

# Physics of Musical Sound

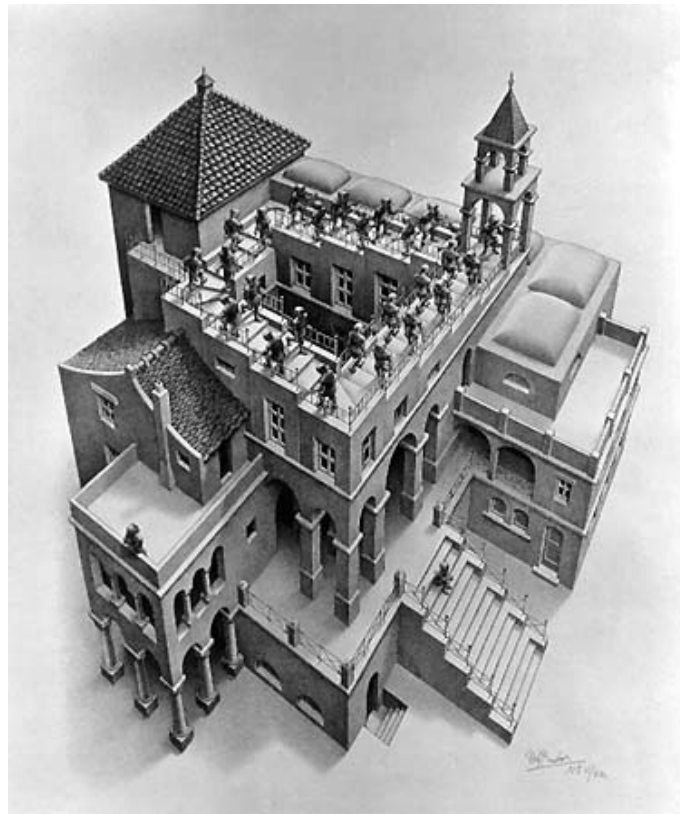
Class 11: Timbre

Read Chapter 8

Homework Due.

# A couple of holdovers

- Repetition pitch with noise
- Circular Pitch
- Pitch and Duration
- Streaming
- Missing  $f_0$



# Timbre

- Everything about a sound except its pitch and volume; that property that makes a violin sound different from a guitar and from a pipe organ.
- Three components of Timbre
  - Spectrum of the sound.
    - Breaks up the sound into the individual frequencies from which is composed.
    - Each individual frequency is called a **Partial**.
  - Envelope of the sound.
    - How the volume changes in time. Especially important for more transient sounds such as a piano or guitar.
  - Evolution of the sound.
    - How the harmonic structure changes in time.

# Timbre Words 1

- There is a fairly generally used set of words to try to describe the sensations of different timbres.
  - Bright, also clear: a quality common to birdsong, young soprano voices, piccolos, oboes, upper strings especially on their A and E strings, lead electric guitars, Luciano Pavarotti, high sounds are usually bright but low sounds can also be bright.
  - Dark, also rich: Paul Robeson, the opening bars of Das Rheingold, a trombone or tuba ensemble, the lower registers of a great contralto. Other things being equal low pitches are darker than high but a bass can sing a bright note and a soprano a dark one.

# Timbre Words 2

- Body or fullness:
- Thin: lacking in body
- Thick: the opposite, usually to the extent that the sound lacks clarity. It gets hard to be sure of the pitch and of when the pitch changes.
- Muddy: worse than thick.
- Clear: strong sensation of pitch, easy to tell as pitch and color change.
- Woody or hollow: sound of a clarinet in its low register.
- Tinny: thin, lacking in body, sounds like a poor trumpet.
- Harsh, opposite of smooth: fuzzed guitar, growling saxophone, common style of blues singing

# Sound Spectra: Analysis

- In reality, there are no truly periodic sounds in music. Instead the sounds evolve slowly in time.
  - Non-periodic sounds will require non-harmonic partials in the sound spectrum. This includes any sound whose volume or pitch is not perfectly steady.
  - So long as sounds evolve slowly the spectrum will be nearly harmonic.
  - If the sound changes its nature rapidly then the spectrum will be quite non-harmonic.
  - Slowly evolving sounds even with some mistuning of the partials still give a strong sensation of tone.
  - The pitch that we hear is the repetition pitch,  $f_0$ , even when that partial is not actually present.

# Timbre Words 1 Revisited

- Now we can relate our timbre words to the spectra.
  - Bright: possessing a lot of high frequency partials with significant amplitude.
  - Dark: has a preponderance of low frequency partials and is relatively weak in upper partials.
  - Body: related to the complexity of the spectrum. Sounds with a lot of body will have complex spectra with energy spread over a wide range of frequencies.
  - Thin: energy concentrated in a few frequencies, especially in a few upper partials.

# Timbre Words 2

- Thick: energy spread over a very wide range without much variation in strength.
- Muddy: typically caused by all energy in low partials and often with poorly tuned partials.
- Clear: well tuned partials and usually not too many very strong ones.
- Woody or hollow: Missing the even numbered low partials.
- Tinny: too much energy in the upper partials compared to the lower.
- Harsh: usually a sign of significant amounts of non-harmonic energy often due to rapid modulation of the sound too fast for vibrato.



# Envelope

- The envelope of a sound is the overall volume of the sound.
- A typical instrumental sound begins fairly rapidly (the attack) and then the sound falls, possibly to a sustained level before finally fading away (the decay).
- The envelope is quite important in recognizing the instrument making the sound. If we alter the envelope then we may make the sound unrecognisable.