3.9.2.2: Beats and Critical Bands Simulation

In this simulation you can hear and see two frequencies and their combination. You can view either the red signal or the green signal and/or their combination (in blue) using the check boxes at the top. The slider labeled Δ adds or subtracts an amount from f_A to modify f_B. The plot is what you would see on an oscilloscope connected to a microphone near the two sound sources with these frequencies. The delay slider sets the phase difference between the two signals so that you can see how they combine at different times which is equivalent to moving the microphone closer or further from the sources. The Scope Δt menu adjust the horizontal axis scale on the oscilloscope, allowing you to zoom in or out on the view. Time is measured in seconds.

Simulation Questions:

1. Listen to the combination $f_A = 300\text{ Hz}$ and $f_B = 305\text{ Hz}$ and describe what you hear.
2. The beat frequency is calculated by subtracting the two frequencies and taking the absolute value (to get a positive number). What is the beat frequency for the combination $f_A = 300\text{ Hz}$ and $f_B = 305\text{ Hz}$?
3. Change the Scope Δt measurement to zoom in and out on the signal. Why does the combination wave (blue) get larger and smaller?
4. Change f_B to be 302 Hz. Does the beat frequency get larger or smaller?
5. Now try a frequency of 310 Hz for f_B. What do you notice about the beat frequency?
6. It is also possible to hear beats between notes that are nearly an octave apart (double the frequency). This is called ***waveform beats***. First listen to a 201 Hz signal and a 200 Hz signal. Now listen carefully to a 201 Hz signal and a 400 Hz signal (this is a little hard to detect without earphones). Is it the same beat frequency?
7. In the previous example you should have heard a beat frequency of 1 Hz for the 201 Hz plus 200 Hz combination but a 2 Hz beat frequency for the 201 Hz signal added to the 400 Hz signal. This is because our ear/brain system hears the beating between $2 \times 201 = 402\text{ Hz}$ and 400 Hz. Now compare this to a 200 Hz signal added to a 401 Hz signal. What is the beat frequency in this case? In this case our ear/brain system compares $2 \times 200 = 400\text{ Hz}$ with 401 Hz and hears a beat frequency of 1 Hz.
8. Reset the simulation and very slowly adjust the Δ slider to hear different combinations. For small differences in frequency you will hear beats. For slightly larger differences you will hear roughness (as described in the text). As the frequencies get even further apart you will hear two notes (or a combination that does not sound rough). Adjust Δ until the perception of beats begins to sound rough. What is Δ at this point?
9. Now try to find the value of Δ where the perception of roughness starts to sound like separate notes or harmonious. What value ofΔ did you get for this transition?
10. If you repeat the previous two questions for a different starting frequency for f_A you may get a different critical band. Try this and describe your results.