



MIDTERM REVIEW

Structure

30 Questions, all multiple choice

Designed to take about 35-40 minutes

Questions draw primarily on lecture content, although the readings are fair game.

If you've been attending the lectures you are in good shape.

Part I - Listening // Part II - Multiple choice (concepts & people)

Alternate Testing Site

For students who have provisions for extra time or a distraction free environment

same time — 12pm

Old Cabell Hall, Room B011 — also known as the VCCM

please email me by Tuesday night if you plan on taking the test in the B011

TechnoSonics (the festival)



TERMS & PEOPLE

PSYCHOACOUSTICS

ACOUSTICS

LOUDNESS



AMPLITUDE

Decibels (Db)

PITCH



FREQUENCY

Hertz (Hz)

QUALITY



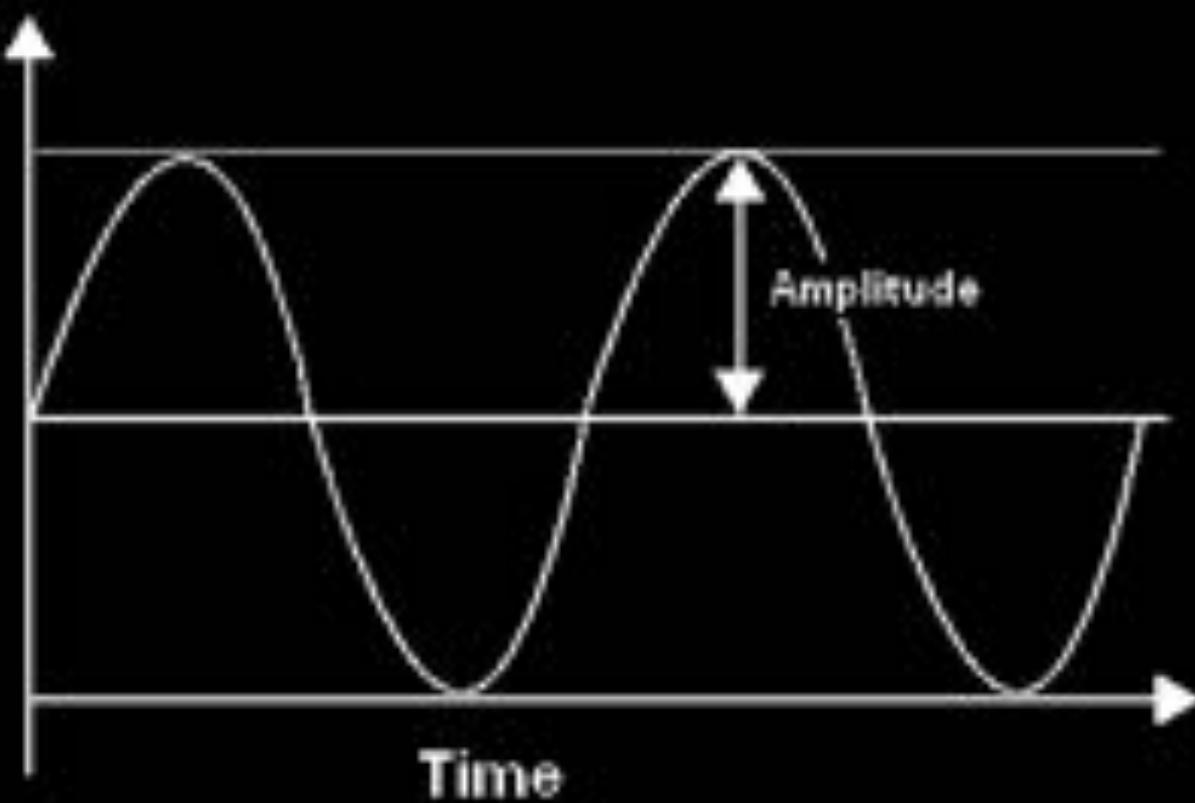
TIMBRE

Spectra + Envelope

Amplitude

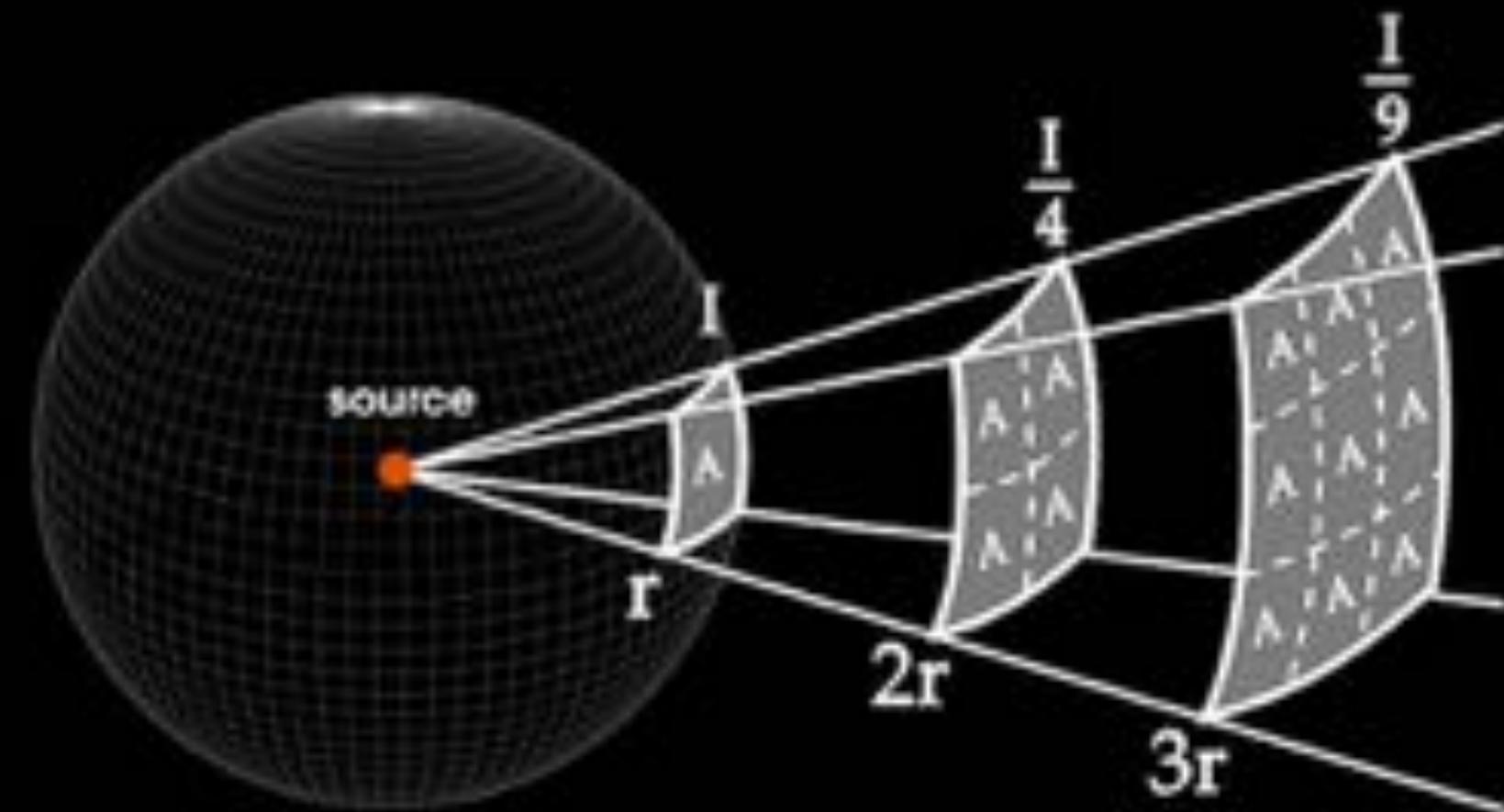
the intensity or perceived loudness of a sound

commonly measured in decibels (dB) - logarithmic unit

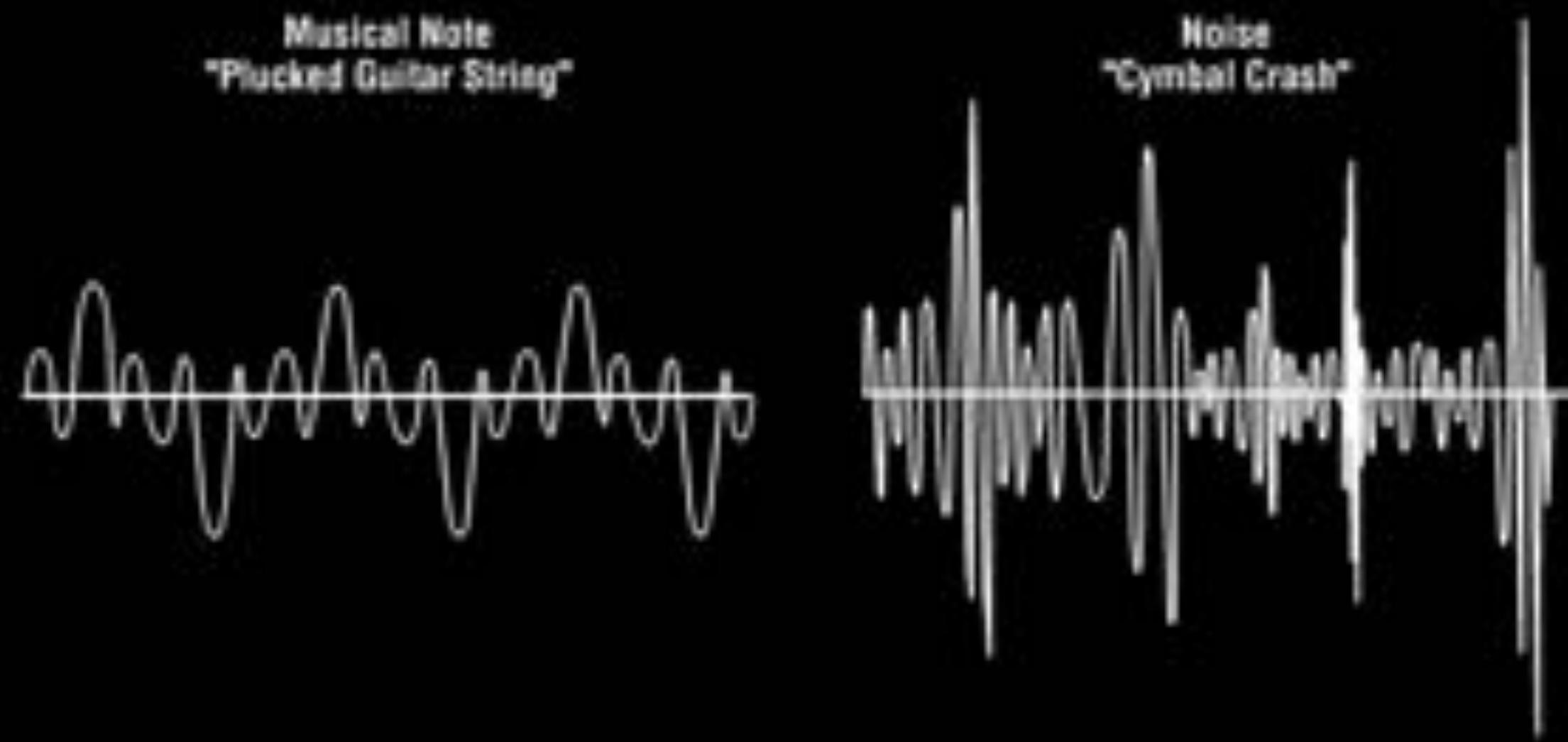


Amplitude - inverse square law

sound intensity is inversely proportional to the square of the distance from the source



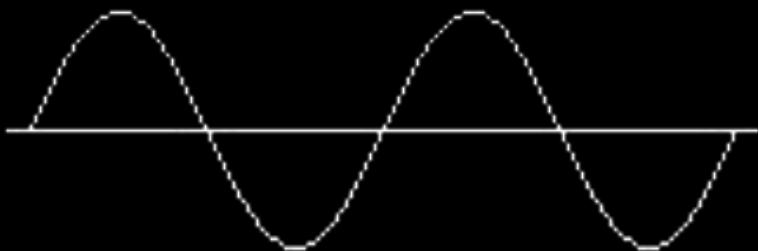
Periodic vs Aperiodic



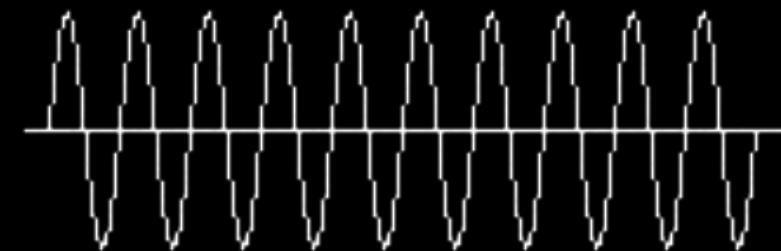
Frequency

rate at which the air pressure fluctuates is the frequency of the sound wave

Cycles per second, Hertz (Hz)



Low Frequency



High Frequency

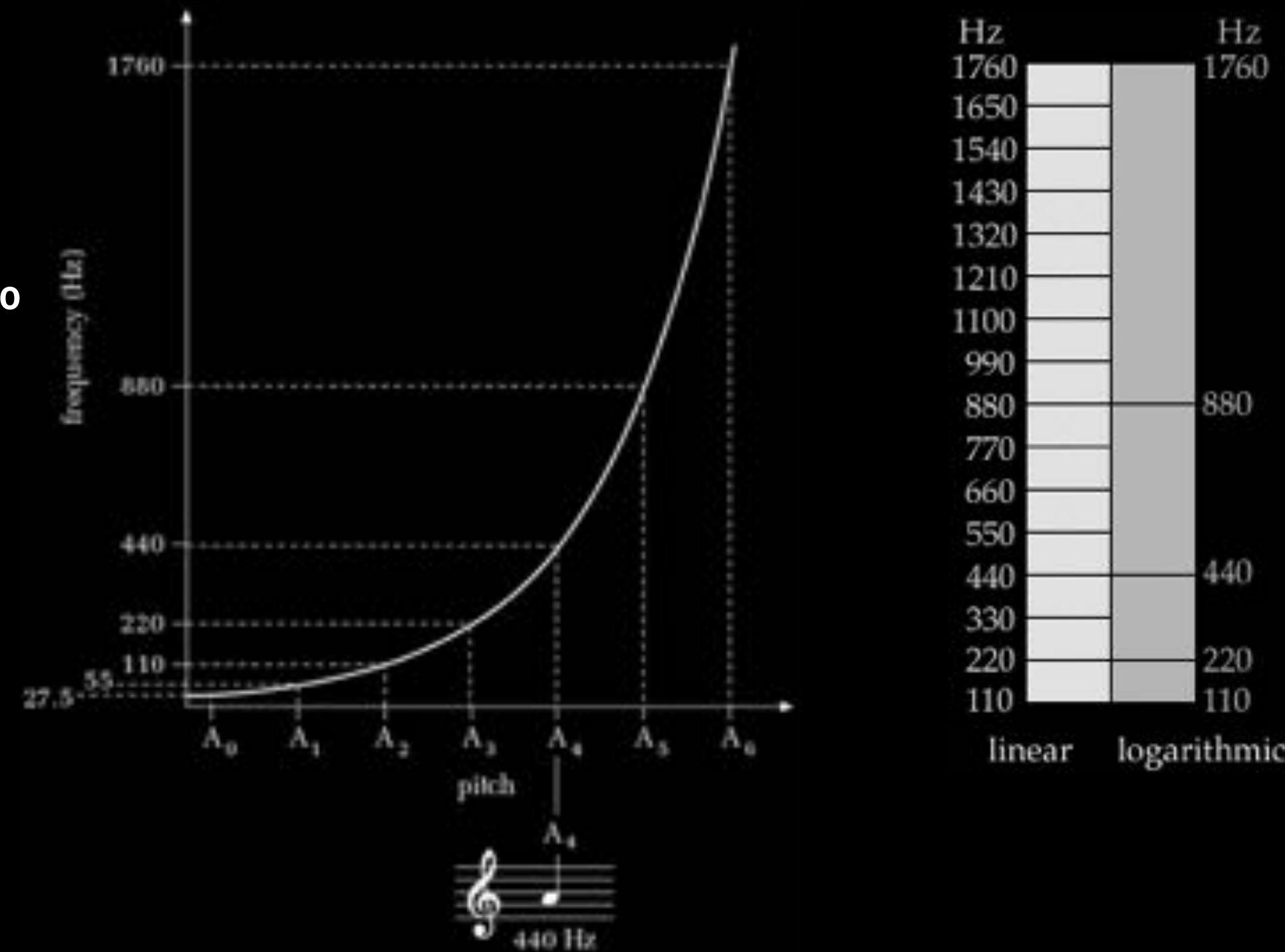
Frequency & Pitch

We experience pitch logarithmically as well

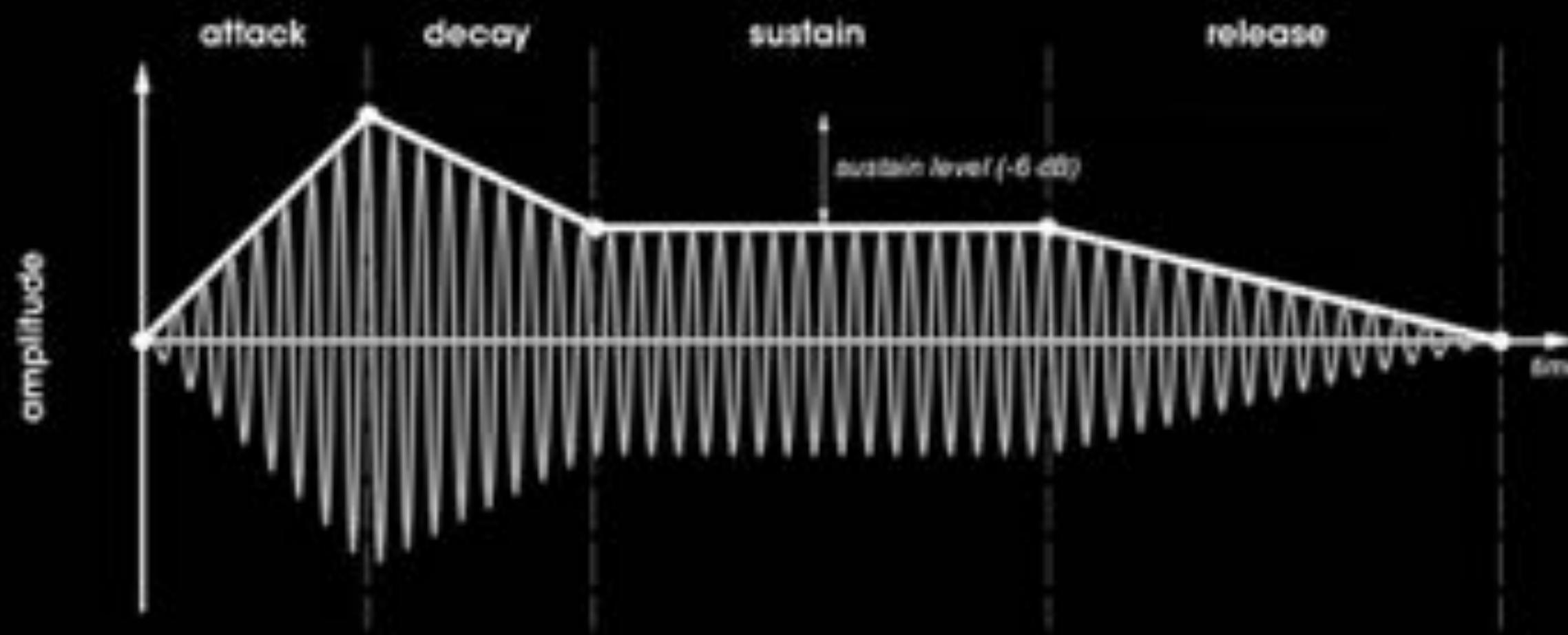
Octave - 2:1 frequency ratio

Octaves 1, 2, 3

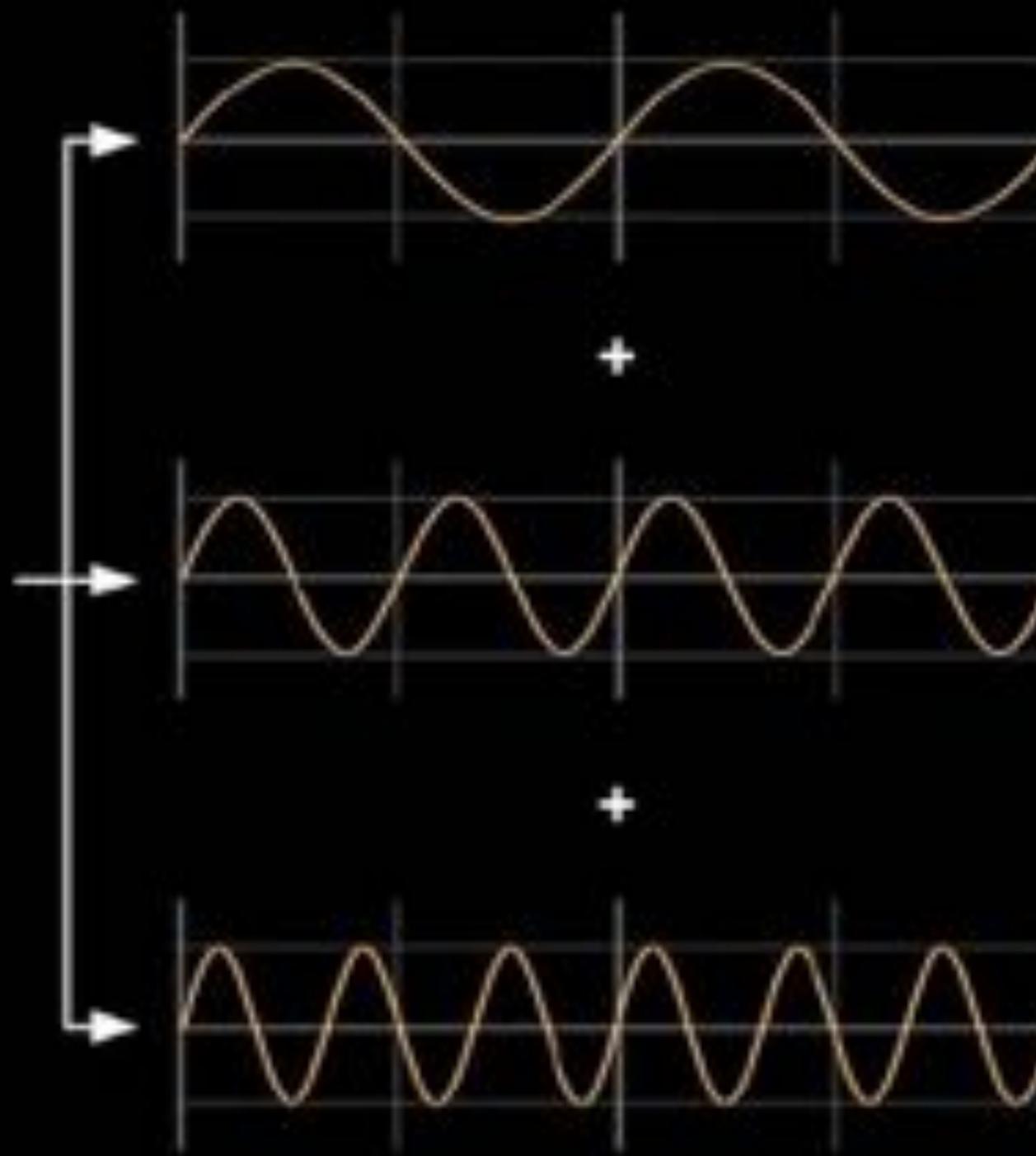
440 Hz
880 Hz
1760 Hz

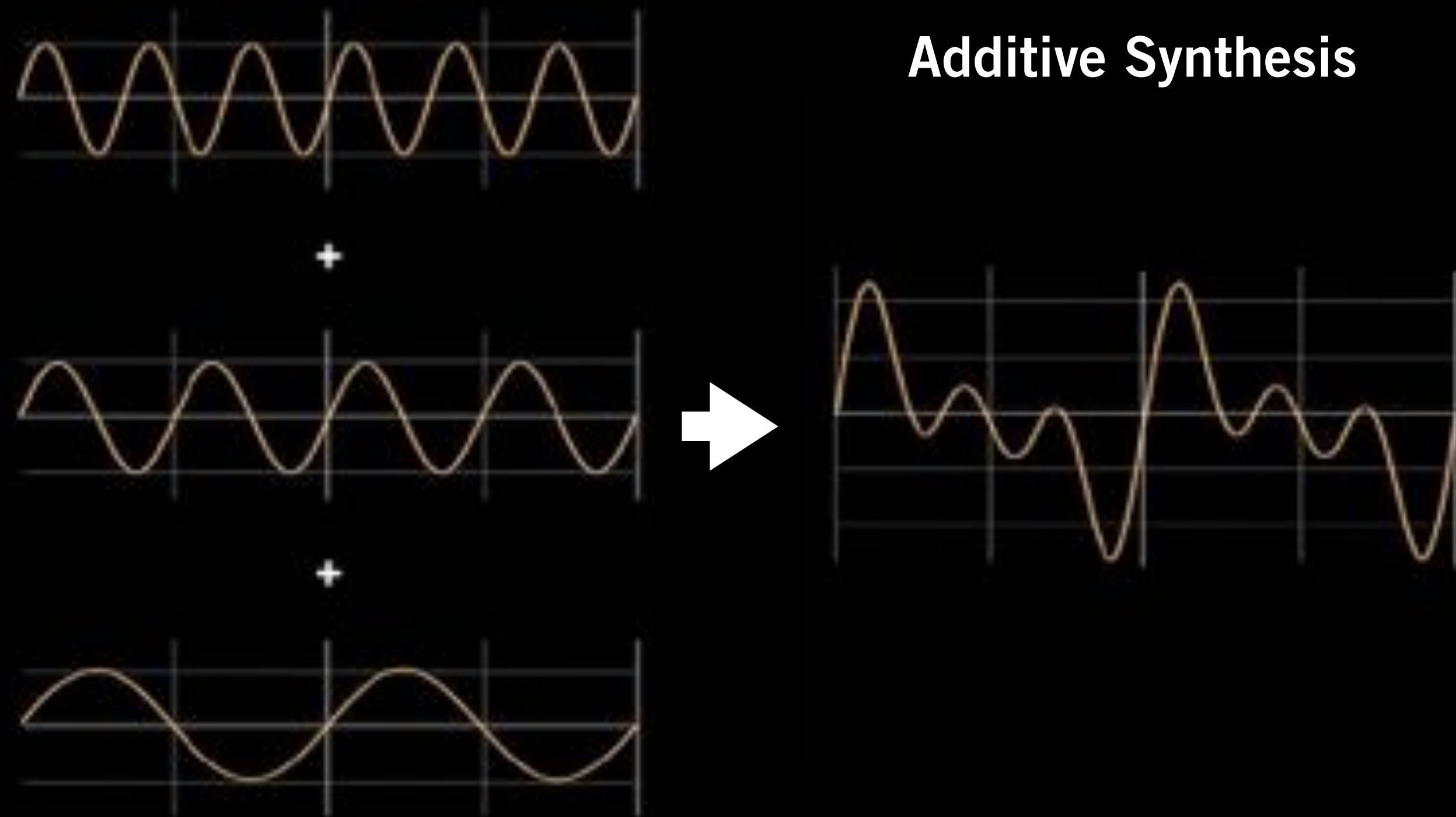


ADSR Envelope



Spectral Analysis





Additive Synthesis

harmonic / overtone series

the **fundamental** is the lowest partial - perceived pitch

A **harmonic partial** conforms to the overtone series which are whole number multiples of the fundamental frequency(f)

(f)1, (f)2, (f)3, (f)4, etc.

if f=110

110, 220, 330, 440

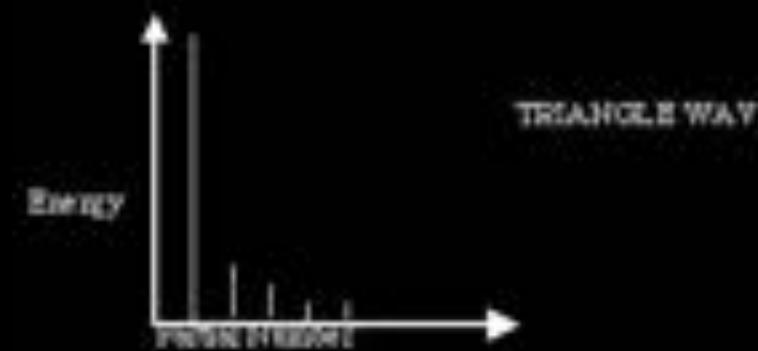
doubling = 1 octave

An **inharmonic partial** is outside of the overtone series, it does not have a whole number multiple relationship with the fundamental.

Basic Waveforms

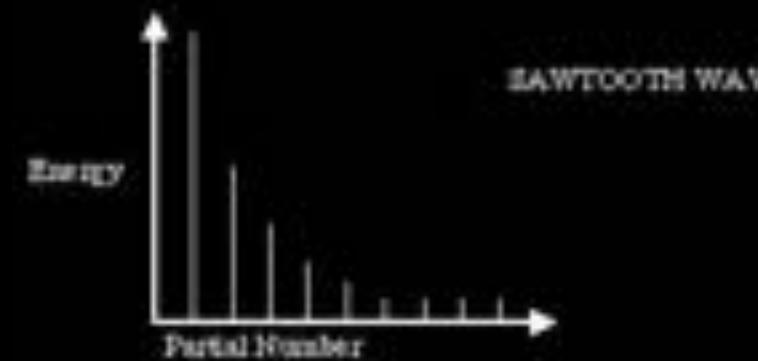


fundamental only, no additional harmonics



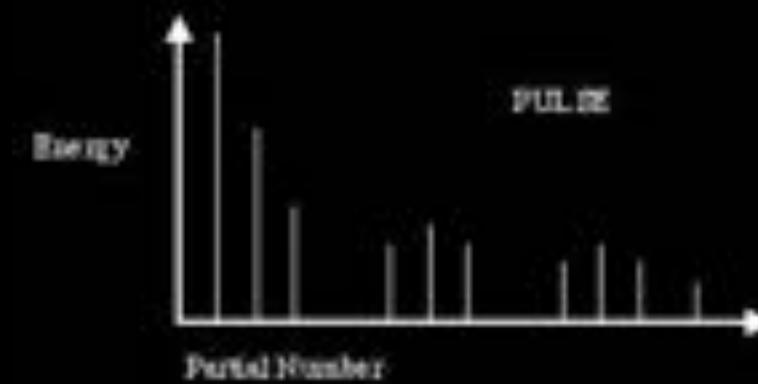
odd partials only (1,3,5,7...)

$1 / p^2$ (3rd partial has 1/9 the energy of the fundamental)



all partials

$1 / p$ (3rd partial has 1/3 the energy of the fundamental)



only odd-numbered partials

$1 / p$ (3rd partial has 1/3 the energy of the fundamental)

(max patch)

Room Acoustics

DIFFRACTION - Long waves will bend around objects.

ABSORPTION <---> REFLECTION

Hard surfaces reflect, soft surfaces absorb.

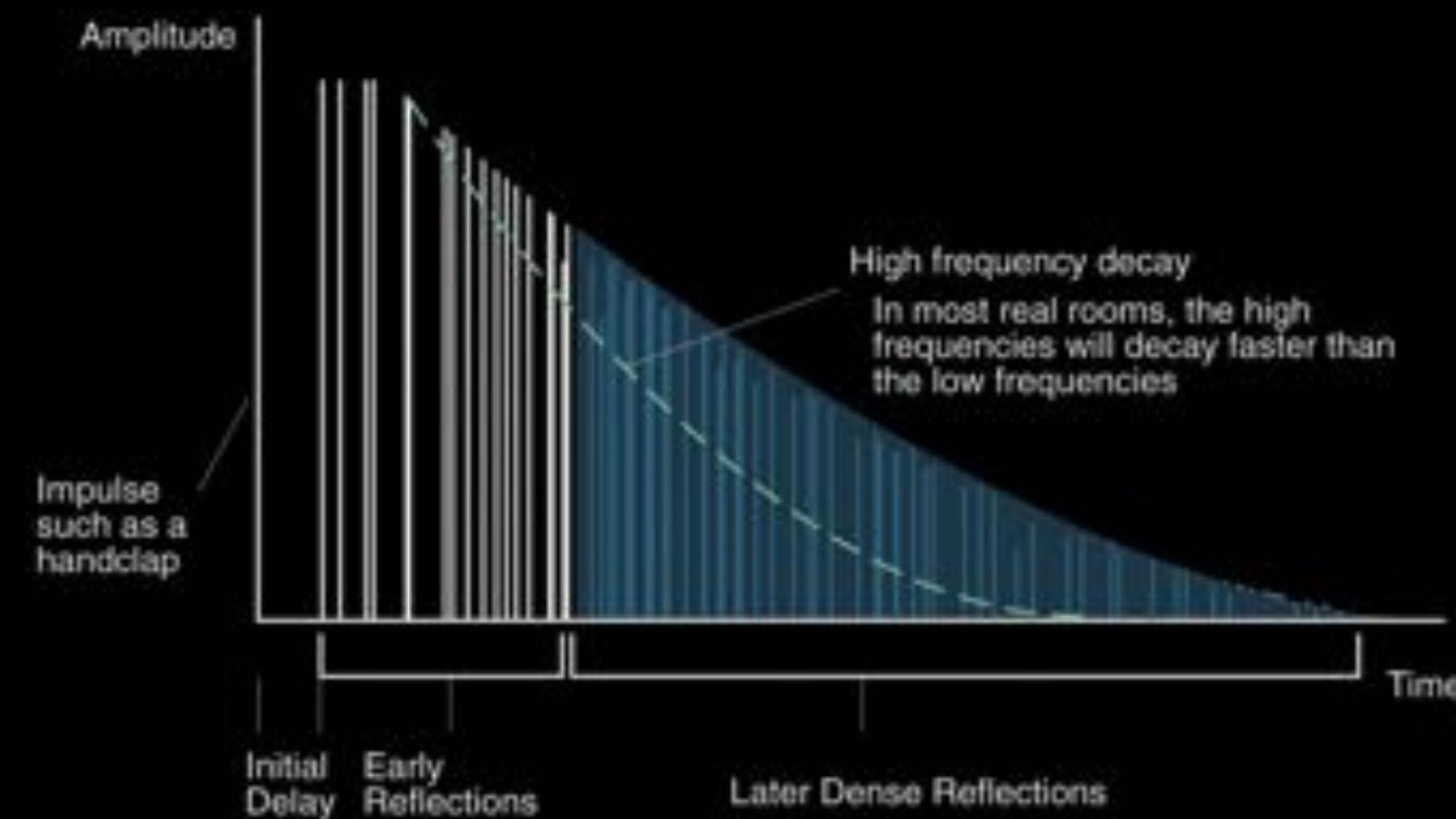
Short wavelengths become trapped in soft material - carpets, drapes, etc.

Reflected sound is **REVERBERATION**, a series of echoes, and reverberation time depends on the size and material of the space

Reverberation

Natural - reflections caused by the resonant qualities of a space

Artificial - simulated digitally or through an analog system



Luigi Russolo

“The Art of Noise”



Intonorumori - noise orchestra

Electricity

Recording systems



Electronic Instruments





PHONOGRAPH

Invented 1877 by Thomas Edison



could **record and playback** sound

sound is no longer strictly a live event. It can be captured and replayed.

sound is represented as a physical medium (Cylinder, Record, Tape, etc), material that can be manipulated.

listen: “I am the Edison Phonograph” (1906)

GRAMOPHONE

Emile Berliner in 1887



rotating disc, harder material, louder. Patent 1894.

1897-1901 Introduced commercially

spiral not a helix, lateral rather than vertical cuts

Electricity

Recording systems



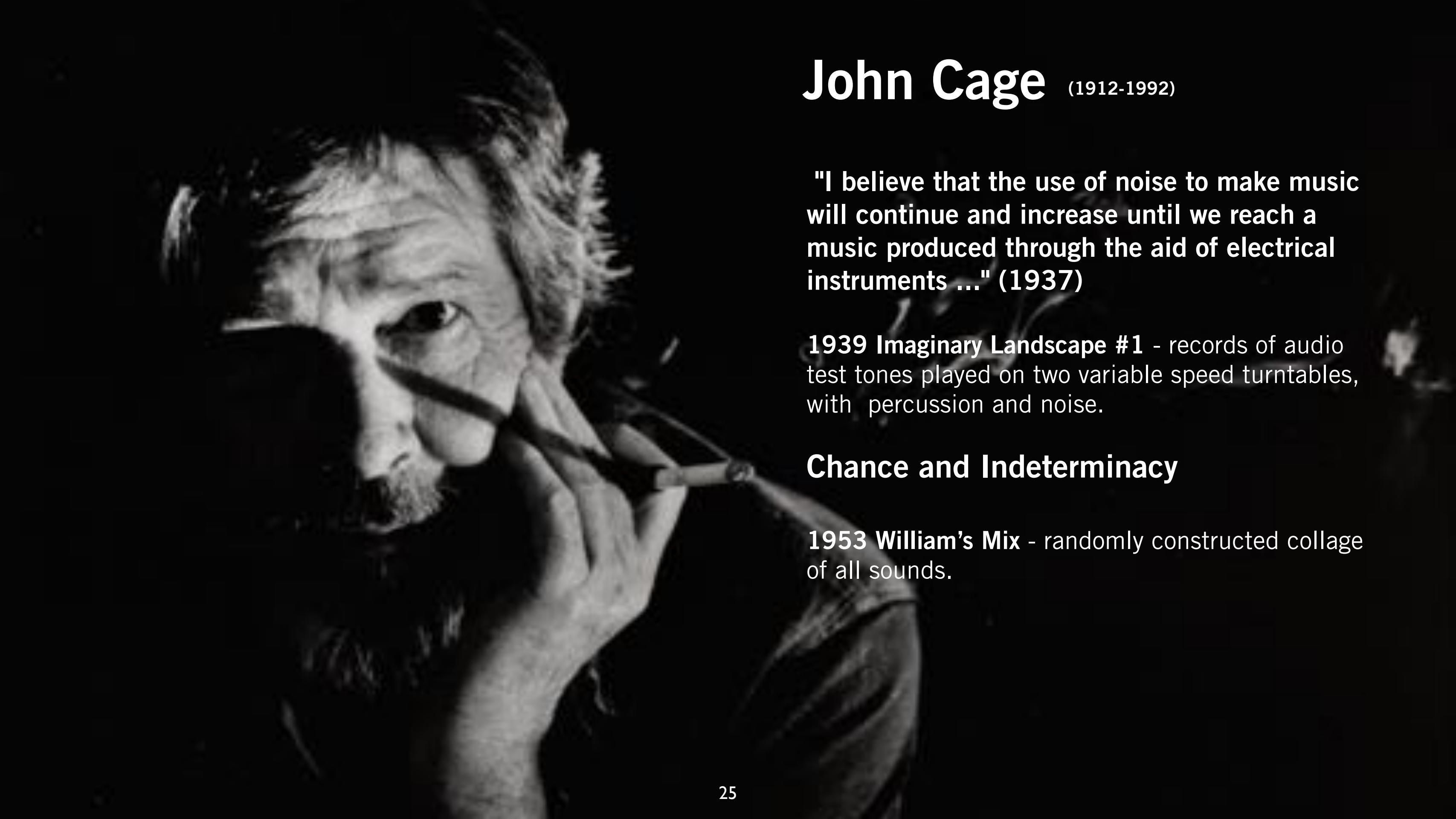
Electronic Instruments



BASIC TAPE MANIPULATION PROCEDURES

1. Speed - transposition
2. Backwards - direction
3. Cutting - remove attacks, change envelopes
4. Splicing - editing, crossfade sounds
5. Looping - create rhythm from repetition
6. Mixing - record multiple layers of sound
7. Delay – run one tape past two machines, mix outputs





John Cage (1912-1992)

"I believe that the use of noise to make music will continue and increase until we reach a music produced through the aid of electrical instruments ..." (1937)

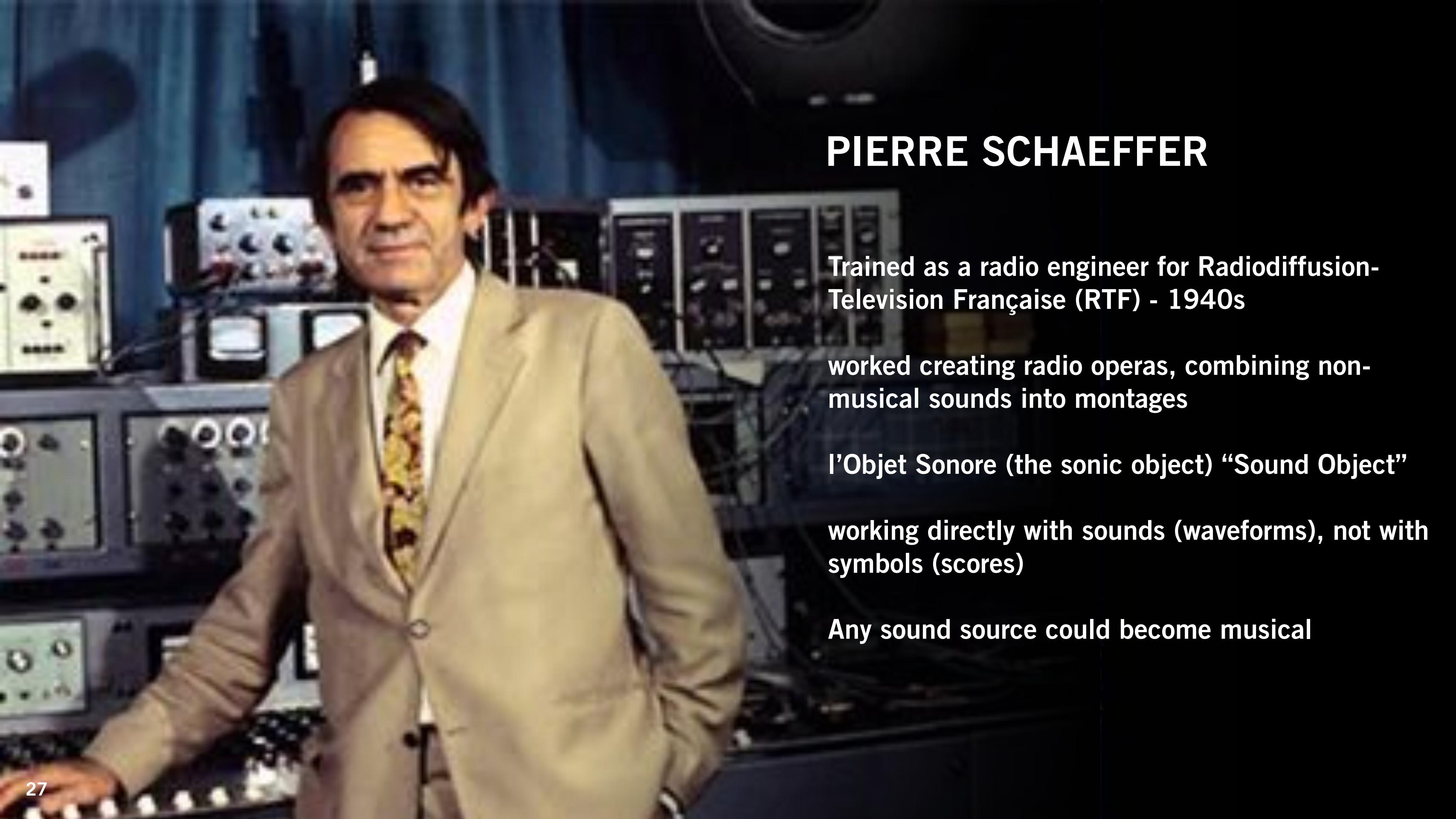
1939 Imaginary Landscape #1 - records of audio test tones played on two variable speed turntables, with percussion and noise.

Chance and Indeterminacy

1953 William's Mix - randomly constructed collage of all sounds.

TO RECORD OR TO SYNTHESIZE

Music Concrete	Elektronische Musik (moozeek)
France	Germany
Recorded Sounds	Synthesized Sounds
Montage, Film	Art Music, Serialism
Pierre Schaeffer	Herbert Einmert

A color photograph of Pierre Schaeffer, a man with dark hair and a mustache, wearing a light-colored suit jacket, a white shirt, and a patterned tie. He is standing in front of a wall of vintage electronic audio equipment, including several large, dark rectangular panels with numerous knobs and switches. The lighting is dramatic, with strong highlights on his face and the equipment.

PIERRE SCHAEFFER

Trained as a radio engineer for Radiodiffusion-
Television Française (RTF) - 1940s

worked creating radio operas, combining non-
musical sounds into montages

l'Objet Sonore (the sonic object) "Sound Object"

working directly with sounds (waveforms), not with
symbols (scores)

Any sound source could become musical

ELEKTRONISCHE MUSIK

& the Cologne Studio

NWDR (Northwest German Broadcasting) Studio opens in 1951

Founded by Dr. Werner Meyer-Eppler, Herbert Einmert, Robert Beyer

Synthesized sounds over recorded sounds

An extension of serialism with all musical aspects carefully controlled, such as timbre, duration, volume, etc.

Music Concrete was just “fashionable and surrealistic”

Things changed when Stockhausen took over in 1963 (even a bit before)

listen: Herbert Einmert's *Klangstudie II* (1952)

Karlheinz Stockhausen



GESANG DER JÜNLINGE (SONG OF THE YOUTHS) (1955-56)

Karlheinz Stockhausen

combines electronic sounds with prerecorded and manipulated sounds. Recorded on five distinct tracks and one of the first surround-sound works.

Three sound sources: a boy soprano, generated sine tones, and generated noises (clicks).

Based on the biblical story of Daniel.

Plays in the space between recognizable speech & ‘abstract’ sound. Phonemes translated to sound, vowels are sine tones, consonants are bands of noises, plosives are impulses.

Sound as speech, speech as sound.

Built a bridge between French and German schools

Brussels World's Fair

The Philips Pavilion



Project directed by Le Corbusier

Philino Agostini - projected visuals

Main music by Edgard Varèse "Poem Electronique"

Interlude by Iannis Xenakis "Concret PH"

Music developed at the Philips laboratory in Eindhoven, Netherlands

350 speakers, mounted on walls, with 10 on the floor

500 people saw the 10 minute performance at a time; 2 million had seen it by the end of the Worlds Fair

A black and white photograph of Edgard Varèse, an elderly man with a mustache, wearing a dark suit and tie. He is standing in front of a large, complex electronic music installation. The installation features several large, circular, perforated metal panels mounted on a wooden frame, along with various electronic components like knobs and switches. The background is a plain, light-colored wall.

Edgard Varèse

Poème Électronique (1958)

A black and white photograph of Iannis Xenakis, looking slightly to his right. He has dark, wavy hair and is wearing a dark jacket over a light-colored shirt. The background is blurred, showing what appears to be a window or a view of a city.

Iannis Xenakis

CONCRET PH (1958)
GRANULAR SYNTHESIS

Hugh Le Caine

Canadian scientist/composer with the National Research Council of Canada (NRC) in Ottawa

Transformations of a single sound source as an organizing principle, the sound of a single drop of water

Le Caine also invented the Electronic Sackbut in 1945, an early voltage controlled synthesizer (pictured)

Listen: Dipsody (1955)





BBC Radiophonic Workshop (1958)

Daphne Oram, Brian Hodgson, Delia Derbyshire, David Cain, and many more...

LOOK AT ORAMICS (1961)

Daphne Oram

Developed “Oramics” in 1959, a graphically controlled synthesizer.

Classically trained musician and BBC engineer.

Visited Schaeffer and RTF in Paris

First to notate ideas for synthetic sounds that could be reproduced by sound-generating instruments

Drawing Sounds



DELIA DERBYSHIRE

Doctor Who Theme (1963)

Top Engineer and Composer
at the BBC



SYNTHESIZER HISTORY

- 1897 Telharmonium (Thaddeus Cahill)
- 1919 Theremin (Leon Theremin)
- 1928 Ondes Martenot (Maurice Martenot)
- 1930 Trautonium (Trautwein)
- 1935 Hammond Organ (Laurens Hammond)
- 1945 Electronic Sackbut (Hugh Le Caine)
- 1956 RCA Mark I & II (Olson and Belar)
- 1964 First Buchla and Moog Modular Synths
- 1970 Minimoog (portability)



Types of Synthesis

Additive Synthesis

Combines sine waves to make more complex waveforms.

Subtractive Synthesis

Removes some aspect of a sound through filtering.

Modulation

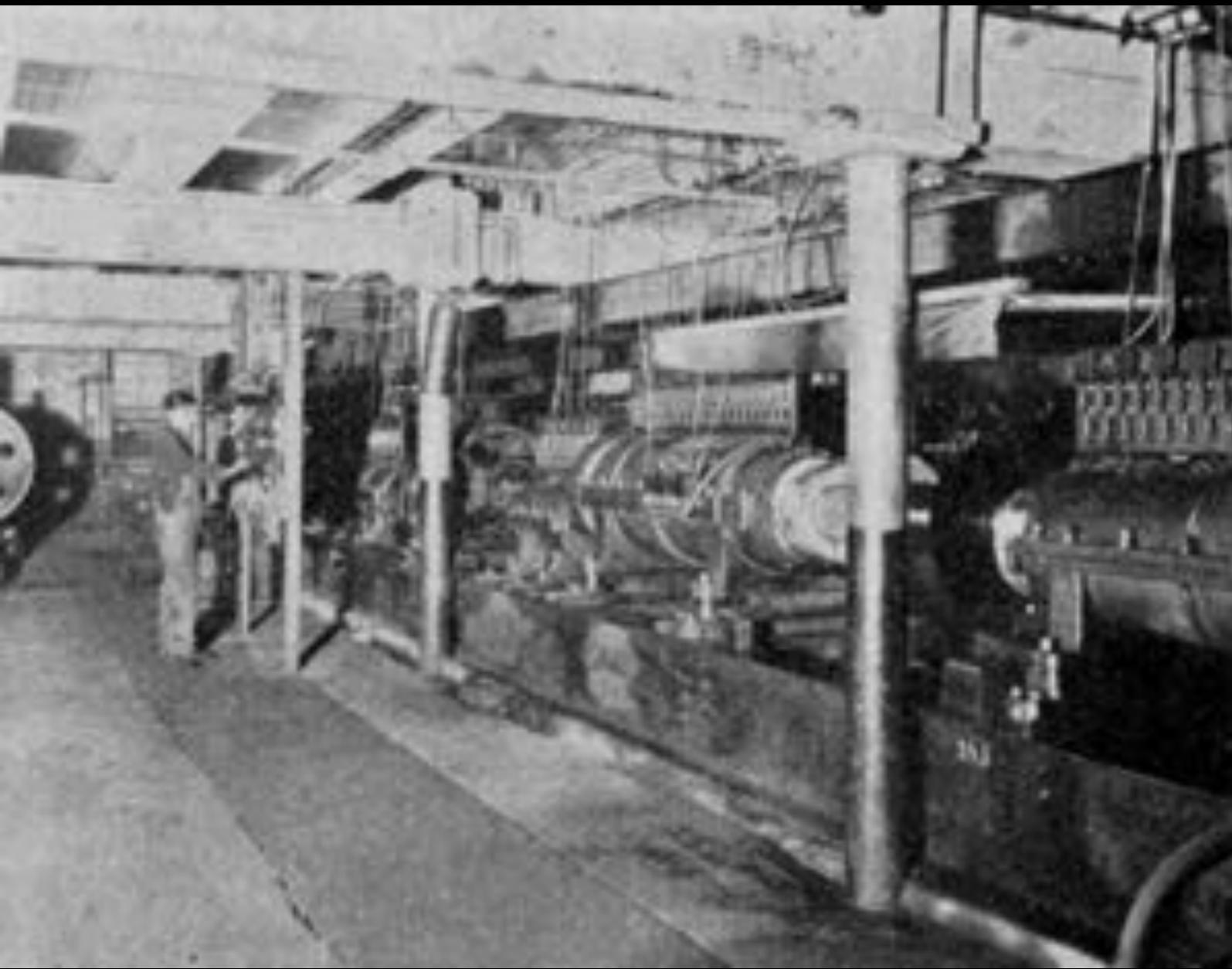
- Amplitude Modulation --> Tremolo
- Frequency Modulation --> Vibrato

Telharmonium (1897)

Thaddeus Cahill



weighed 200 Tons and cost \$200,000 to make in 1897



Additive Synthesis
rheotomes (later tone-wheels)



Theremin (1919)

Leon Theremin

monophonic

played without physically
touching the instrument,
gestural control

A black and white photograph of Clara Rockmore, a pioneer of the theremin. She is shown from the waist up, leaning forward over a dark theremin. Her right hand is positioned near the top antenna, and her left hand is near the bottom. She has short, dark hair and is wearing a light-colored, long-sleeved dress. The background is a plain, light-colored wall.

Clara Rockmore

ONDES MARTENOT (1928)



Maurice Martenot

Oraison (1937)

by Olivier Messiaen



Trautonium (1929)



Friedrich Trautwein



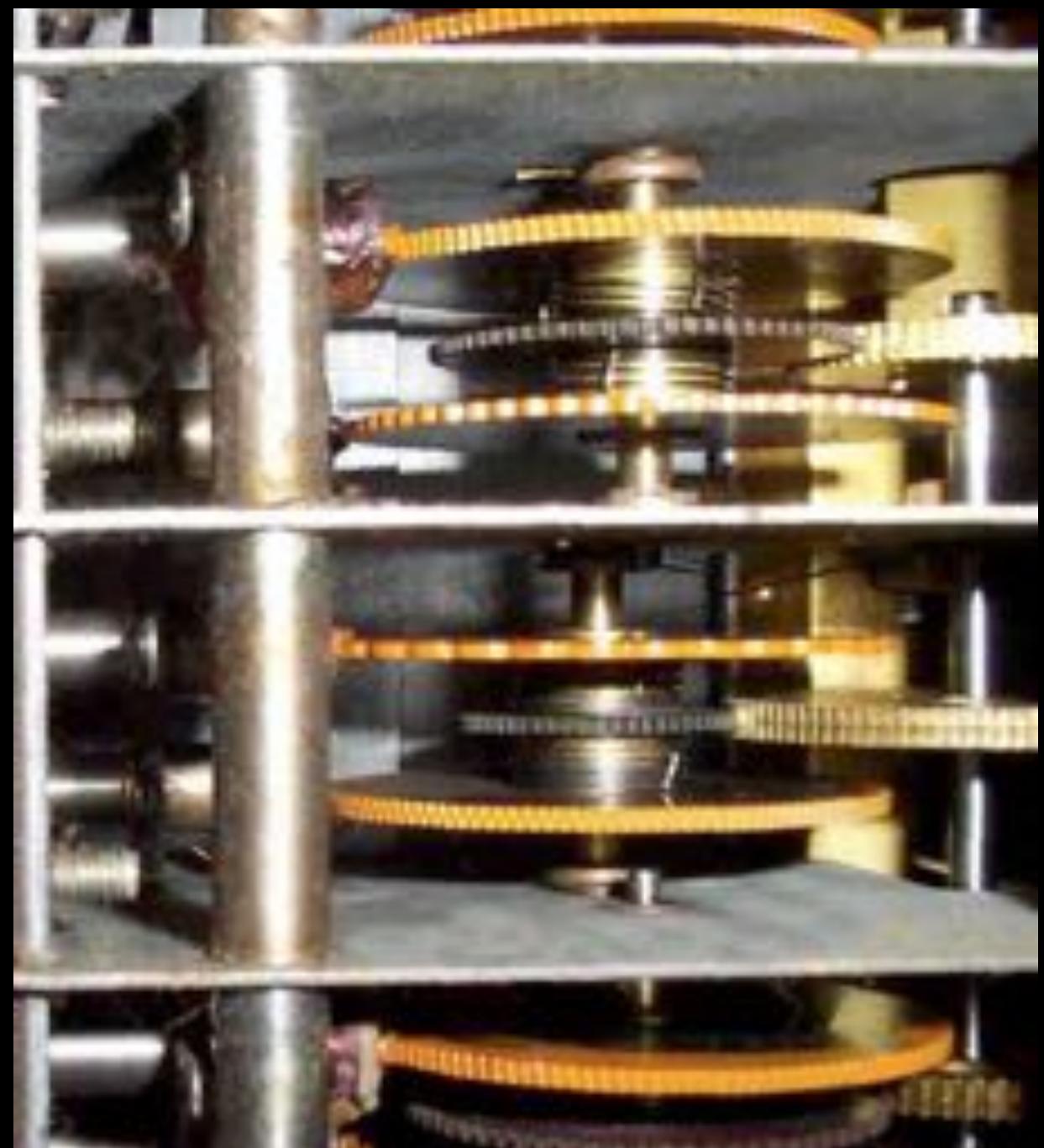
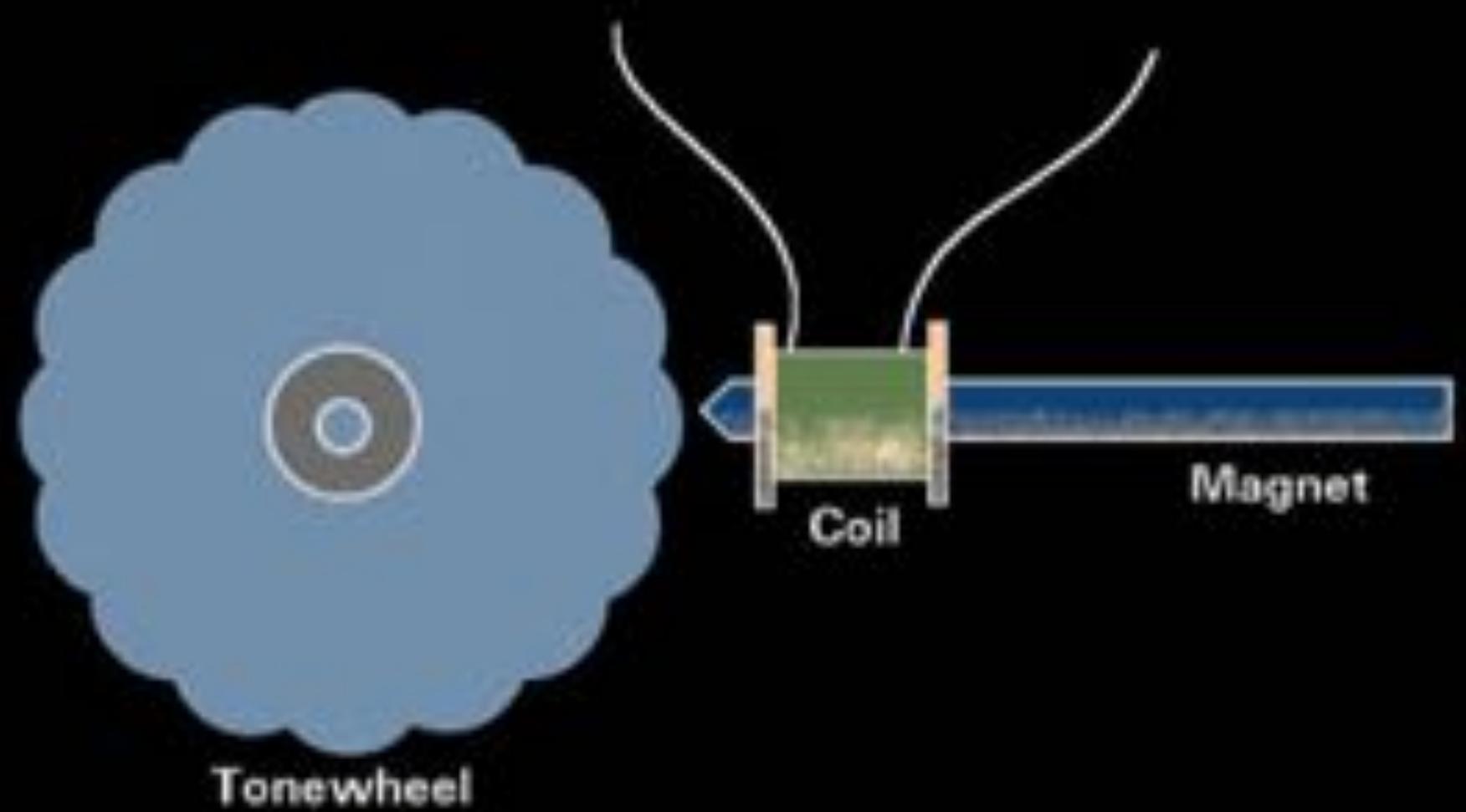
Oskar Sala

Hammond Organ (1935)

Originally sold as an alternative to expensive pipe organs, the Hammond B3 became popular in the 30s and continued to be a standard in the 60's and 70's for rock, blues and jazz.

Jimmy Smith

Tonewheels



Manhattan Research

Raymond Scott

Donald Buchla West Coast



In 1964, Buchla, an engineer with a musical background, was approached by the San Francisco Tape Music Center to build a customized synthesizer for their studio.

The Buchla 100 used voltage control and featured the first sequencer. Instead of a keyboard, it had programmable metal plates.

Robert Moog East Coast

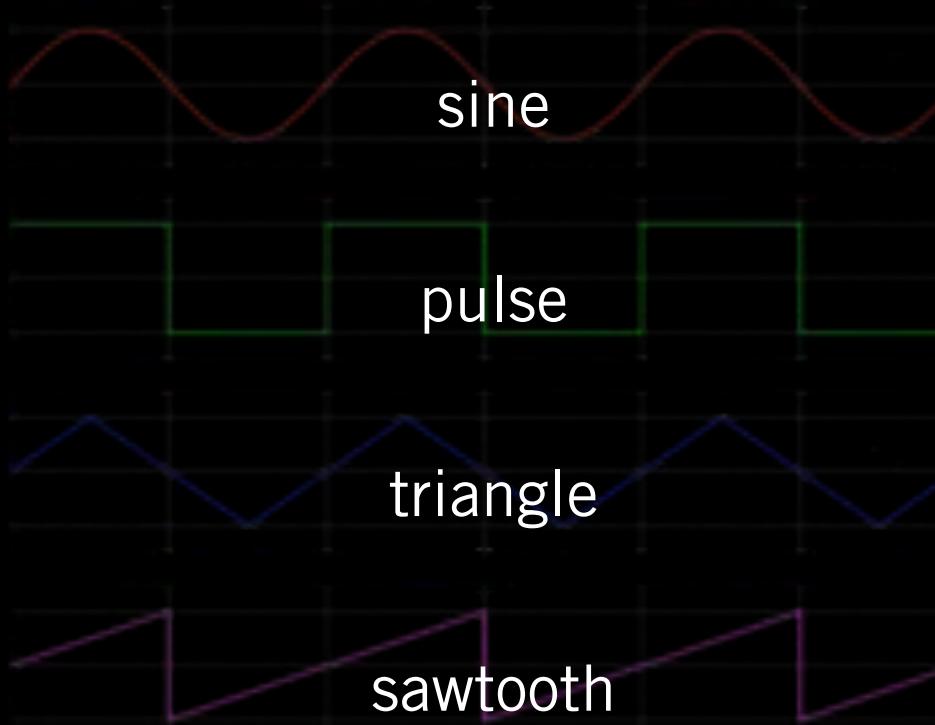


Moog studied physics and electrical engineering, putting himself through school by selling theremins he built.

In 1964, Moog began experimenting with voltage-controlled oscillators, eventually completing an early synthesizer with keyboard control; his first synthesizer was sold in 1965.

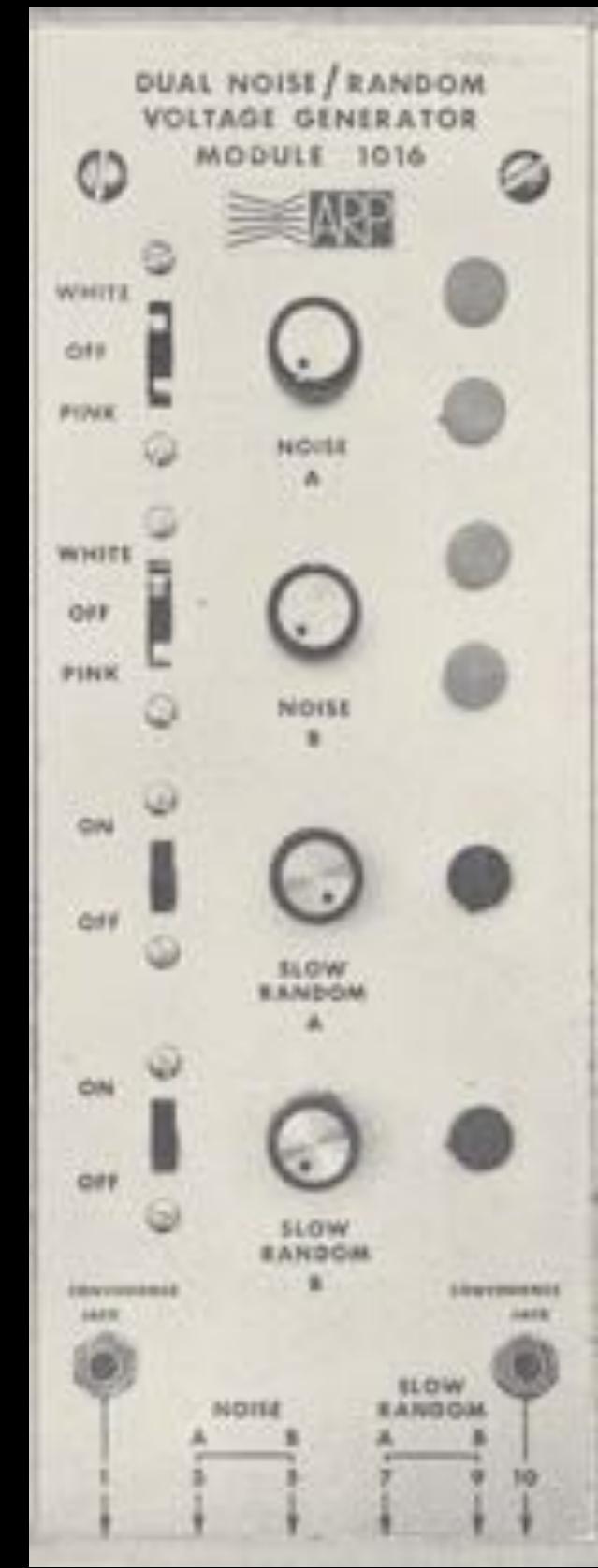
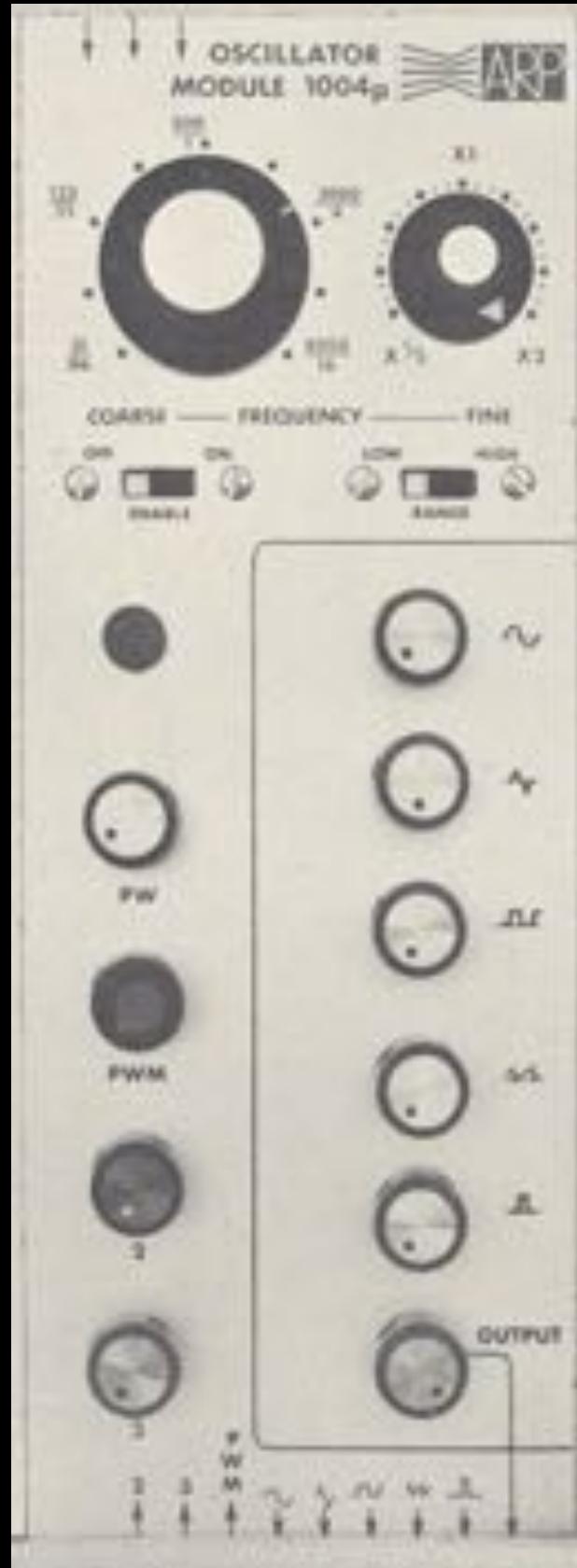
SOURCES

OSCILLATORS (VCO)



NOISE GENERATORS

Often the simplest module on the machine. There may be a choice of white or pink noise, or even a species of low frequency noise for random control voltages.



FILTERS

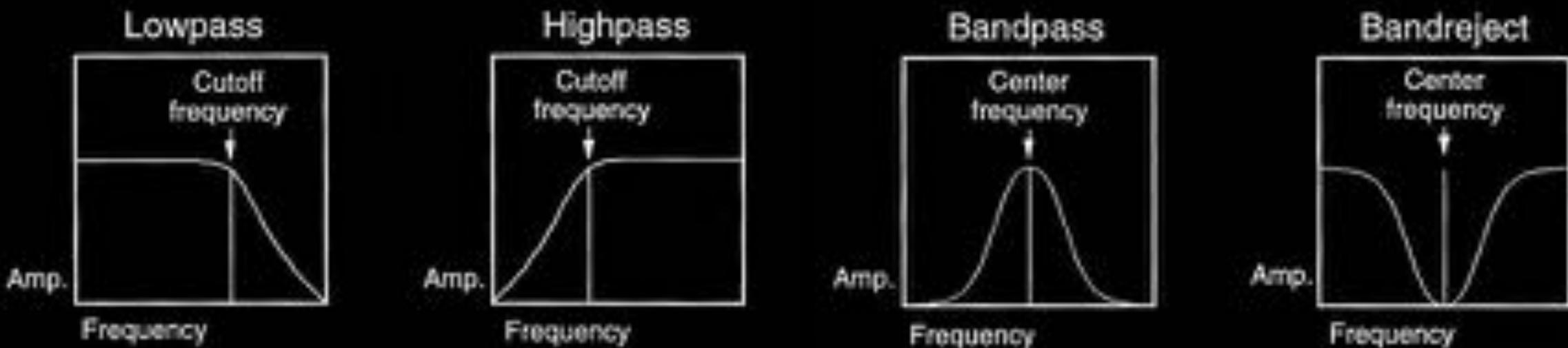


signal processing module, Voltage-controlled filter (VCF)

much of the timbral flexibility of a synthesizer comes from the filters

Boost or cut the amplitude of spectral components

Common varieties: low pass (LPF), high pass (HPF), band pass (BP), notch



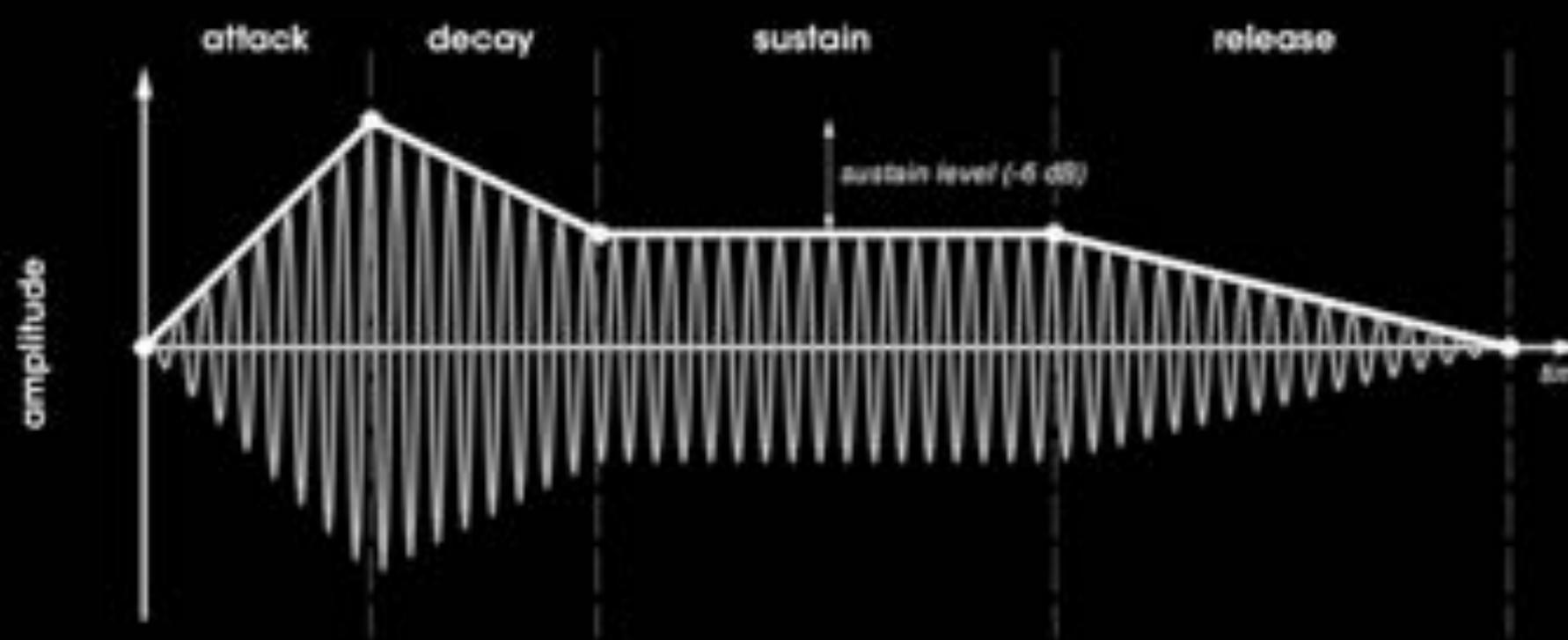
“Q” characterizes a resonator's bandwidth relative to its center frequency. Higher the Q, narrower the filter

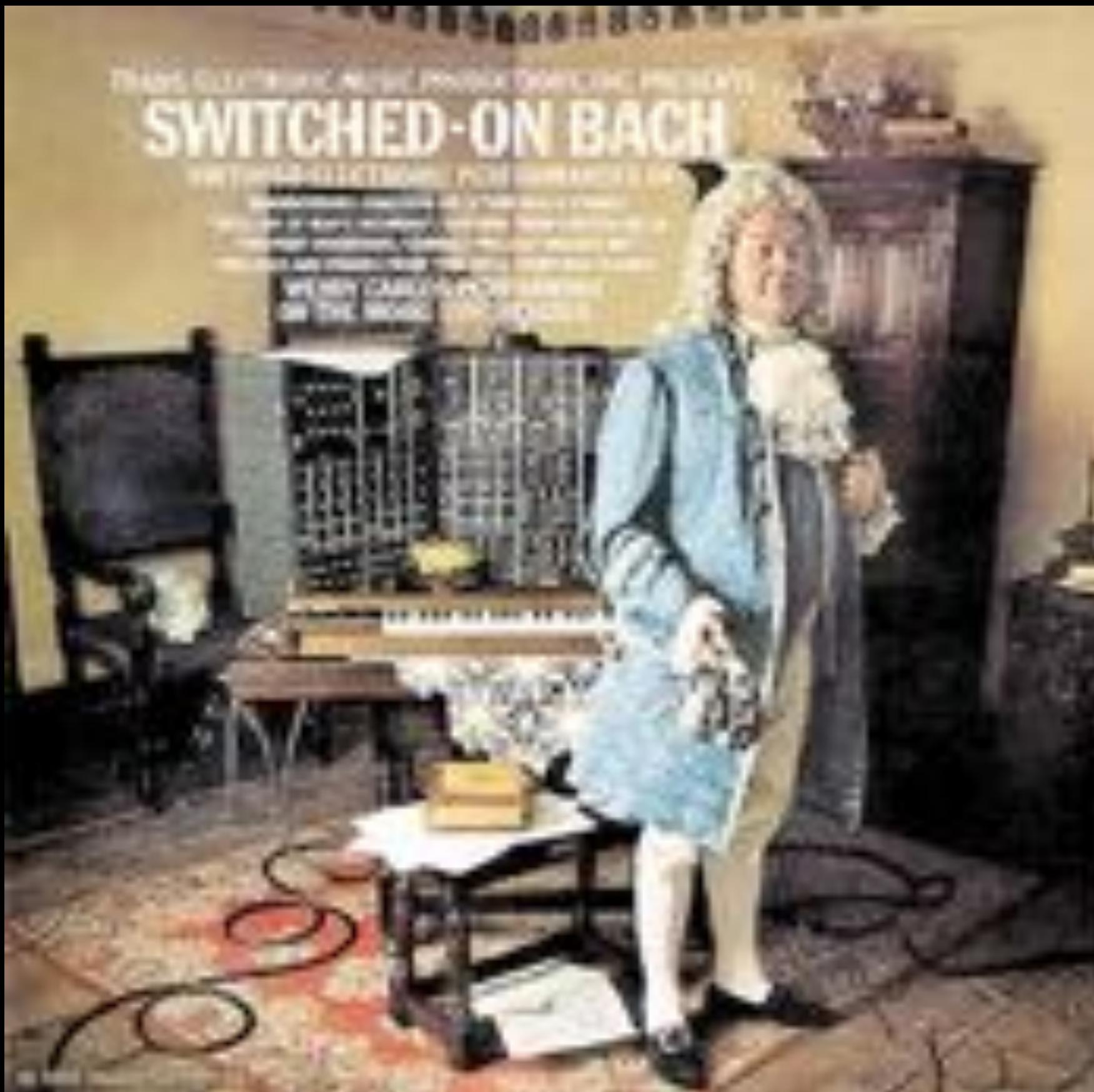
ENVELOPES



An envelope generator produces a control voltage that rises and falls once, according to a voltage command. The output rises to full on (ATTACK) and then falls over some time (DECAY) to an intermediate value (SUSTAIN) remains there before continuing to zero (RELEASE), often when the key is released.

ADSR design built by Moog at request of Ussachavesky





SWITCHED-ON BACH WENDY CARLOS

Performed by Wendy Carlos on a Monophonic Synthesizer!
Recorded on an 8-track tape recorder custom-built by Carlos.
One of the first classical albums to go platinum
Won Three Grammy awards
Brought the sound of the Moog synthesizer to the masses.





ISAO TOMITA

Like Carlos, built a career on covering classical works on monophonic synthesizers.

Pioneer of 'Space Synth Music'

4 Grammy nominations for his album *Snowflakes are Dancing*, 1974

Played a Moog III modular synthesizer

His sounds are often emulated in synth presets

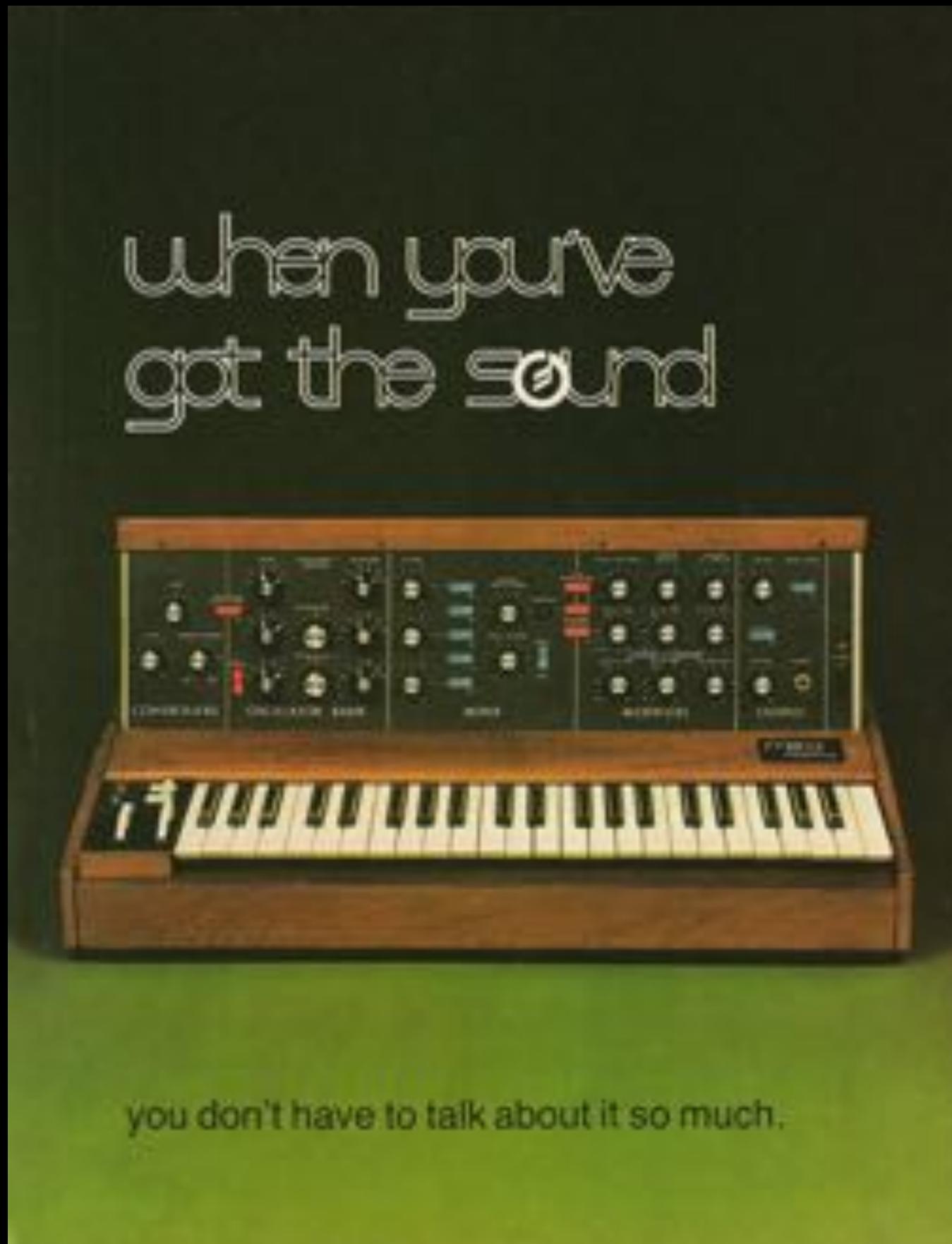


Morton Subotnick

Silver Apples of the Moon (1967)

created entirely with the Buchla 100 Synthesizer that he helped develop with Donald Buchla.





Minimoog (1970)

The first pre-patched, portable performance synthesizer.

Featured pitch bend and vibrato wheels (modulation wheels), which are now standard on all digital synthesizers.

popular and ‘affordable’ (\$1500) - sold 13,000 units.

the analog circuits were largely the same, but switches replaced patch points in a simplified arrangement called "normalization"

Made famous by **Keith Emerson** of Emerson, Lake and Palmer (ELP), first to tour with the instrument. Later used by groups such as Yes, Kraftwerk, Devo, Bob Marley, George Clinton, Chuck Corea and Pink Floyd.

Keith Emerson

In designing the minimoog, Bob Moog worked with virtuoso keyboardist Keith Emerson.

Emerson played in the band Emerson, Lake & Palmer (ELP) and gladly swapped his modular touring rig for the portability of the Minimoog.

ELP also covered a few classical tunes...



A black and white photograph of Charlie Christian, a jazz guitarist, performing at Minton's Club in New York City in 1941. He is wearing a dark tuxedo with a bow tie and a white shirt. He is looking down at his guitar, which is a Gibson ES-150. The background is slightly blurred, showing other musicians and the interior of the club.

SWING TO BOP

CHARLIE CHRISTIAN // GIBSON ES-150

1941 AT MINTON'S NYC

Muddy Waters

BLUES GUITARIST

PART OF THE 1940s CHICAGO JAZZ SCENE



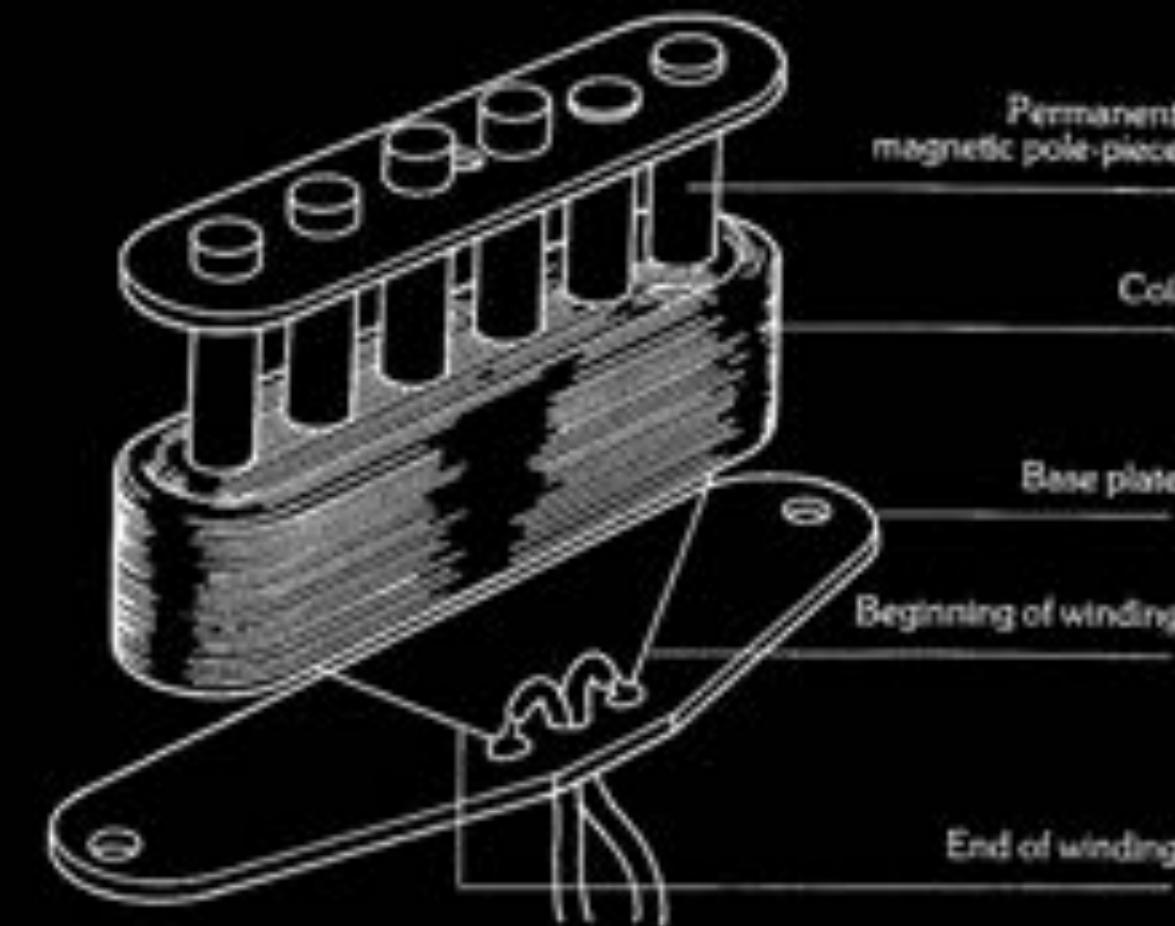
SOLID BODY ELECTRIC GUITARS

LES PAUL INVENTS “THE LOG” IN 1940



HOW DO GUITAR PICKUPS WORK?

Faraday's Law - a changing magnetic field will generate electricity in a conductive wire



Les Paul and Overdubbing



Listen: Lover (1948)

MULTITRACK TAPE

Late 50s and 60s

8 tracks recorded to 1 inch or 2 inch tape

Allowed for non-destructive overdubbing

no mechanical sync problems

creative bouncing



NEW FORMS

Concept Album: conceived as a single composition more than a collection of songs.

Studio Album: studio techniques and instrumental forces that could not be reproduced on stage.

NEW ELEMENTS

Synthesized sounds, surrealist collage, tape manipulation, echo, extreme panning, vocal processing, feedback, sound effects (everyday sounds), spatial effects, orchestral effects.

Beach Boys and Brian Wilson

songwriter, producer & studio perfectionist

- ★ studio arrangements were “impossible to perform live”
- ★ why mono?
- ★ the studio as an instrument, a compositional tool

using studio techniques (mixing, mixing, bouncing, collage, etc) and effects (primarily echo & reverb) songs became explorations of musical soundscapes.

context as a compositional device?

Good Vibrations (1966)



THE BEATLES

formed in 1960 in Liverpool, England

over 1 billion records sold

In 1966 they released the Revolver LP and followed with what would be their last commercial tour.

stopped touring in 1966 and focused on studio production

Listen: A Day in the Life (1967)

John Lennon, George Harrison, Paul McCartney, Ringo Starr at Shea Stadium 1966

FRANK ZAPPA

Zappa purchased a recording studio in LA in 1967, and devoted himself to learning to “play studio.”

Influenced by classical music, especially Varèse; later works combined synthesizers and Synclavier with orchestral instruments.

"conceptual continuity"

“***Brown shoes don't make it***” described as a 2-hour musical condensed into 8 minutes

Brown shoes don't make it (excerpt)



JIMI HENDRIX

in short time, redefined the electric guitar

pioneered the use of effects pedals and feedback.

Clear overdriven tone, extreme sustain, wah & octave

played guitar for Little Richard

Moved to London in 1966

first major US appearance was the **1967 Monterey Pops Festival** (guitar burn)

studio virtuoso (Electric Ladyland, 1968)

died of asphyxia at the age of 27



TYPES OF EFFECTS UNITS

Distortion	reshape sound by “clipping” the audio waveform
Dynamics	Boost / Compression / Noise Gate / (tremolo)
Filter	EQ / Talk Box / Wah Wah
Modulation	Chorus / Flanger / Phaser / Tremolo / Vibrato
Pitch / Frequency	Pitch Shifter / Harmonizer
Time-based	Delay / Looping / Reverb

STEVE REICH

influenced by both tape loops and Ghanaian drumming

Phase Music

- Come Out (tape loops)
- Piano Phase (acoustic instruments using techniques developed working with tape)

2009 Pulitzer Prize in Music

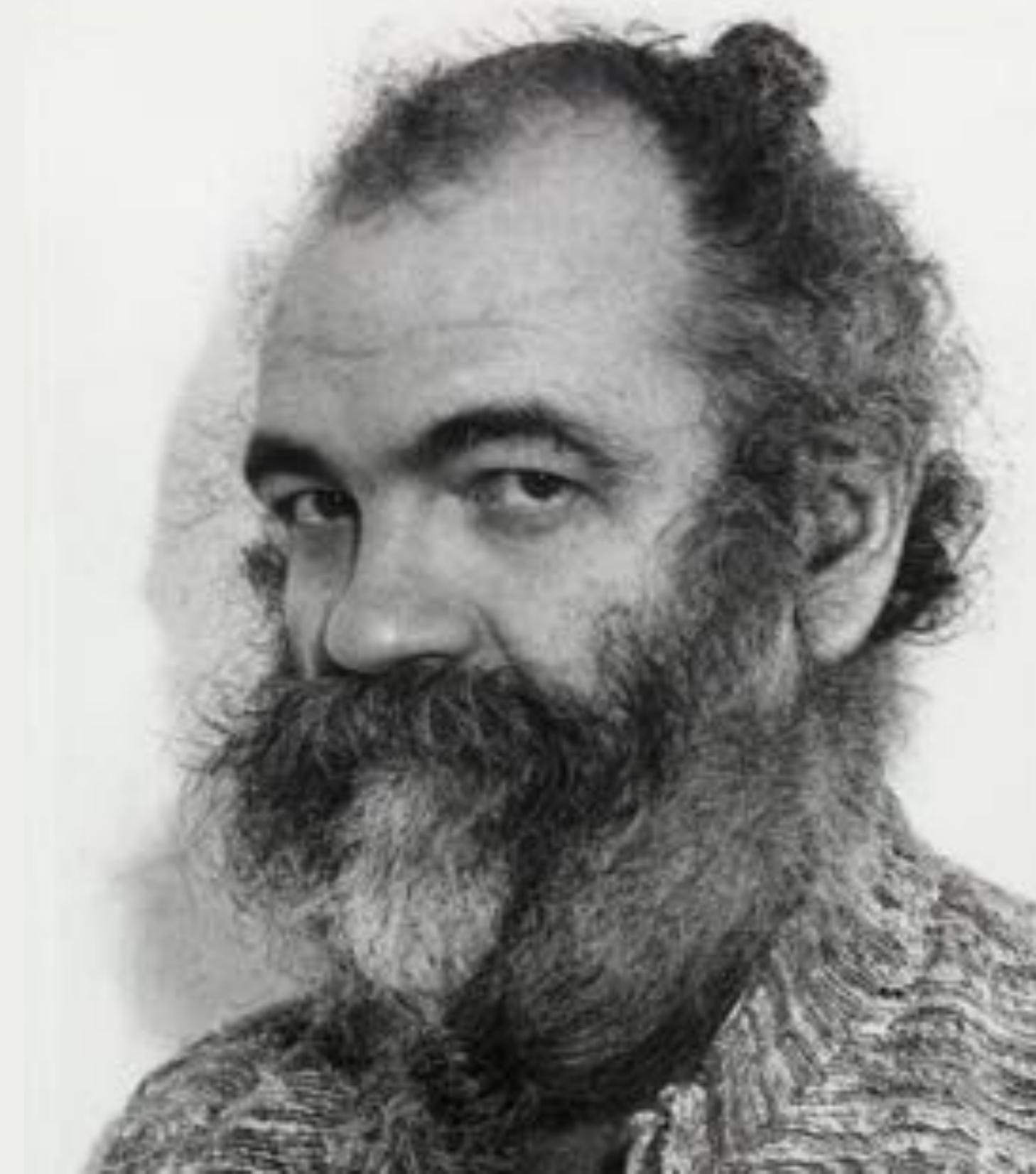


LA MONTE YOUNG

Often cited as the first “minimalist” composer -
musical reductionist

Worked with Cage, Stockhausen, Tudor & Riley

Dream House project started in 1962.



ÉLIANE RADIGUE

Assisted Pierre Schaeffer and Pierre Henry

Studied at NYU

In 1975, Radigue became a disciple of Tibetan Buddhism, greatly influencing her music.

slow, purposeful "unfolding" of sound

Worked extensively with the Arp 2500 Modular Synthesizer

Early 'drone music'

Listening: Arthesis (1973)

TERRY RILEY

Riley was part of the San Francisco Tape Music Center with Pauline Oliveros, Steve Reich and Morton Subotnick.

In C (1964) was inspired by tape loops and jazz improvisation. It consisted of 53 musical figures played sequentially, with each being repeated a few times.

The work brought minimalism to prominence, introducing rhythmic patterns that could be combined and repeated.

Electronic techniques inspiring methods for acoustic music.



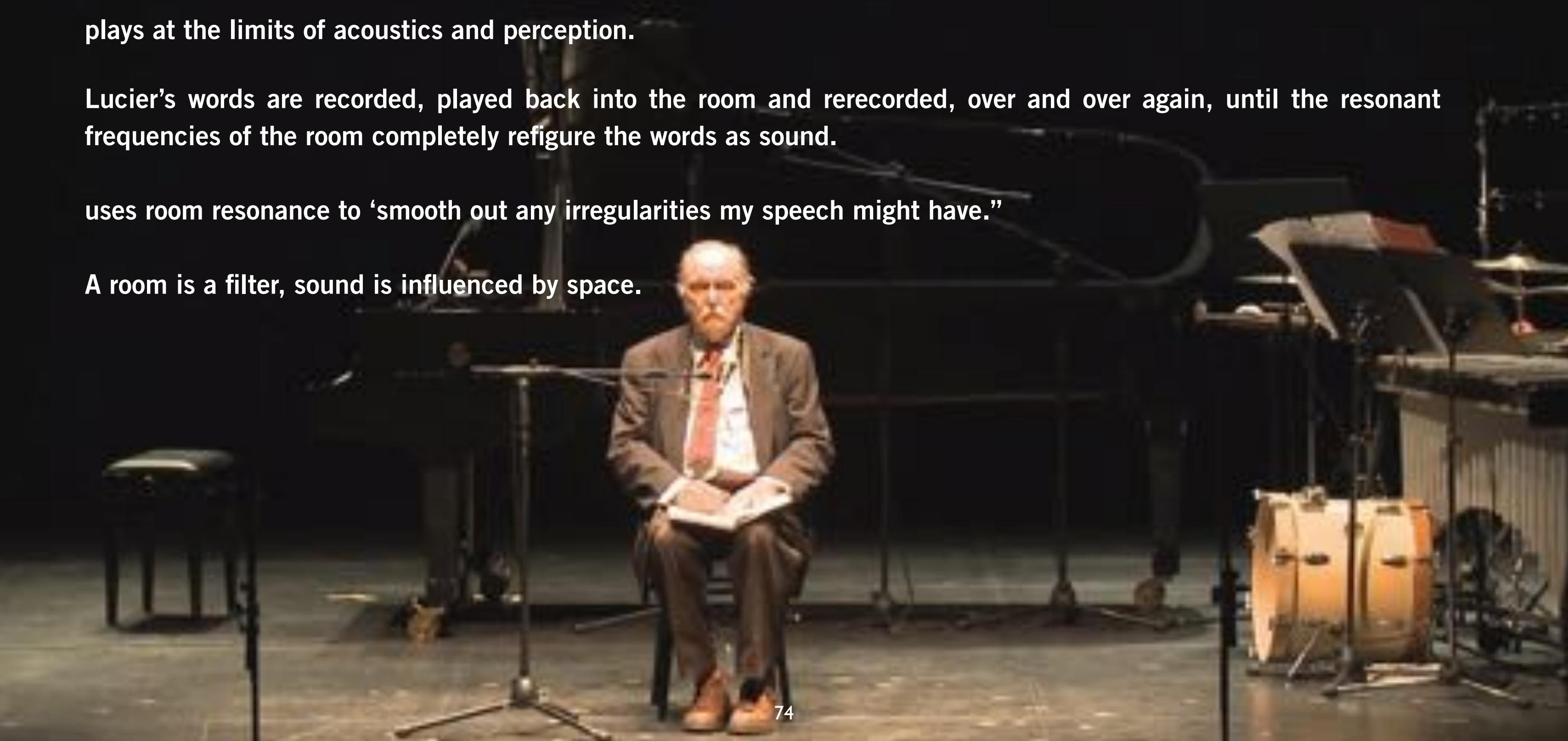
I AM SITTING IN A ROOM (1970)

plays at the limits of acoustics and perception.

Lucier's words are recorded, played back into the room and rerecorded, over and over again, until the resonant frequencies of the room completely refigure the words as sound.

uses room resonance to 'smooth out any irregularities my speech might have.'

A room is a filter, sound is influenced by space.





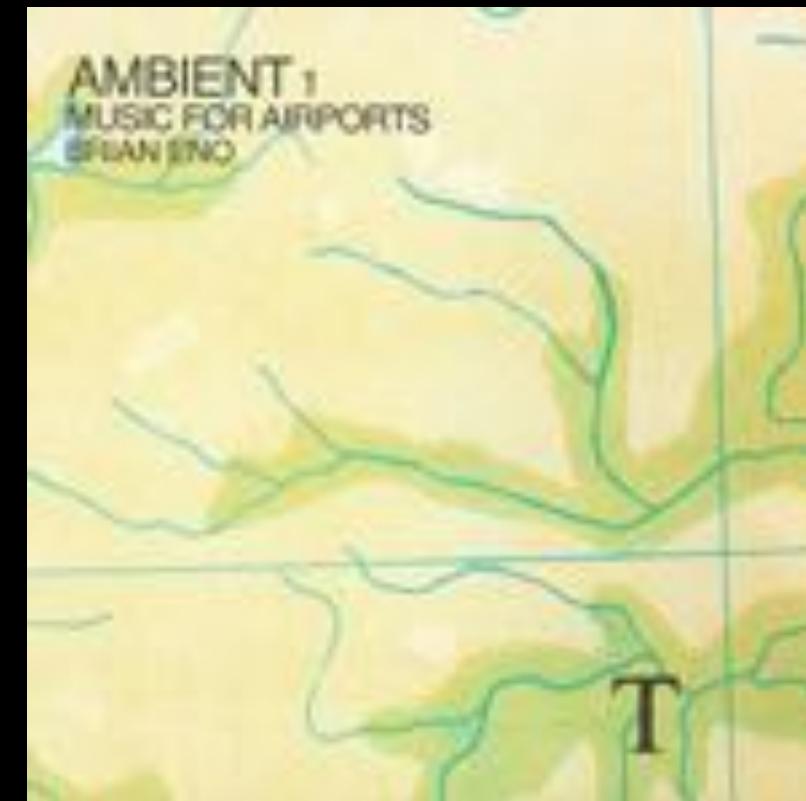
Brian Eno

Credited with naming / inventing Ambient Music

Produced records by the Talking Heads, U2, David Bowie, Coldplay, and many others.

Oblique Strategies — chance based studio prompts

Listen: Music for Airports



Ambient Music Recap

Ambient Music often focuses on the timbre, changes in the quality of the sound rather than the traditional focus of rhythm, melody and harmony.

Often evocative of a “place,” “atmosphere,” “visual” or “environment.”

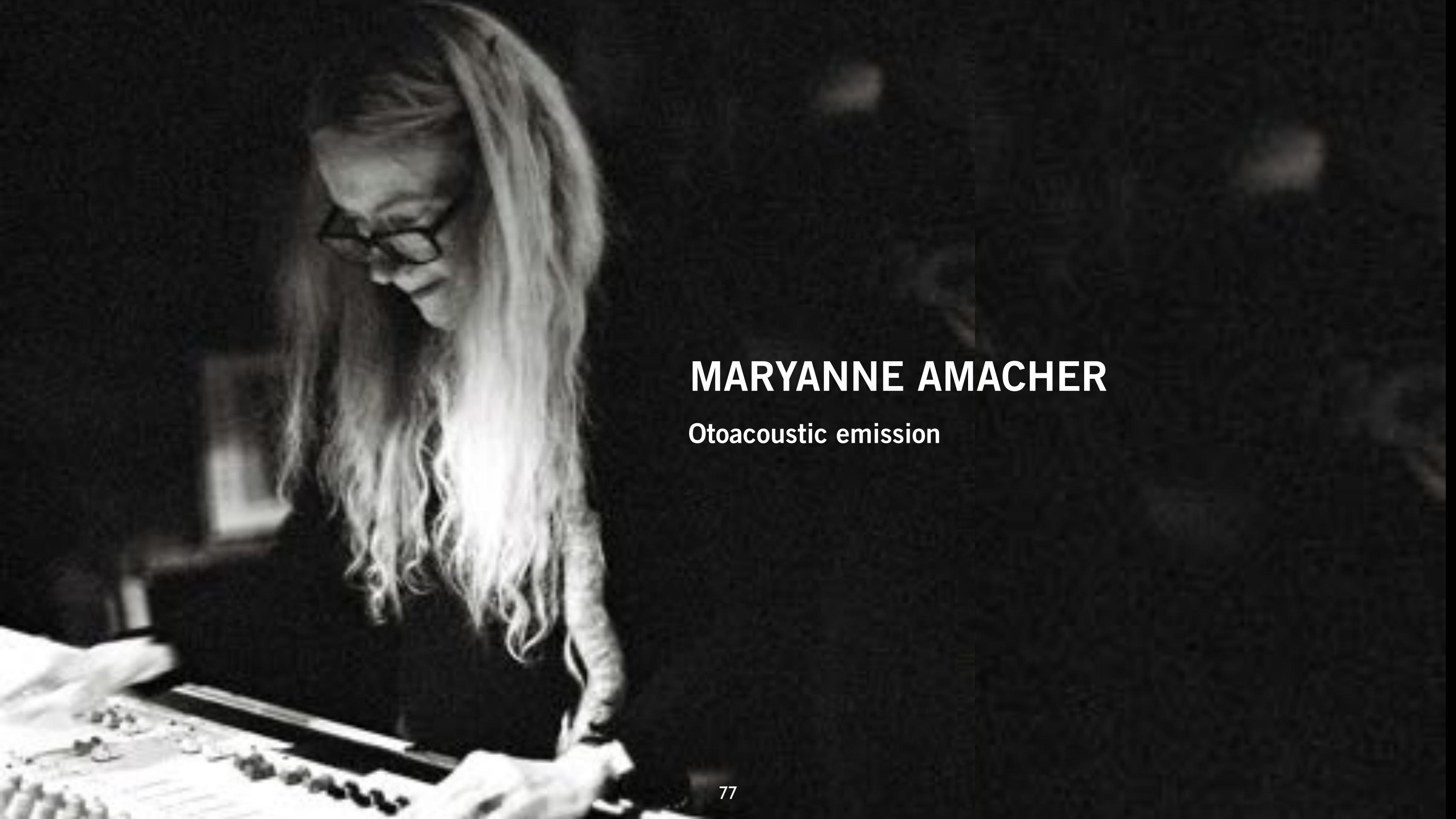
“Not music from the environment but music for the environment” - Eno

It's typically less-dramatic, and often non-linear, without clear directionality.

It has roots in the work of John Cage, Wendy Carlos, La Monte Young and the “minimalist” composers.

It spans aesthetics ranging from Sound Art to Dance Music

matured as a genre through the work and writing of Brian Eno



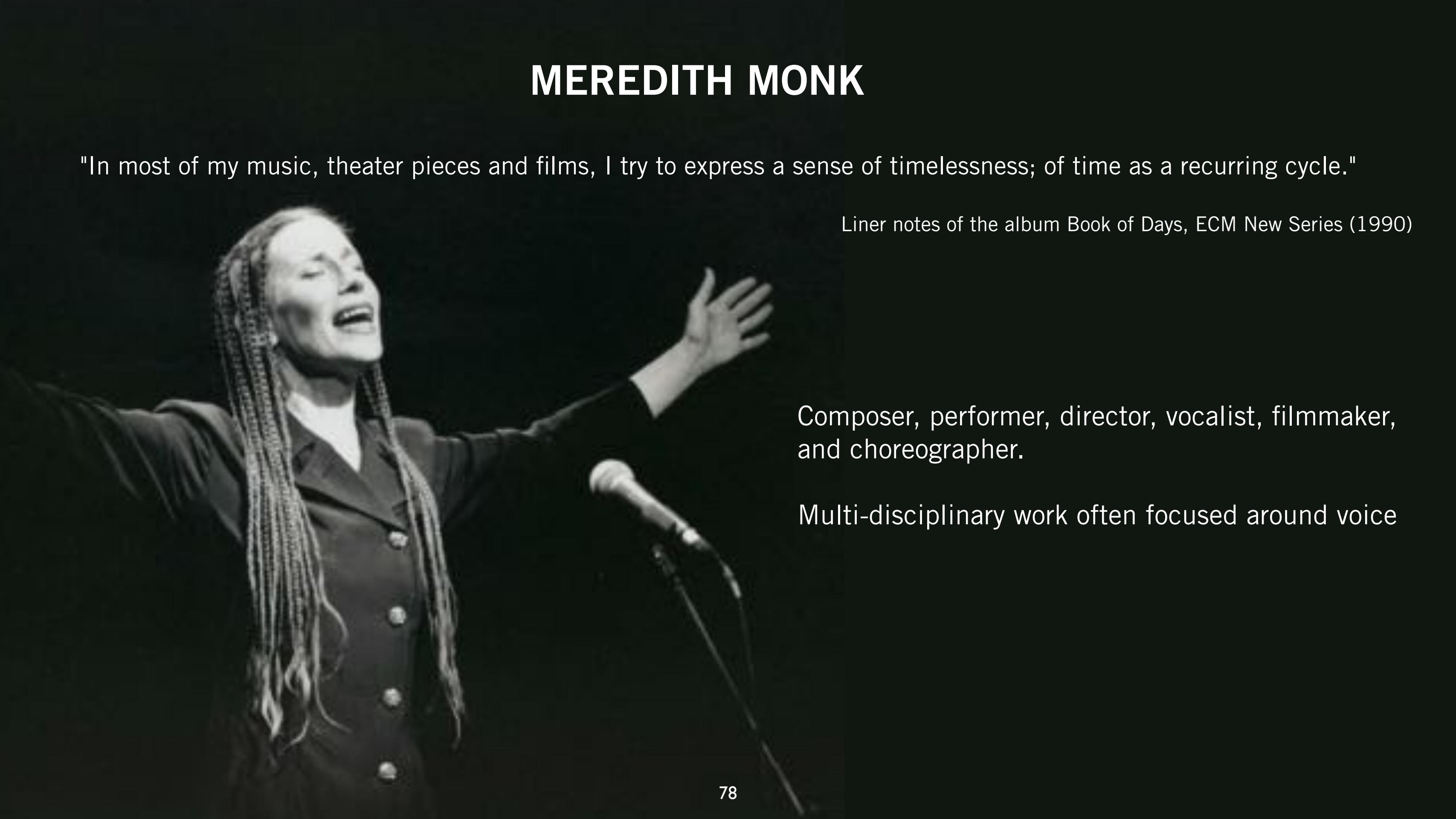
MARYANNE AMACHER

Otoacoustic emission

MEREDITH MONK

"In most of my music, theater pieces and films, I try to express a sense of timelessness; of time as a recurring cycle."

Liner notes of the album Book of Days, ECM New Series (1990)

A black and white photograph of Meredith Monk singing. She has long, dark, braided hair and is wearing a dark, button-down shirt. Her eyes are closed, and she is singing with her arms raised and hands open, conveying a sense of emotion and expression. A microphone stand is visible in the foreground.

Composer, performer, director, vocalist, filmmaker,
and choreographer.

Multi-disciplinary work often focused around voice

ROCKIT

Herbie Hancock

DJ Grand Mixer DXT





CHRISTIAN MARCLAY

Experimental Sound Artist working primarily with records and record players

Grandmaster Flash

Expanded on Herc and Theodore's techniques to elevate the turntables to a virtuosic instrument

DJ mixer



Maria Chavez

Book of Abstract Turntable Techniques!



ON TURNTABLES OF TECHNIQUE: CHANCE PROCEDURES

A BOOK OF ESSAYS & ILLUSTRATIONS
BY MARIA CHAVEZ