# Lab Assignment #03 — Resonance frequencies

Due W Sept 7 at 11:15am on Sakai (Tests & Quizzes)
20 points total

***Lab session:*** Part of class on F Sept 2 is a lab session for this assignment. You will have an opportunity to collaborate with classmates, get help with Praat, and ask questions.

## Purpose

This assignment provides an opportunity to:

- Review **period** and $f_0$ and how to determine them using the **waveform** of a sound file in Praat
- Use the Praat **spectral slice** (=**power spectrum** in *AAP*) function to find the **components** of a complex wave and **determine resonance frequencies**
- Relate the **resonance frequencies** of a tube to the **boundary conditions** and **length** of the tube

## Task

### A. Prepare to complete the lab assignment

- **Download** the following files from the "Lab assignments" page and save them on your computer, and then open them with Praat. You will probably need to right-click on the link and choose "Download as...", "Save as...", "Save link as...", or something similar.

  `[lab03_tube01.wav]`
  `[lab03_tube02.wav]`
  `[lab03_tube03.wav]`

### B. Answer questions (1)–(10) directly in Sakai

- Go to Tests & Quizzes, "Lab 03 | Resonance frequencies" (may be saved; no time limit)
- Reminders: Use Praat handouts #2–4 to help you navigate in Praat, open sound files, and play sounds. Use my feedback on your previous labs to check your understanding of concepts from earlier in the course.

## Part 1: Review—Calculating $f_0$ from a waveform

Open each of the three sound files `[lab03_tube01.wav]`, `[lab03_tube02.wav]`, and `[lab03_tube03.wav]` in its own Sound window in Praat. (Refer to the Praat handouts and previous lab assignments if you need reminders for how to do this.)

(1) For **Tube01**, use the Praat waveform display to measure the **period** of the wave. Then use your measurement to calculate $f_0$. Show your work. Do the same for **Tube02** and for **Tube03**. (Measure the period for each wave near the time midpoint of the sound.)

## Part II: Resonance frequencies

In class, we have discussed in detail how the length of a tube and its boundary conditions determine its resonance frequencies. In this lab, we will **examine the sound waves** produced by a column of air vibrating in three different tubes, using information about the **components** of these sound waves to determine the **boundary conditions** and calculate the **length** of each of the tubes.

Before we being looking at spectra to find components of the sound waves, we will need to fine-tune the spectrogram/spectrum settings.

- Close all your Sound windows in Praat except for the one for Tube01.
- In the top menu of the `Sound lab03_tube01` window, click on `Spectrogram > Spectrogram settings`. A box with various preset values should appear. In the field labeled `Window length (s)`, set the value to **0.5** and click `OK`. (Note: not 0.05 as for Lab #02, but 0.5!)

(2) In the `Sound lab03_tube01` window, click approximately at the (time) midpoint of the Tube01 sound wave. Use `Spectrogram > View spectral slice` to see a **spectrum** of this wave. Find the **three strongest (highest amplitude) components** visible in this spectrum; they should be located toward the low end of the frequency axis. These are the **first three resonances** of the tube—that is, the resonances with the three lowest frequencies. State the **frequencies** of these three resonances, from lowest to highest. (Remember units of measurement.)

(3) Determine the **boundary conditions** for Tube01. Is this tube open at both ends, or open at one end and closed at the other? **Explain** how you determined this.

(4) How **long** is Tube01? Show your work.

(5) Now do the same for Tube02. Open this sound file in a Sound window, click at the (time) midpoint of the sound wave, view a spectrum (spectral slice), and **give the frequencies of the first three resonances** (again, this will be the three strongest components at the low end of the frequency axis.)

(6) Determine the **boundary conditions** for Tube02 and **explain** how you determined this.

(7) How **long** is Tube 02? Show your work.

(8) Finally, do the same for Tube03. Open the sound, view a spectrum, and **give the frequencies of the first three resonances**. (For this sound file, a few of the higher-frequency resonances are about the same amplitude as the third one, so don't be fooled.)

(9) Determine the **boundary conditions** for Tube03 and **explain** how you determined this.

(10) How **long** is Tube 03? Show your work.

## Criteria for success

This lab assignment is worth a total of 20 points. Each question is worth 2 points. Points will be awarded for accuracy, and partial credit will be given where appropriate. Some of the questions will be automatically graded on Sakai, but I will check everything by hand in case of Sakai errors.