SOUND5

TIMBRE

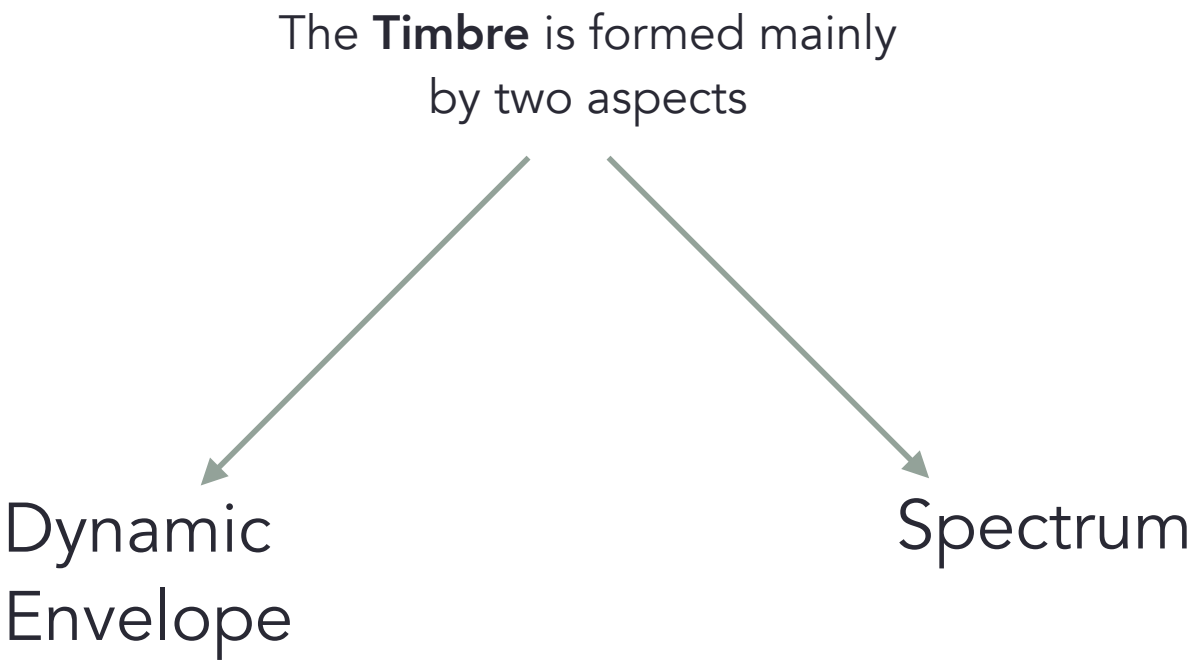
TOMMASO ROSATI

SOUND ART

Timbre

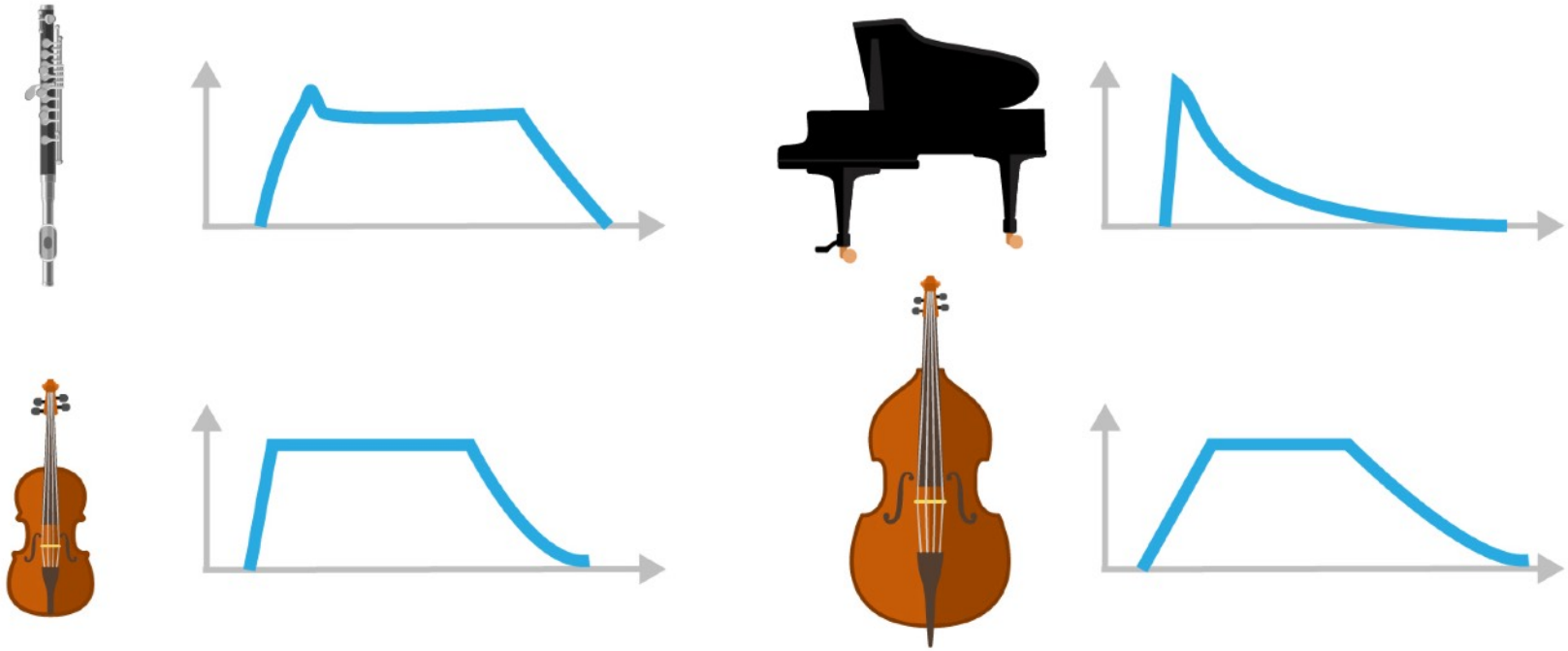
Timbre is that characteristic of sound that makes us distinguish one instrument from another, even if they emit the same note at the same dynamic.

It's not measurable as frequency, amplitude, or phase but needs multiple factors to describe it.


The **Timbre** is formed mainly
by two aspects
Dynamic
Envelope
Spectrum

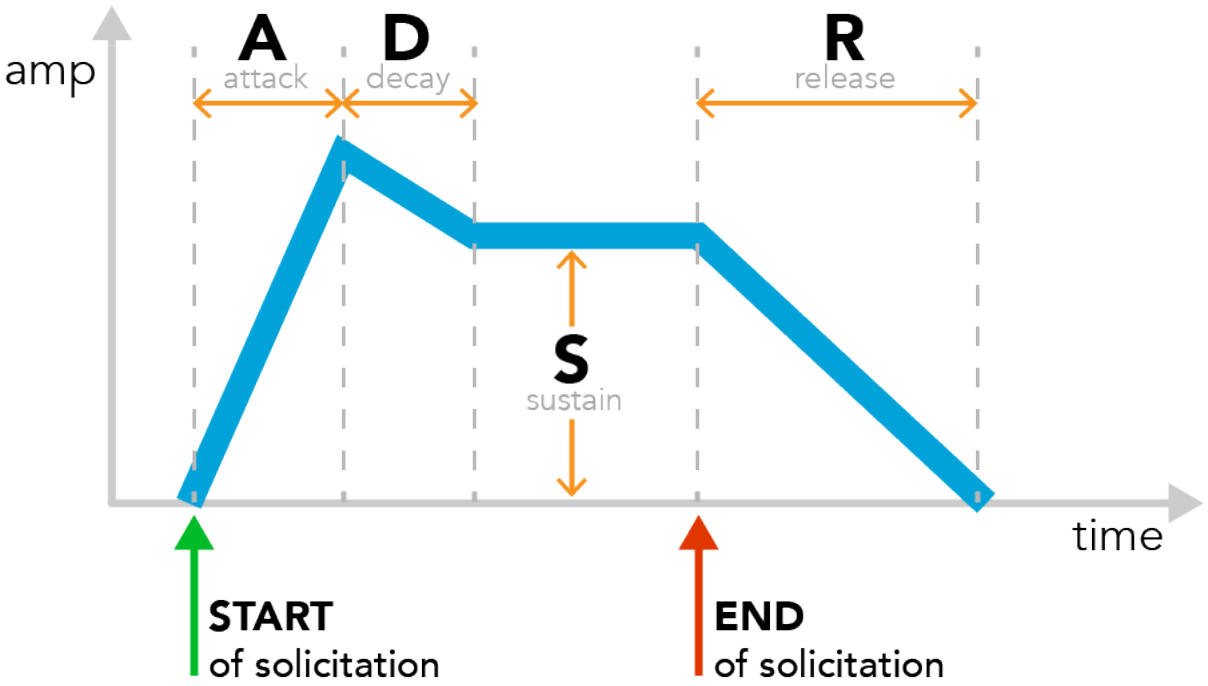
Dynamic envelope

The envelope is the evolution of the amplitude of a sound from the beginning of the vibrating body's excitation to its extinction.



Dynamic envelope

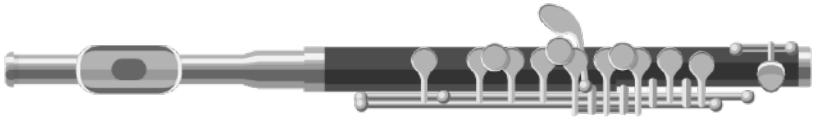
We can break it down into three stages called Attack, Decay, Sustain, Release (ADSR).

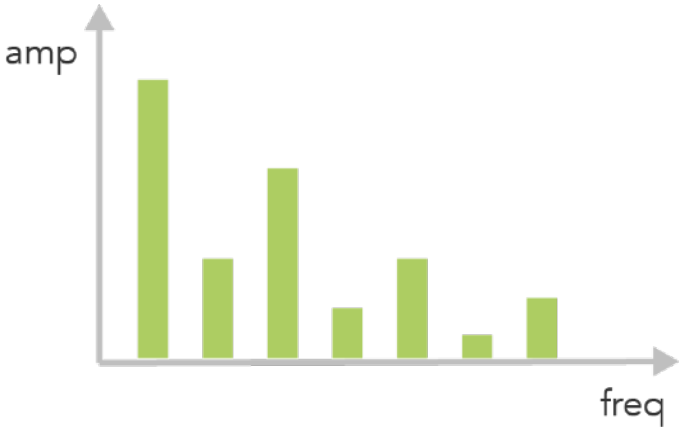


Spectrum

In nature, every sound is made up of simple **sine waves** (Fourier theorem) that form the spectrum of the sound itself.

By photographing an instant of sound, the spectrum can be represented with an **amplitude spectrum** or with a **phase spectrum**



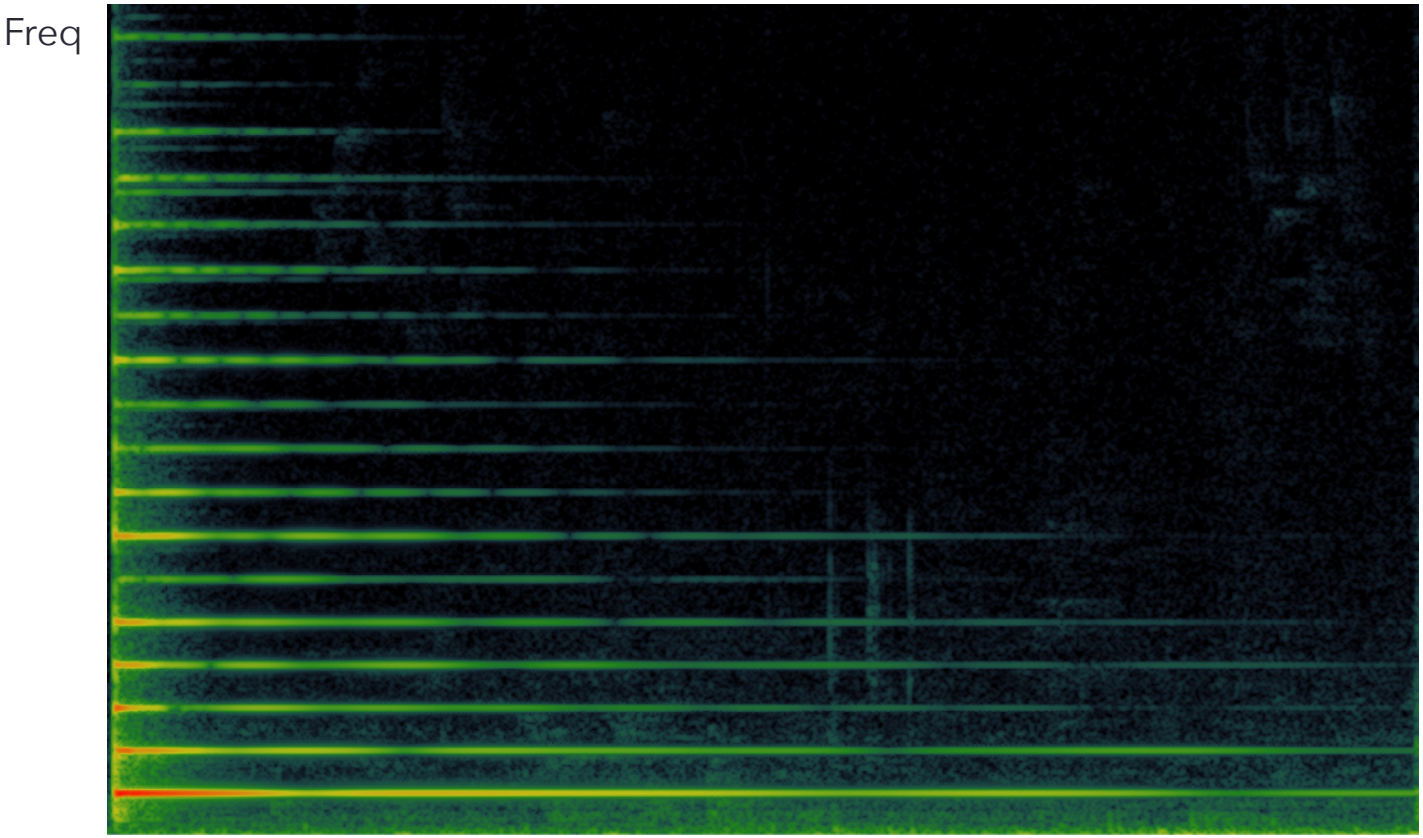


AMPLITUDE SPECTRUM

PHASE SPECTRUM

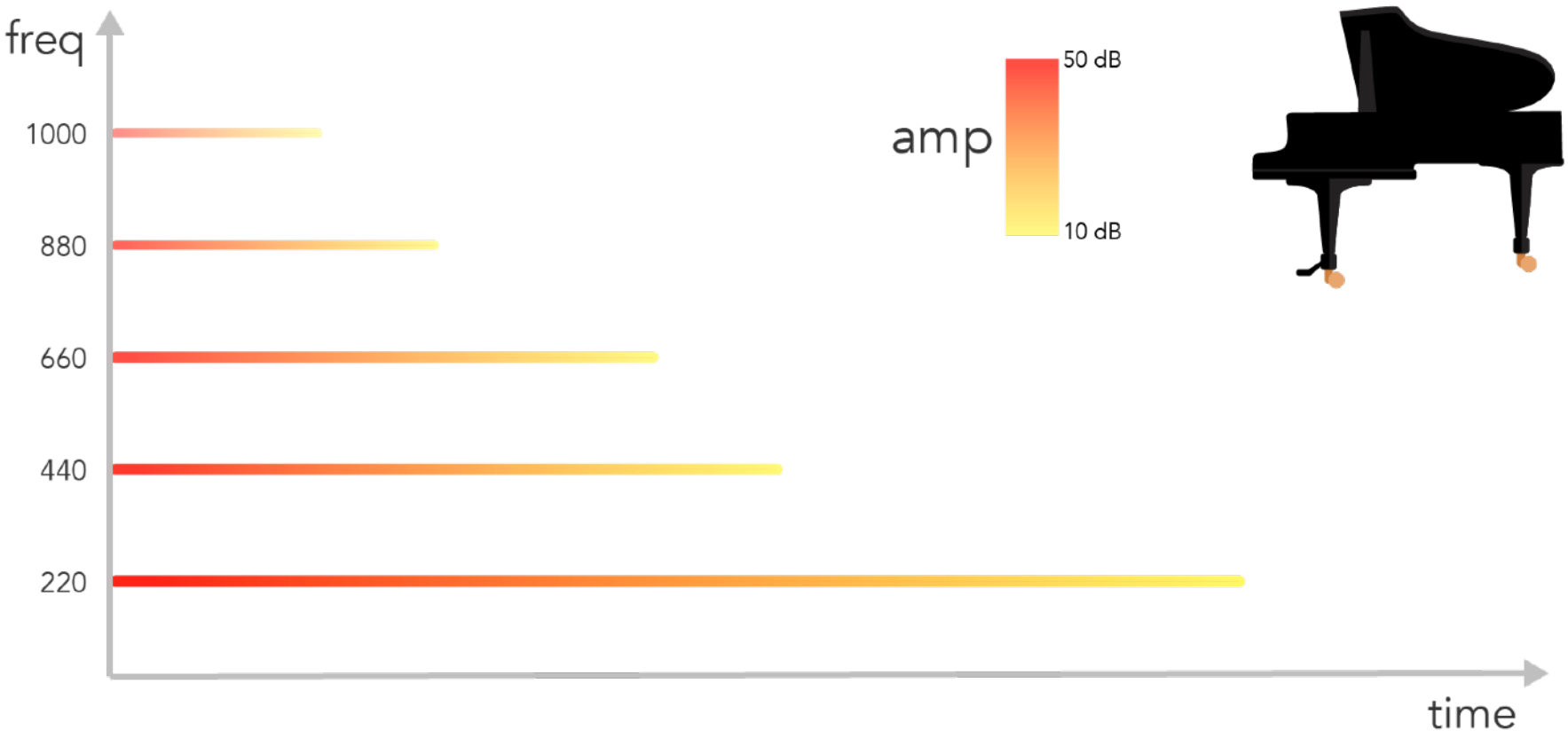
The timbre of an instrument cannot actually be reduced to a static photograph of the spectrum in an instant but is, more properly, a series of consecutive photographs of the spectrum itself.

A **spectrogram** (or sonogram) is used to represent the evolution of the spectrum over time:



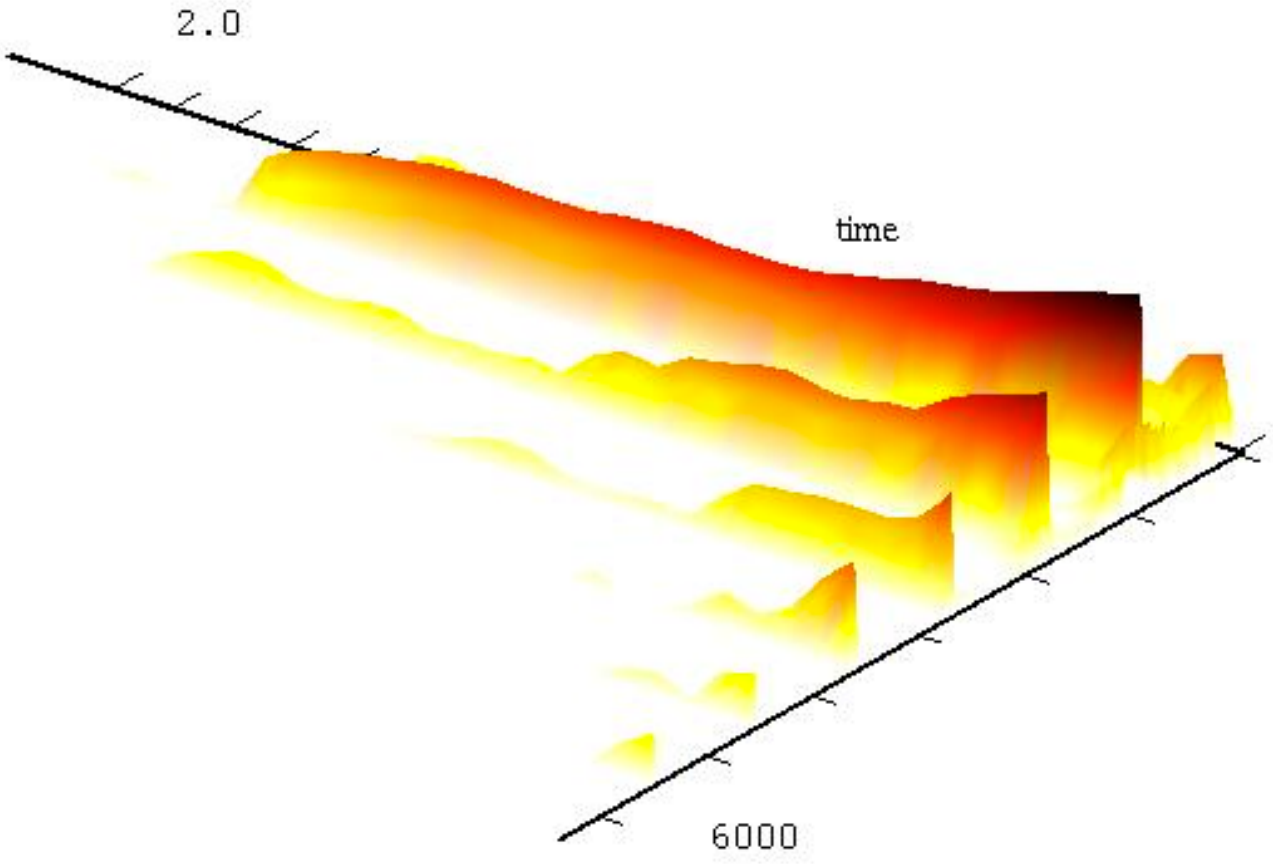
Spectrogram

a pianoforte note



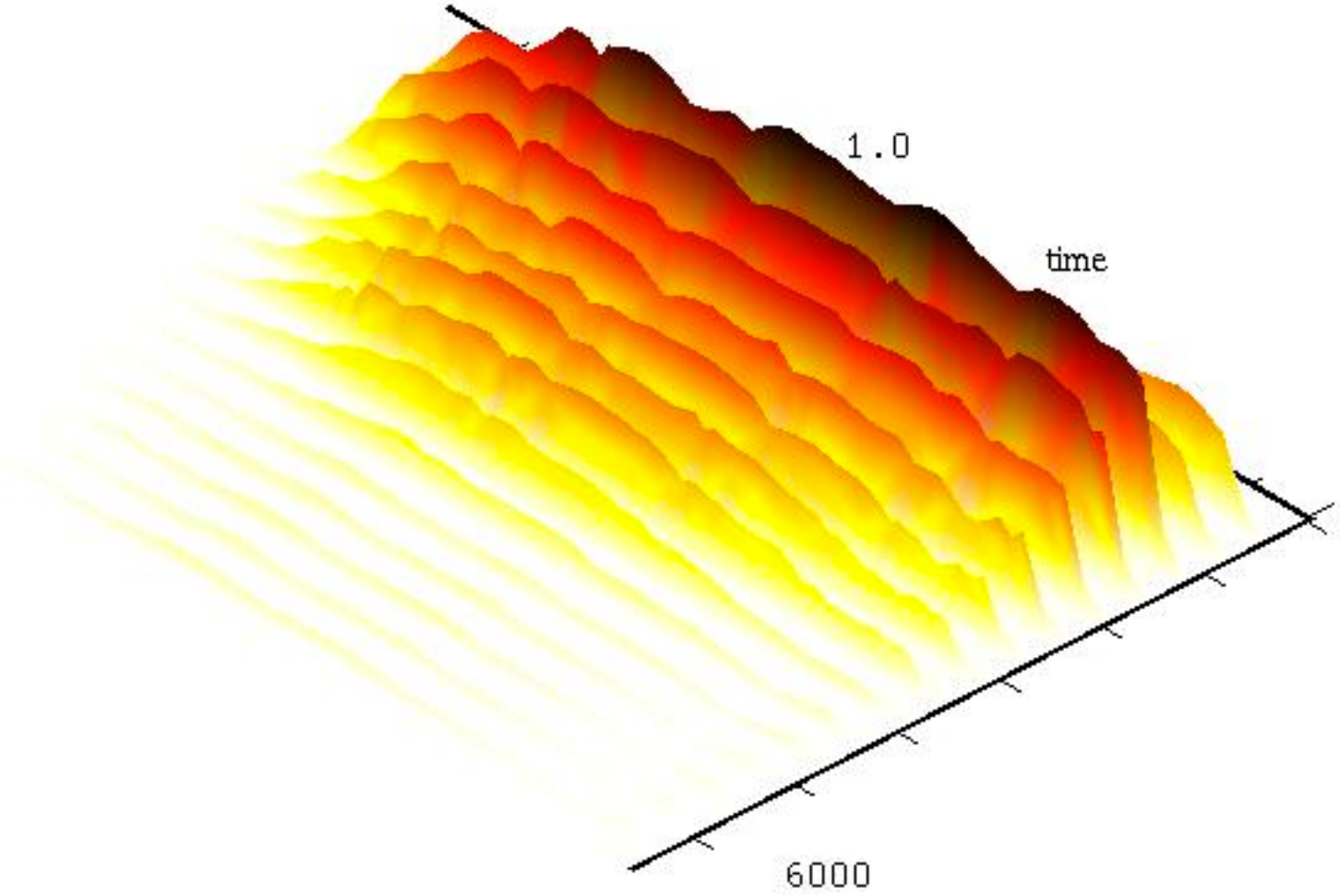
3d Spectrogram

a pianoforte note



3d Spectrogram

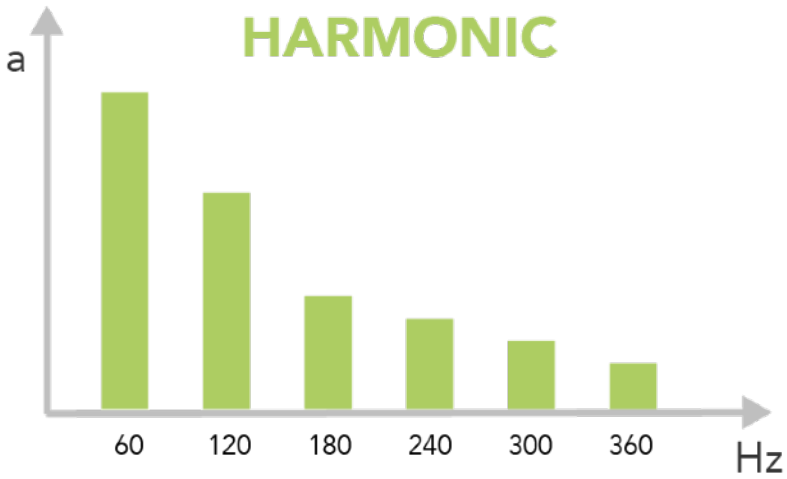
a trumpet note

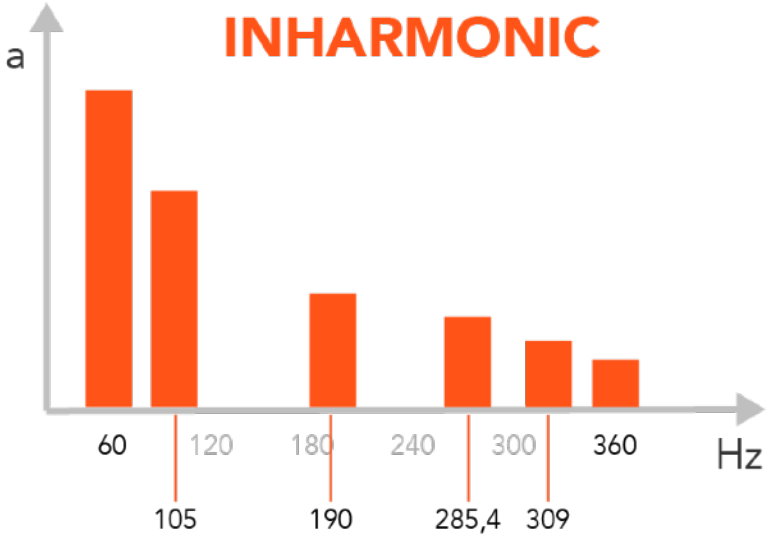


Sine waves in a timbre can be divided in two categories::

- One **Fundamental** (normally the first sine wave from the low and the louder, it is not always identifiable)
- One or more **Overtones** (or **partials)** (all others)

A spectrum can be:



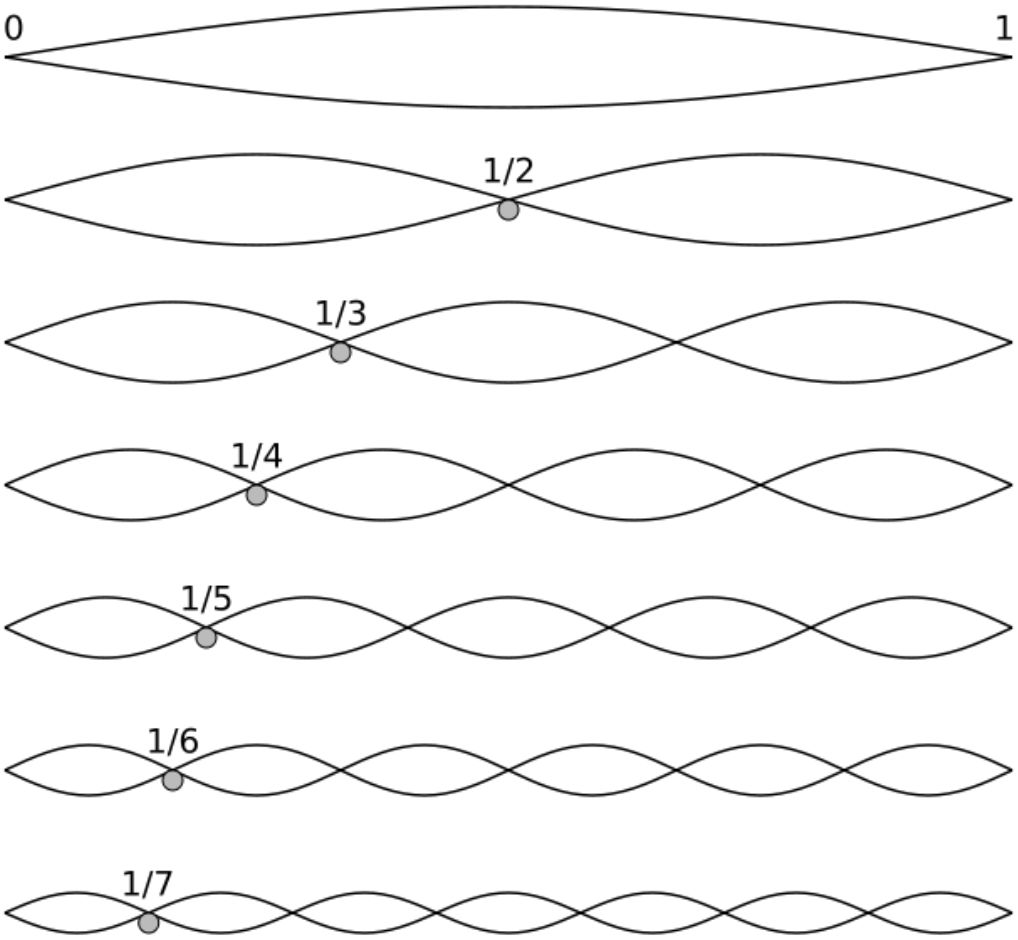


when the overtones are integer multiples of the fundamental

when the overtones are multiples, NOT integers of the fundamental

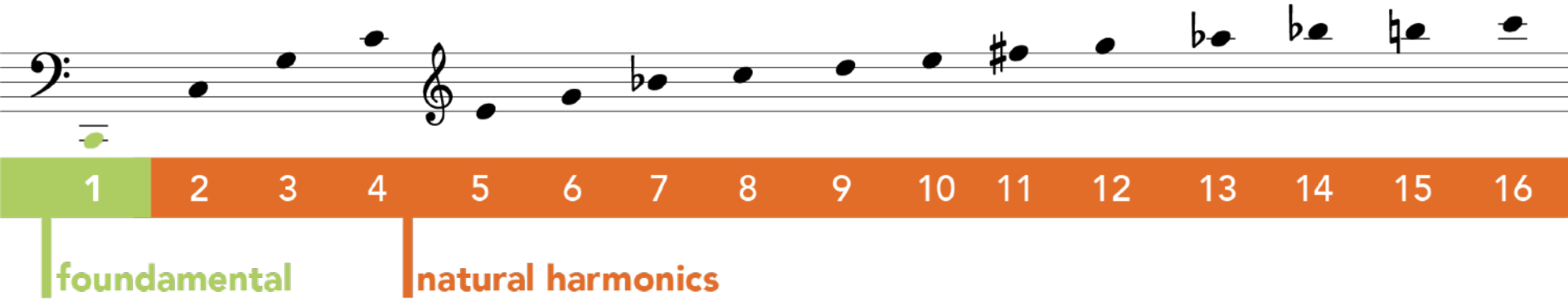
Harmonic overtones

Natural harmonics are a succession of sounds whose frequencies are integer multiples of a base note, called the fundamental.



Natural overtones

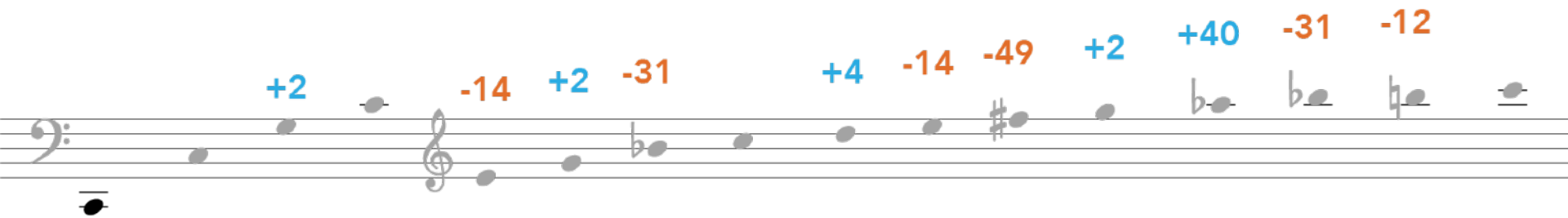
If we consider C as fundamental



C x 1 = C
C x 2 = C
C x 3 = G
C x 4 = C
C x 5 = E
C x 6 = G
C x 7 = Bb
C x 8 = C

C x 9 = D
C x 10 = E
C x 11 = F#
C x 12 = G
C x 13 = Ab
C x 14 = Bb
C x 15 = B
C x 16 = C

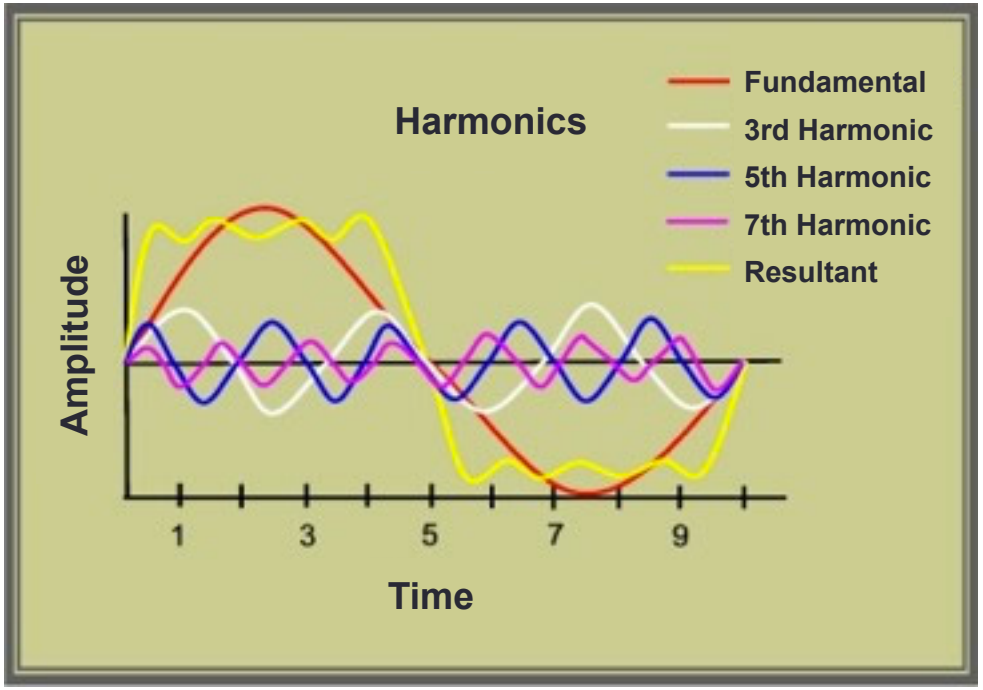
Difference in hundredths of a semitone from the same note in the temperate scale



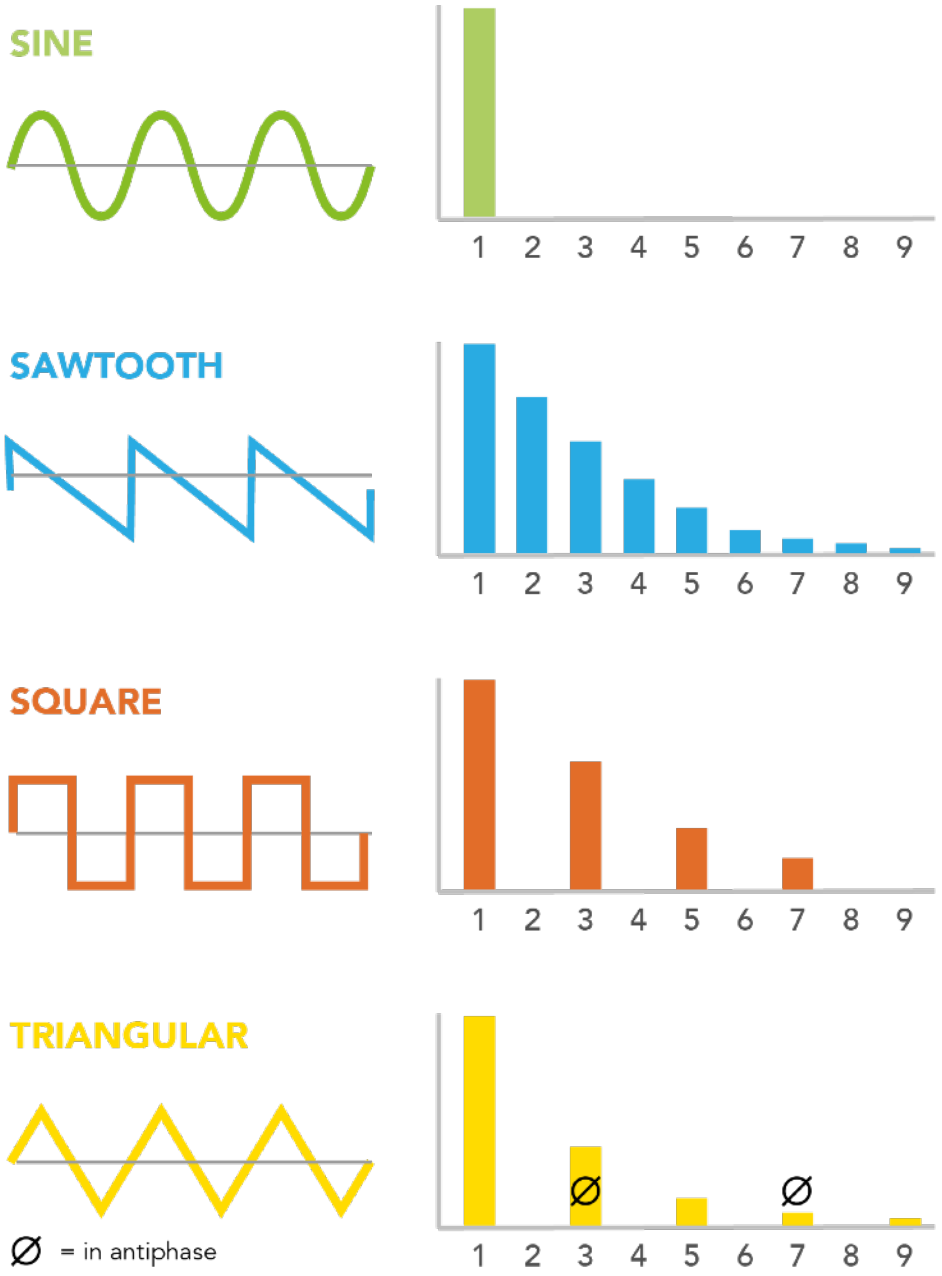
The series of notes obtained from the harmonics is the physical basis for **natural intonation**.

From natural intonation we switched to **equable intonation** to obtain all semitone intervals identical to each other.

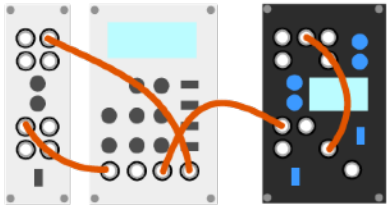
To do this we must use a scale of frequencies that grows exponentially, i.e. multiply each semitone by **r =** $\sqrt[12]{2}$ = 1.0594631…

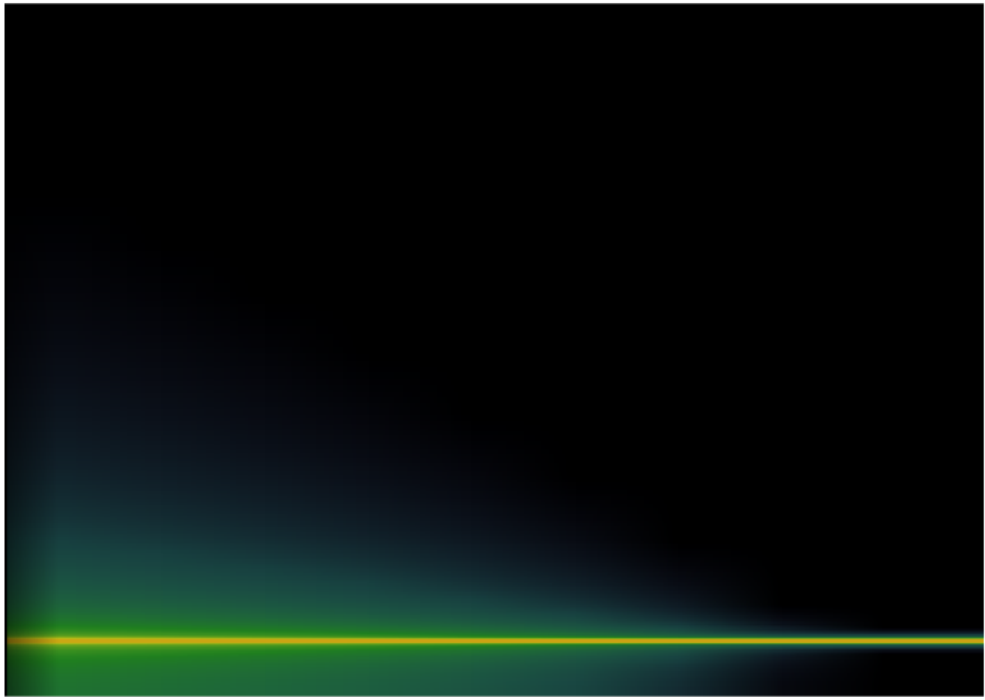

Harmonics
Fundamental
3rd Harmonic
5th Harmonic
7th Harmonic
Resultant
Amplitude
1
3
5
7
9
Time

Spectrum of "classic" waveforms



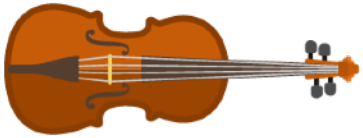
Sine
A4

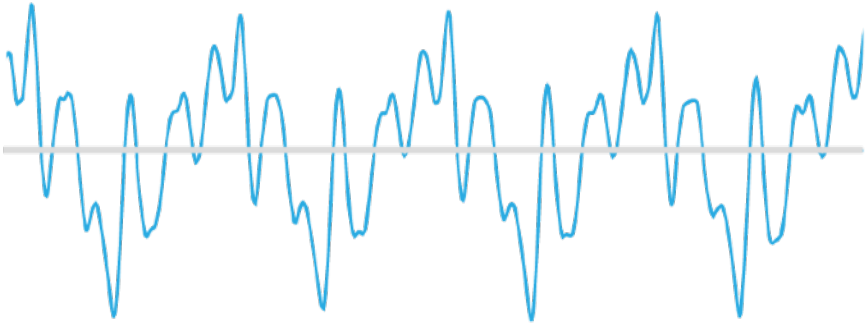


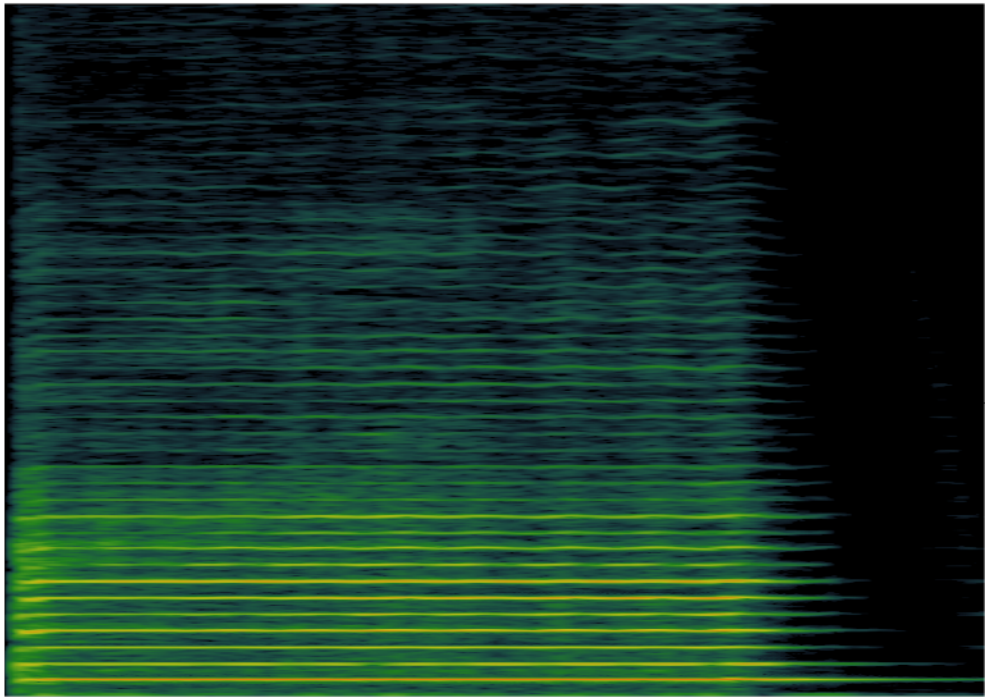


Viola

C3

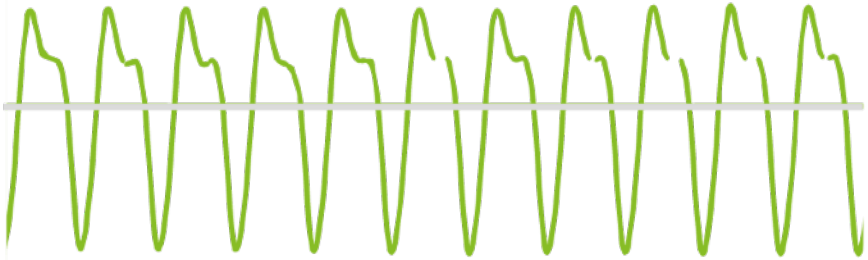


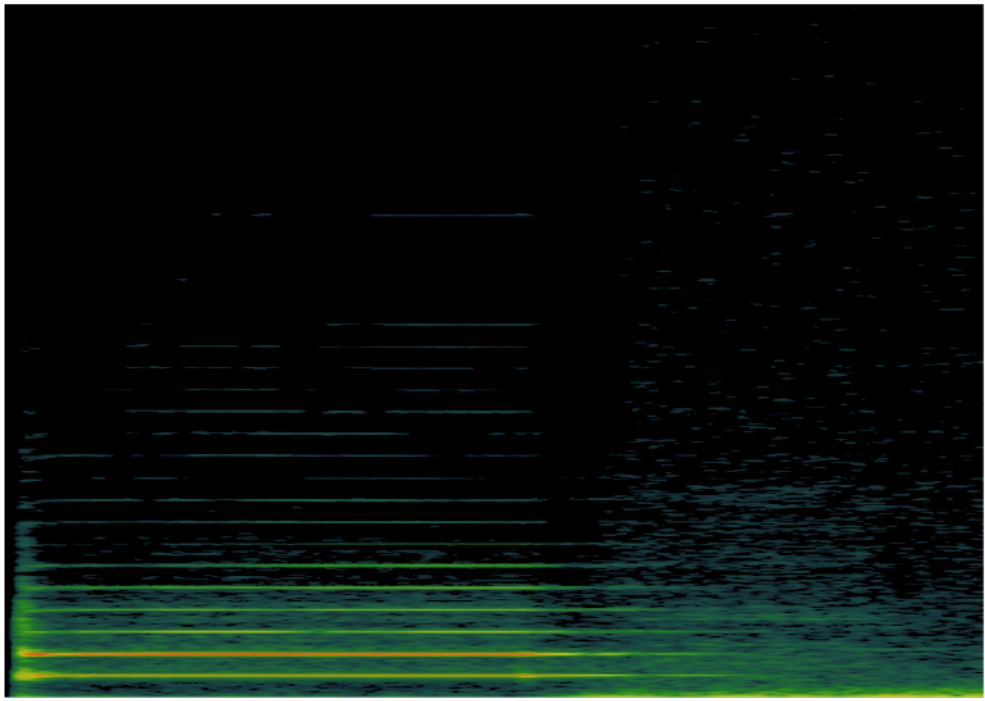




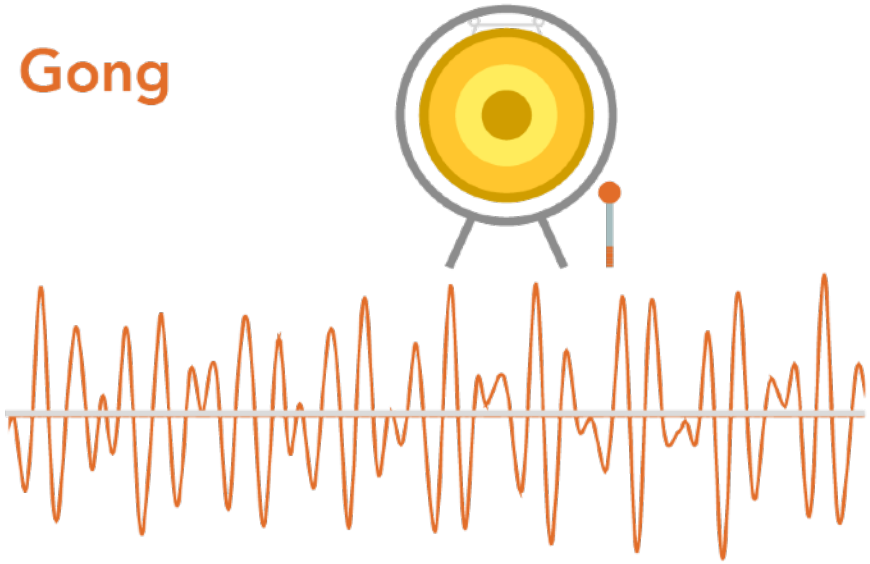
French Horn

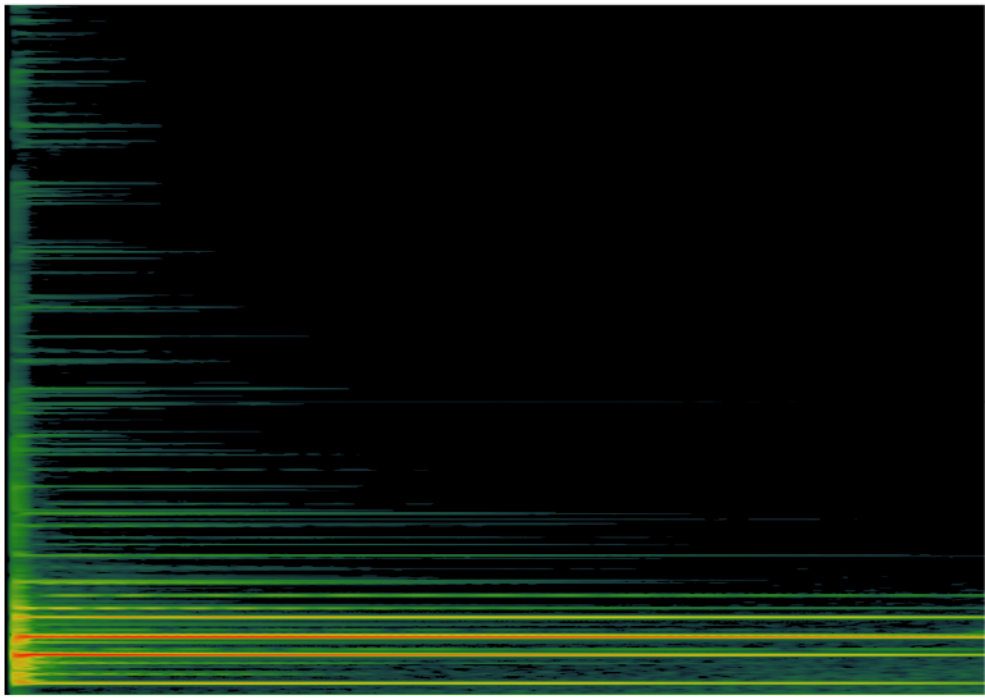
F3



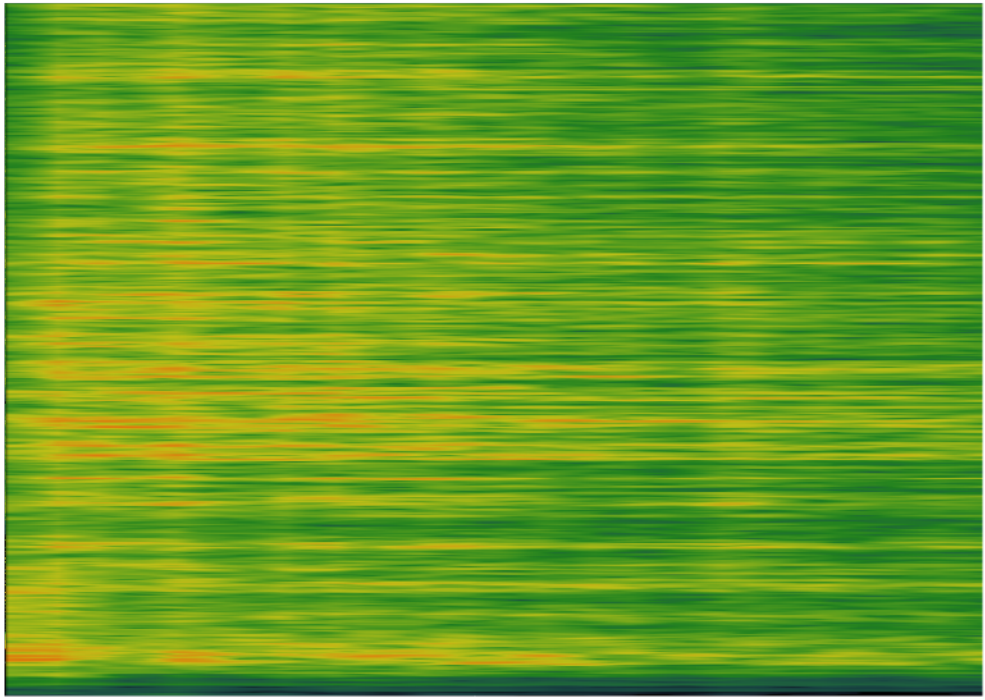


Gong

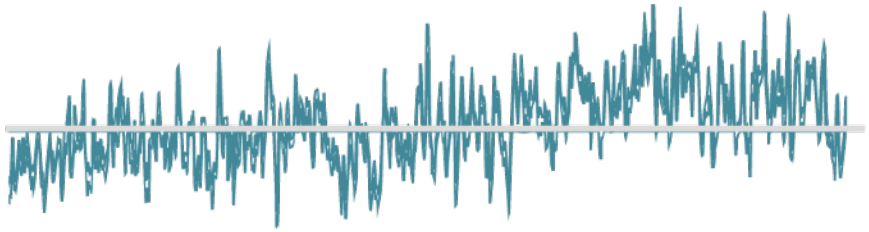


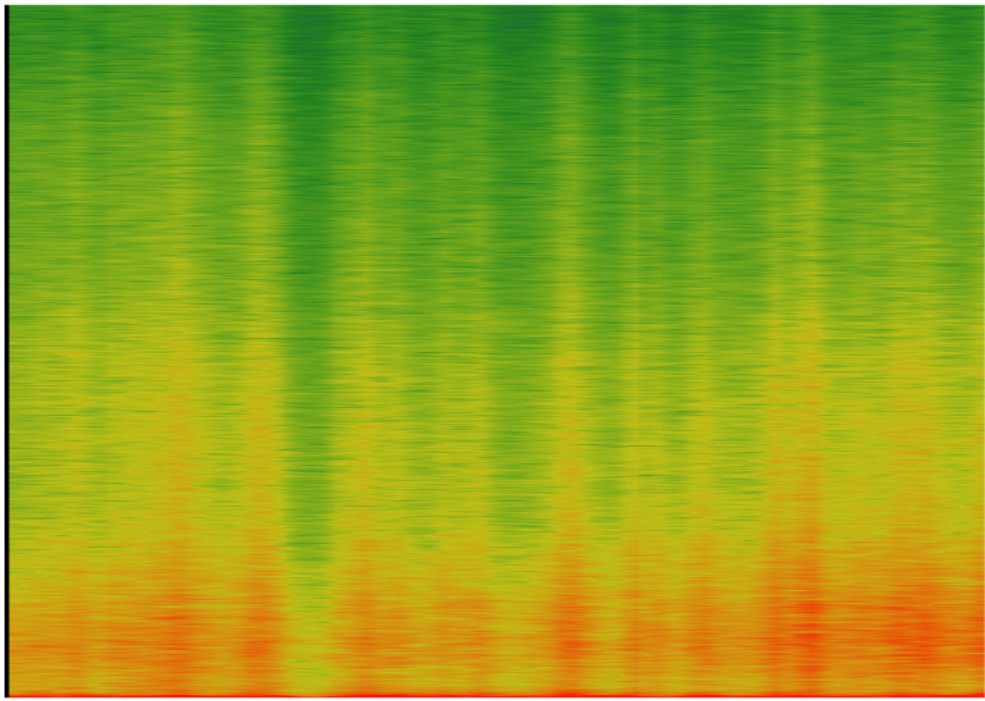


Crash cymbal

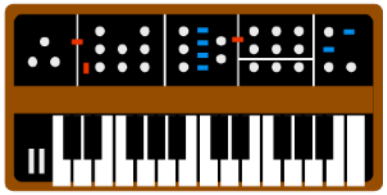


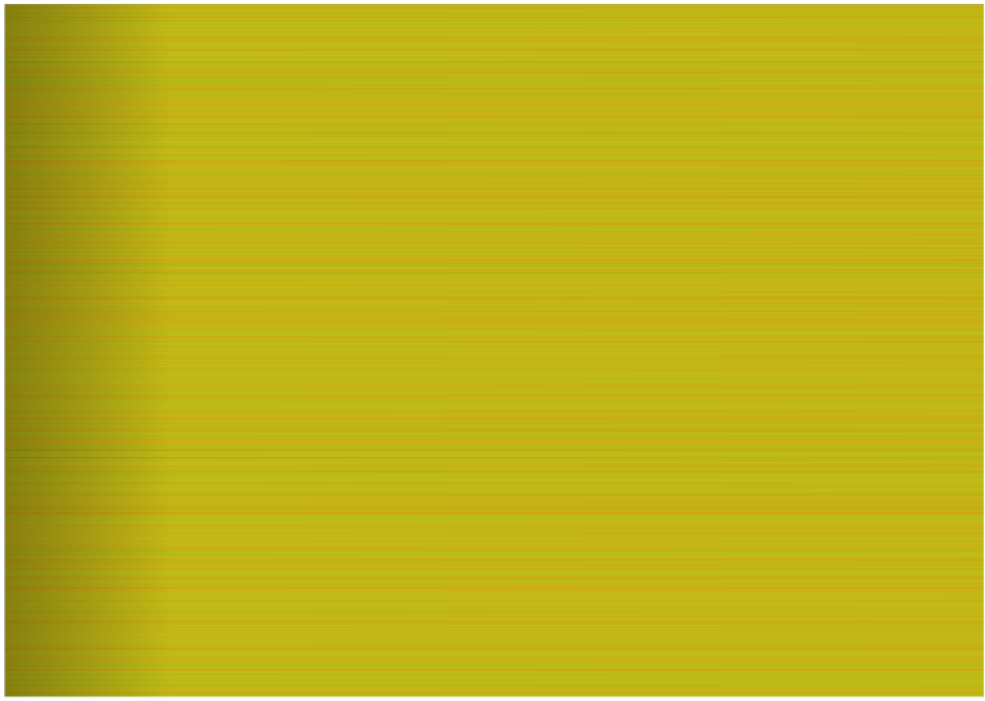
Sea wave





White Noise





www.tommasorosati.it