The White Album

...the full spectrum of sound

Frequency Bandwidth

- a selected range of frequencies
- a frequency (Hz) window

White Noise

- White Noise is an electronically generated spectrum of sound ranging across the entire frequency bandwidth of human hearing.
- White Noise is similar to white light in that it contains all frequency components that are detectable by human perception.

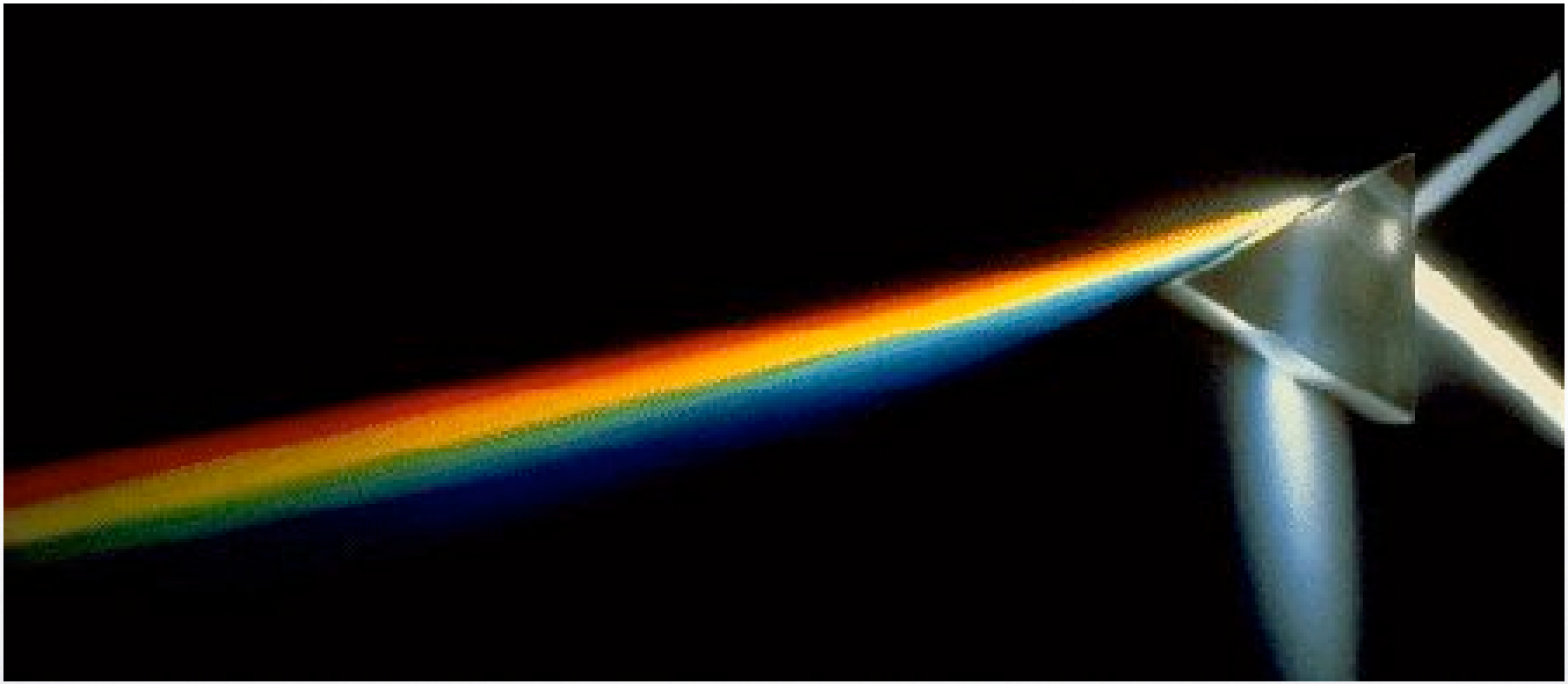
Example...

Let's look at light...

...for a moment.

Prism:

A prism splits white light into the separate frequency components that determine perception of color.




Red 480-405 THz
Orange 510-480 THz
Yellow 530-510 THz
Green 600-530 Thz
Cyan 620-600 Thz
Blue 680-620 Thz
Violet 790-680 Thz

Light Sound and Hz

- Pertaining to **Light**
  - ✴ Frequency ~ **Color**

- Pertaining to **Sound**
  - ✤ Frequency ~ **Pitch**

The closest thing...

...to a prism

Bandwidth in the real world:

Human Hearing: 20 - 20,000 Hz
Hi-fi Stereo: 20 - 20,000 Hz
FM Radio: 20 - 15,000 Hz
AM Radio: 20 - 5,000 Hz
Telephone: 300 - 3,400 Hz

Bandwidth in the real world:

Acoustic Bass: 41-96 HZ
Cello: 65-523 Hz
Violin: 196-1979 Hz
Piano: 28-4186 Hz
Trombone: 58-466 Hz
Trumpet: 165-2349 Hz
Alto Sax: 139-831 Hz
Flute: 262-2093 Hz
Piccolo: 587-4186 Hz
Bass Voice: 82-262 Hz
Tenor Voice: 130-523 Hz
Soprano Voice: 220-1047 Hz
(Mariah Carey - high as 2093 Hz)

Question:

IF the highest musical pitch fundamental is 4186 Hz (piano), then why is it necessary to hear above 4186 Hz?

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1. What is pitch?

2. What determines pitch?

3. What is the difference between "pitch" and "brightness?"

“Tone” vs. “Timbre”

- Tone - for our purposes relates to the perceived pitch frequency of a sound.

- Timbre - refers to the quality of a sound as defined by upper partial harmonics.

Example...

About Pitch

- “**Pitch Frequency**” - frequency of the sine wave that matches the perceived pitch.
- “**Fundamental Frequency**” - frequency of the sine wave that matches the perceived pitch.
- “**Fundamental**” - frequency of the sine wave that matches the perceived pitch.

Review: "Partial Harmonics"

Musical sounds have upper partial harmonics that are integer multiples of the fundamental pitch frequency.

Example:

Open E on guitar - E4

- 1st Partial (fundamental) 329.63 Hz
- 2nd Partial (fundamental x 2) 659.26 Hz
- 3rd Partial (fundamental x 3) 988.89 Hz
- 4th Partial (fundamental x 4) 1318.52 Hz
- 5th Partial (fundamental x 5) 1648.15 Hz

Example...

Remember the telephone question?

How can a male voice resonating at 295 Hz and below be perceived on a telephone line with a bandwidth of 300 - 3400 Hz?

Here is how:

In order for a tonal pitch to be perceived, only three successive partials of the fundamental pitch frequency need be present.

Example...

Loudness

Can you hear me?

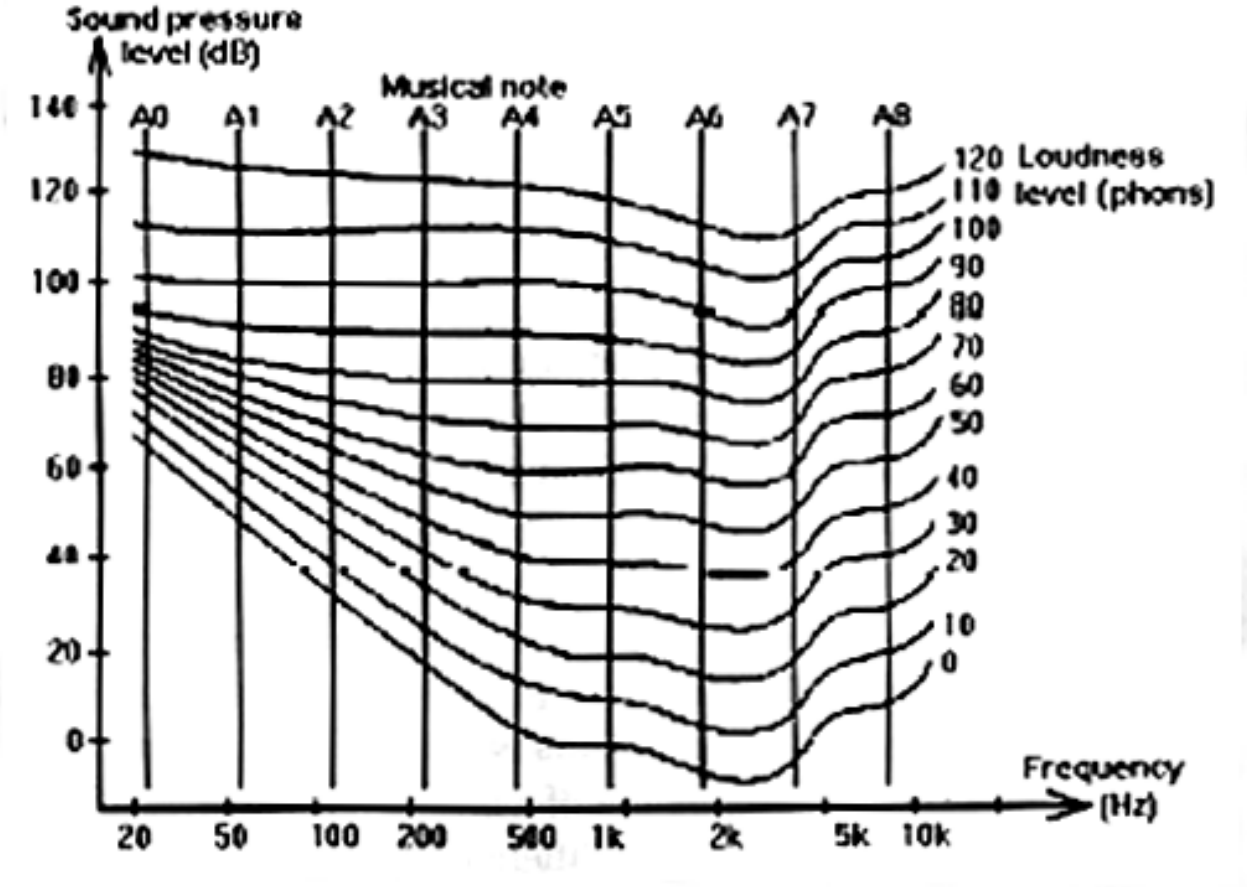
Loudness

- is not the same as amplitude
- does not pertain to SPL

Loudness

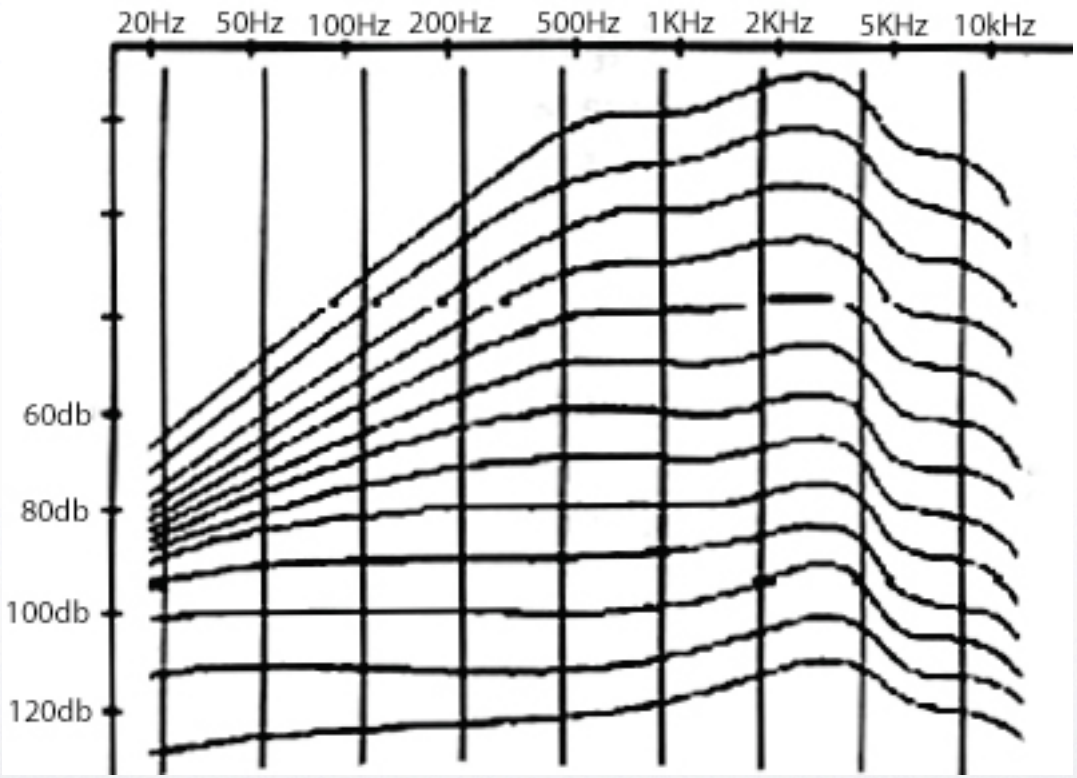
- has to do with how auditory phenomenon are perceived.
- has to do with how audio is decoded by the ears and the brain.

Equal Loudness Curves



Displays the SPL necessary for a sine wave at a certain frequency to sound equally "loud" as sine waves at other frequencies on the same curve.

Equal Loudness Curves (inverted)



Example...

See why partials are important?

Perceived loudness of musical and non-musical tones depends greatly on upper harmonics present.

Why do I care?

- Equal amplitude does not translate to equal loudness.
- Optimum frequency bandwidth for human perception is 500 - 3000 Hz.
- More Partials = Greater Loudness

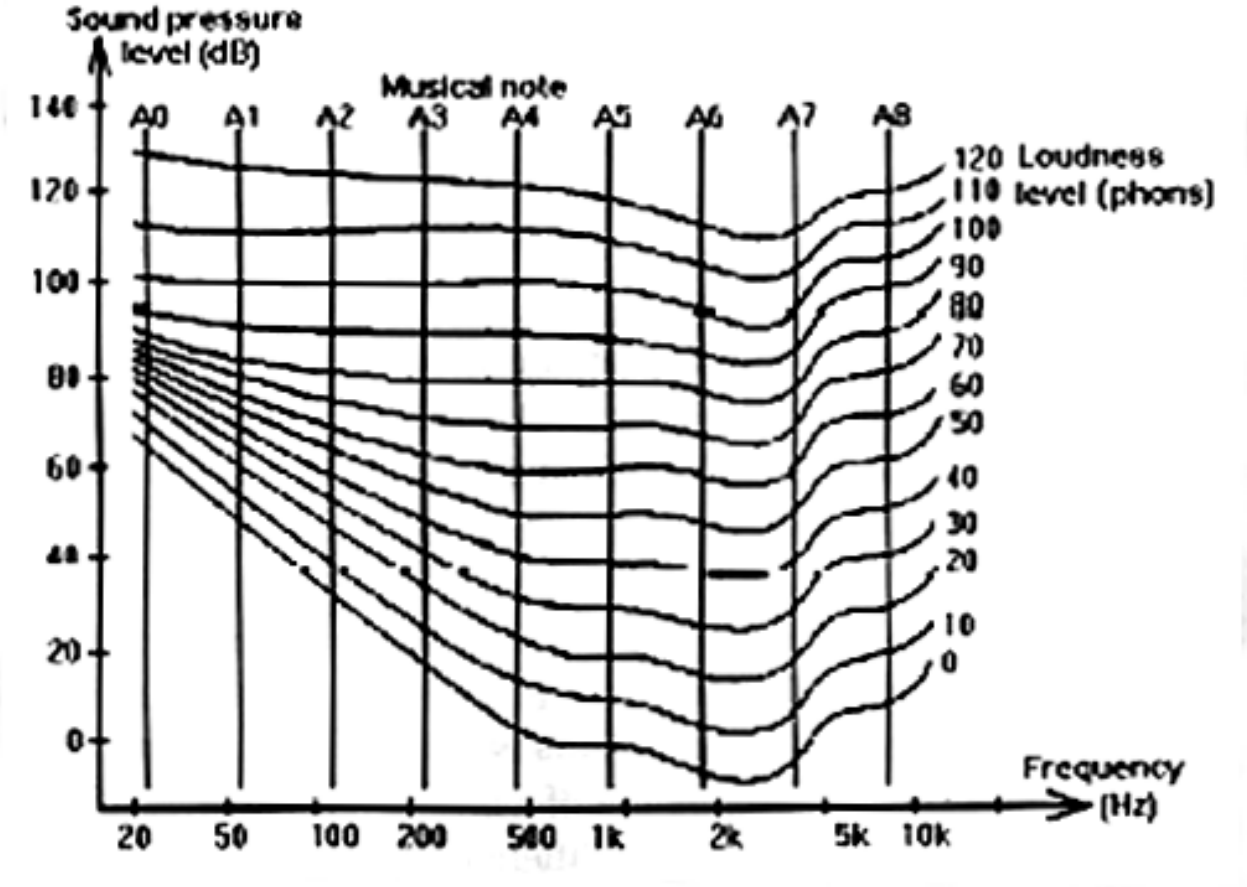
IMPACT

- Impact is created by dramatic contrast.
- In audio, dramatic contrast is produced not only by adjusting amplitude of sounds, but also the complexity (timbre) of sounds.

The DEAD

- The sound engineer kept SPL range at 100 -110 db.
- Why?

Equal Loudness Curves



Displays the SPL necessary for a sine wave at a certain frequency to sound equally "loud" as sine waves at other frequencies on the same curve.

Double the Volume!

- How many "db" makes a sound seem 2x as loud?
  - It depends on frequency, harmonic spectrum, and current level of amplitude.
  - Generally, 5-10 db change in amplitude creates the sense of “twice as loud.”

EQ Bandwidth Ranges

3 Region

- High: 1500 Hz - 20,000 Hz
- Mid: 340 Hz - 1500 Hz
- Low: below - 20 Hz - 340 Hz

Example...

Bye, Bye.