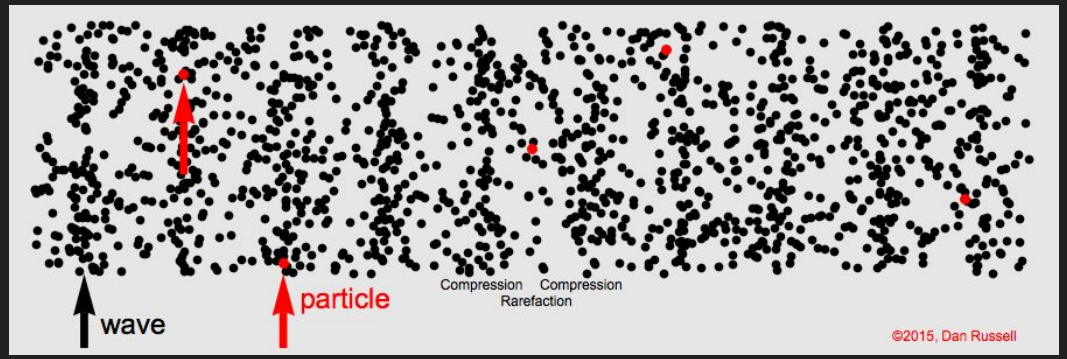
Mathematics of Music

Week 2: Stacking frequencies

Recap of last time

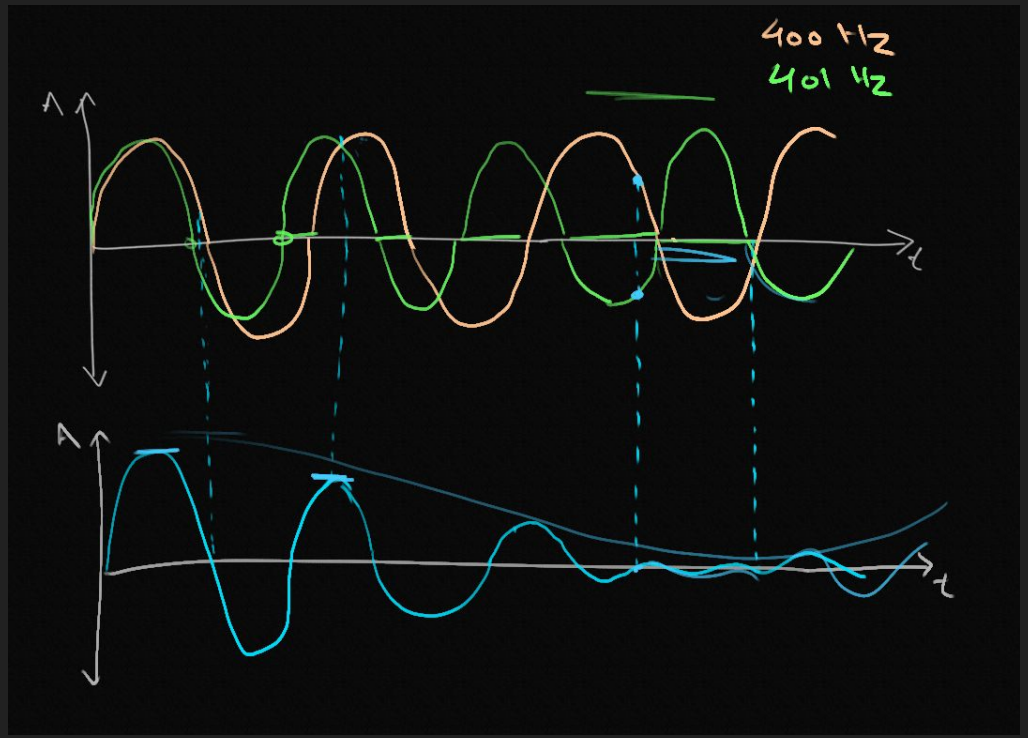
- sound waves:
  - pressure
  - transverse and longitudinal



- frequency and amplitude

Recap of last time

- beats
- speed of sound
  - speed of air?



Pitch and loudness

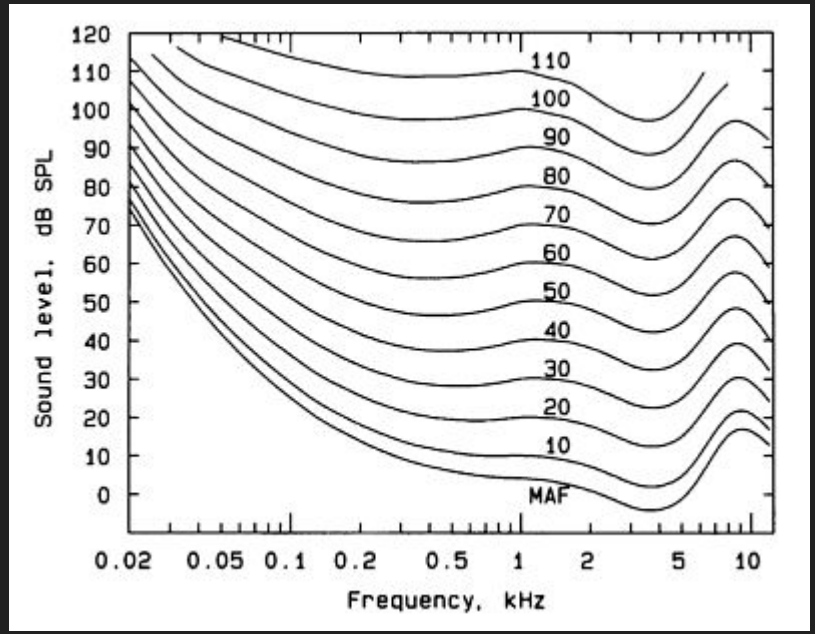
- pitches: C D E F G A B
  frequencies: ?
    - maybe 10, 20, 30, 40, ...
    - maybe 10, 20, 40, 80, ...

- what's special about octaves?

Pitch and loudness

- human hearing: 20 Hz to 20 kHz
- "loud" sounds can...
  - shake your bones
  - pierce your ears
  - drown your thoughts

- 2x amplitude = 2x loudness?



Let's add frequencies

- is 800 Hz
- 400 Hz + 800 Hz
- 400 Hz + 600 Hz
- 400 Hz + 440 Hz (?)

Is there a pattern in what sounds good and what doesn't? What do the waveforms look like?

Sound like a saxophone

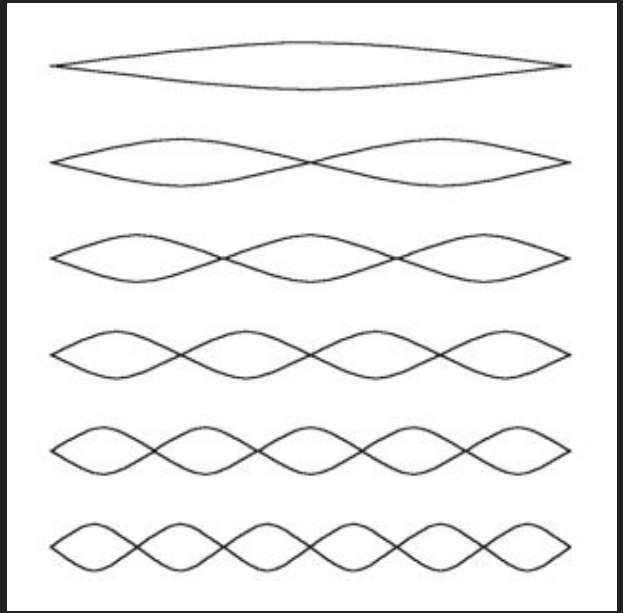
(demo)

→ additive synthesis! used in many older synths

Harmonics

- modes of vibration
- why does a violin sound different from a trumpet? why do our voices sound different?

- "partials", "overtones", etc.



Listening samples

https://youtu.be/YsbrRAgv1b4?t=1830

Listening samples

https://www.youtube.com/watch?v=Bfe4TxvUOiw

More about harmonics

Chladni figures:
https://www.youtube.com/watch?v=lRFysSAxWxI

"Slinky Whistlers" (you can try at home!)
https://esp.mit.edu/download/a6655f18-3dbc-4f7c-a0a3-3605953e7c39/M14117_slinky_whistlers.pdf

Next time

- adding frequencies → sound
- sound → break up into frequencies?
-  ?

Thank you!