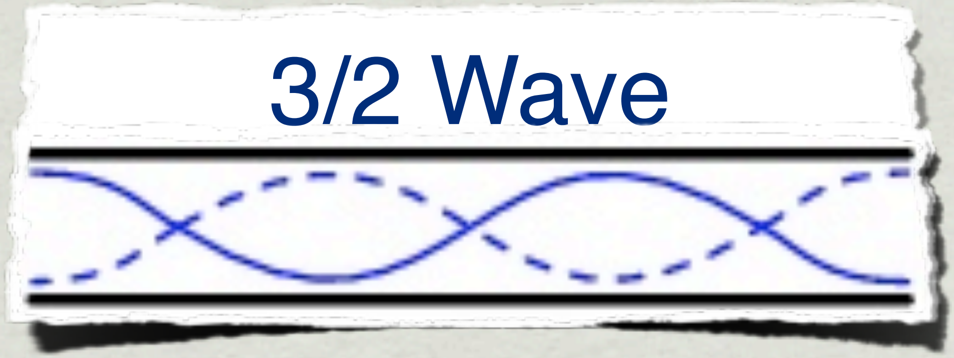


* Fundamental Frequency
* First Harmonic
* Wavelength $\lambda = (2/1)\ L$

Standing waves in an open tube

- First Overtone
- Second Harmonic
- Wavelength $\lambda = (2/2)\ L$

Standing waves in an open tube

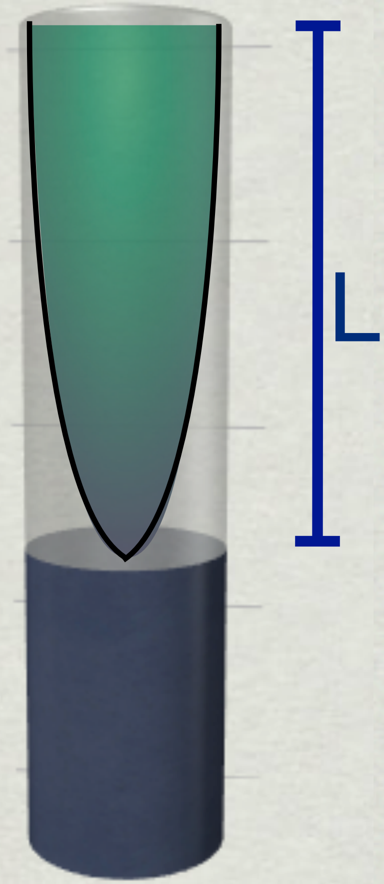


- Second Overtone
- Third Harmonic
- Wavelength $\lambda = (2/3)\ L$

Standing waves in a closed tube

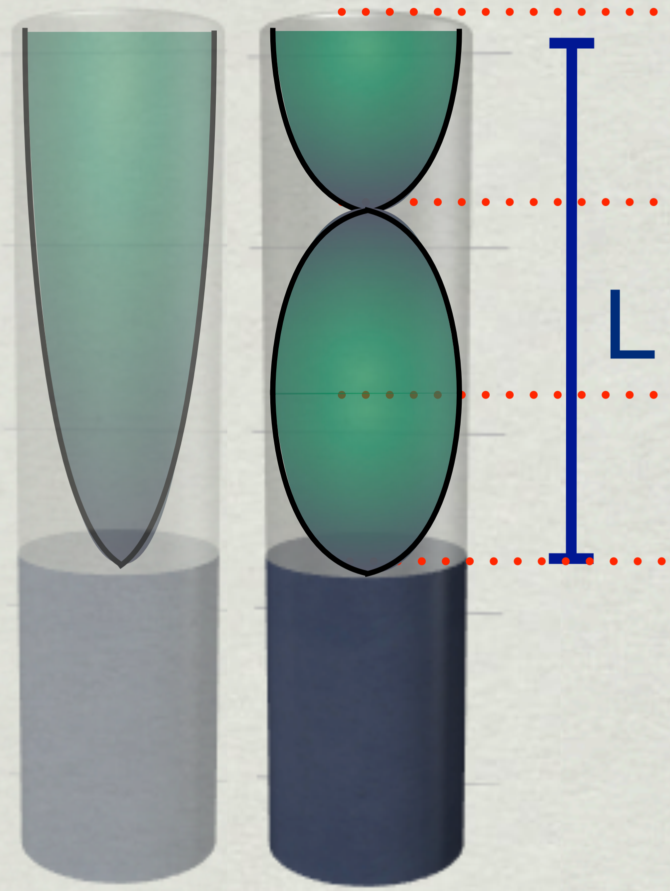
Standing waves in a closed tube

- Fundamental Frequency
- First Harmonic
- Wavelength $\lambda = (4/1)\ L$



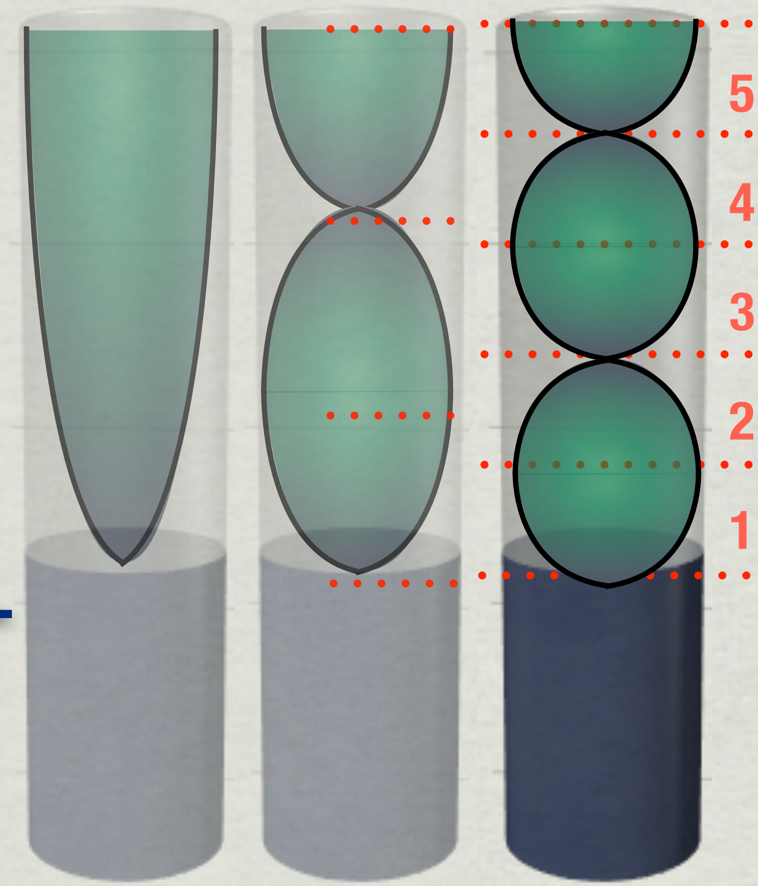
Standing waves in a closed tube

- First Overtone
- **Third** Harmonic
- Wavelength $\lambda = (\mathbf{4/3})\ L$

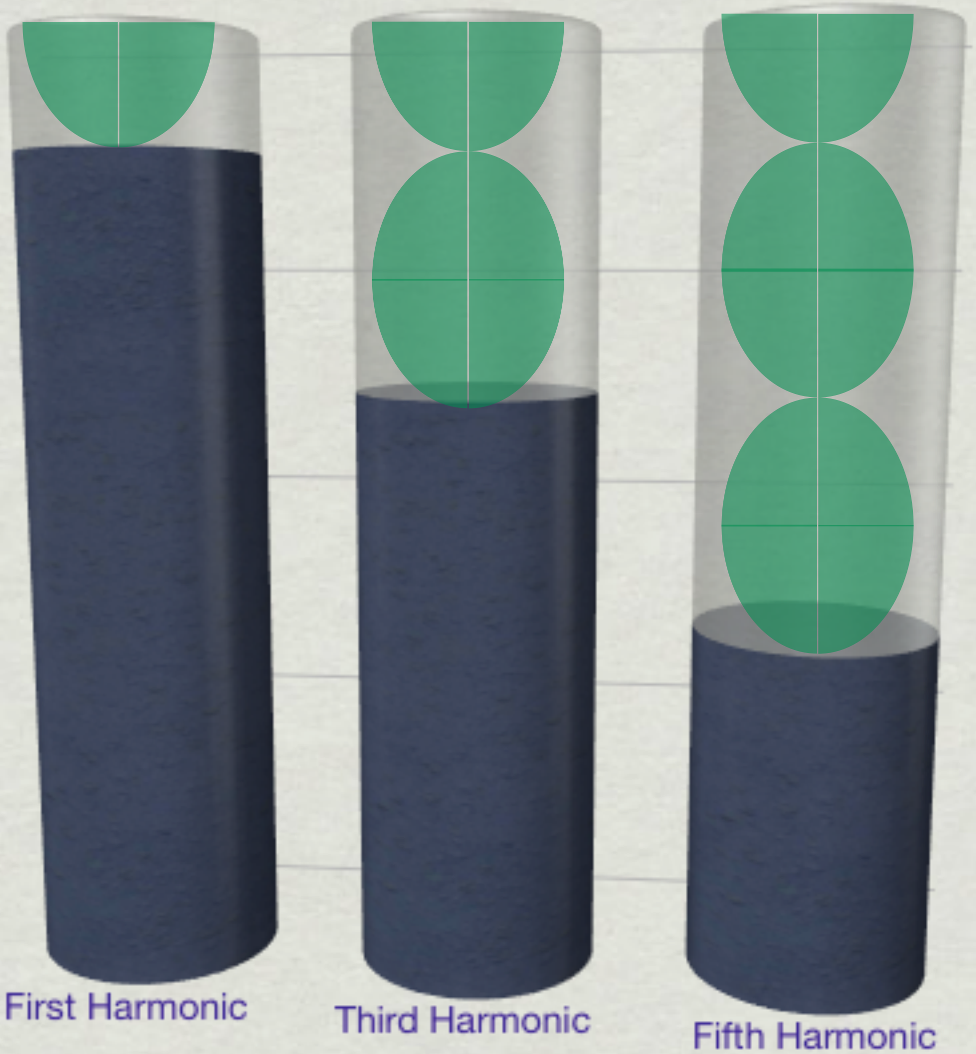


Standing waves in a closed tube

- Second Overtone
- **Fifth** Harmonic
- Wavelength $\lambda=(\mathbf{4/5})L$



* Constant wavelength
* change L instead of f



Or... the same note at new lengths