



Offshoots

Aaron Colverson

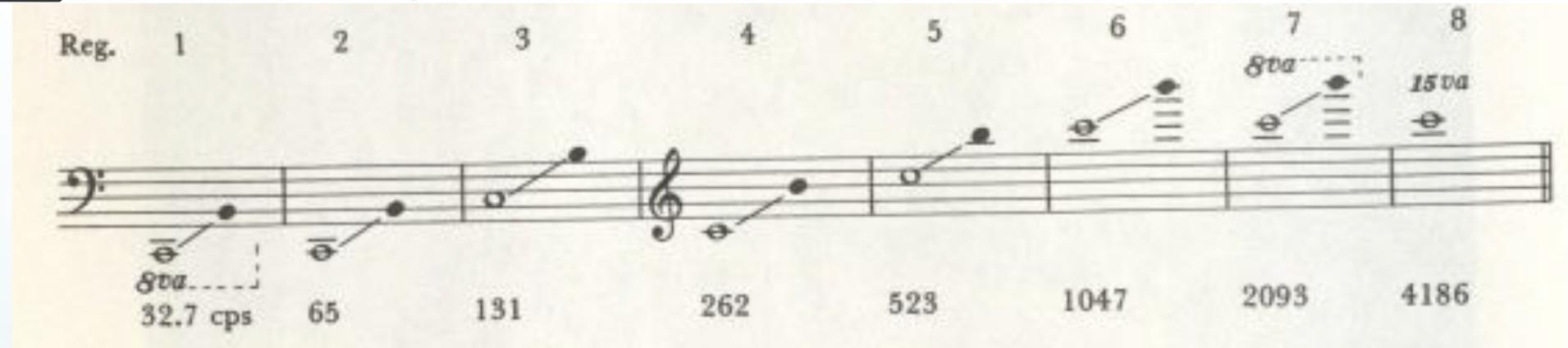


Overview

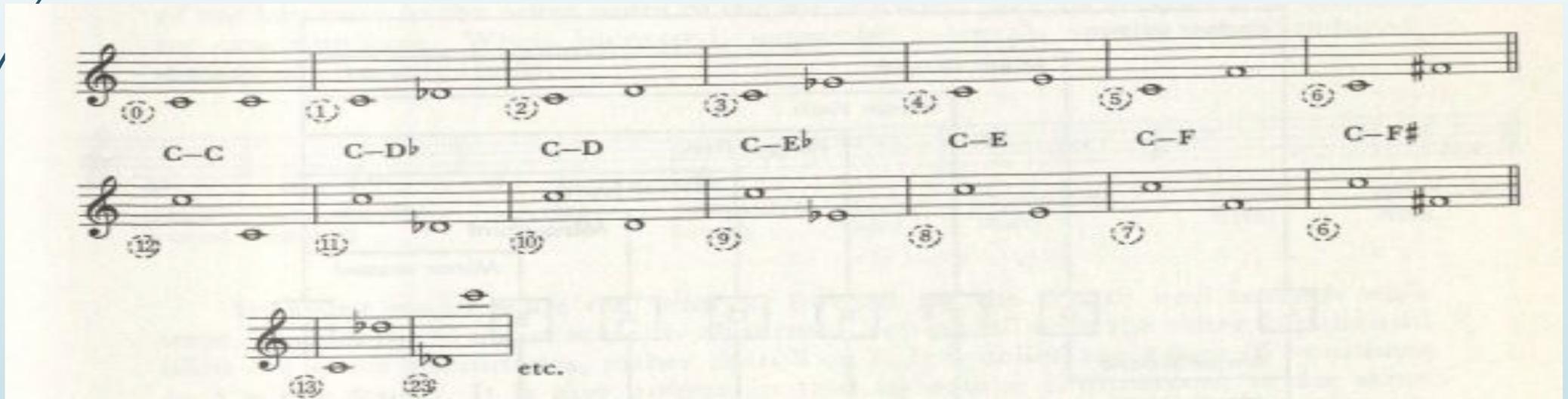


- ▶ Naming Registers and Intervals
- ▶ The psychophysics of Sound
- ▶ Rāga systems of India
- ▶ Tonal Extensions

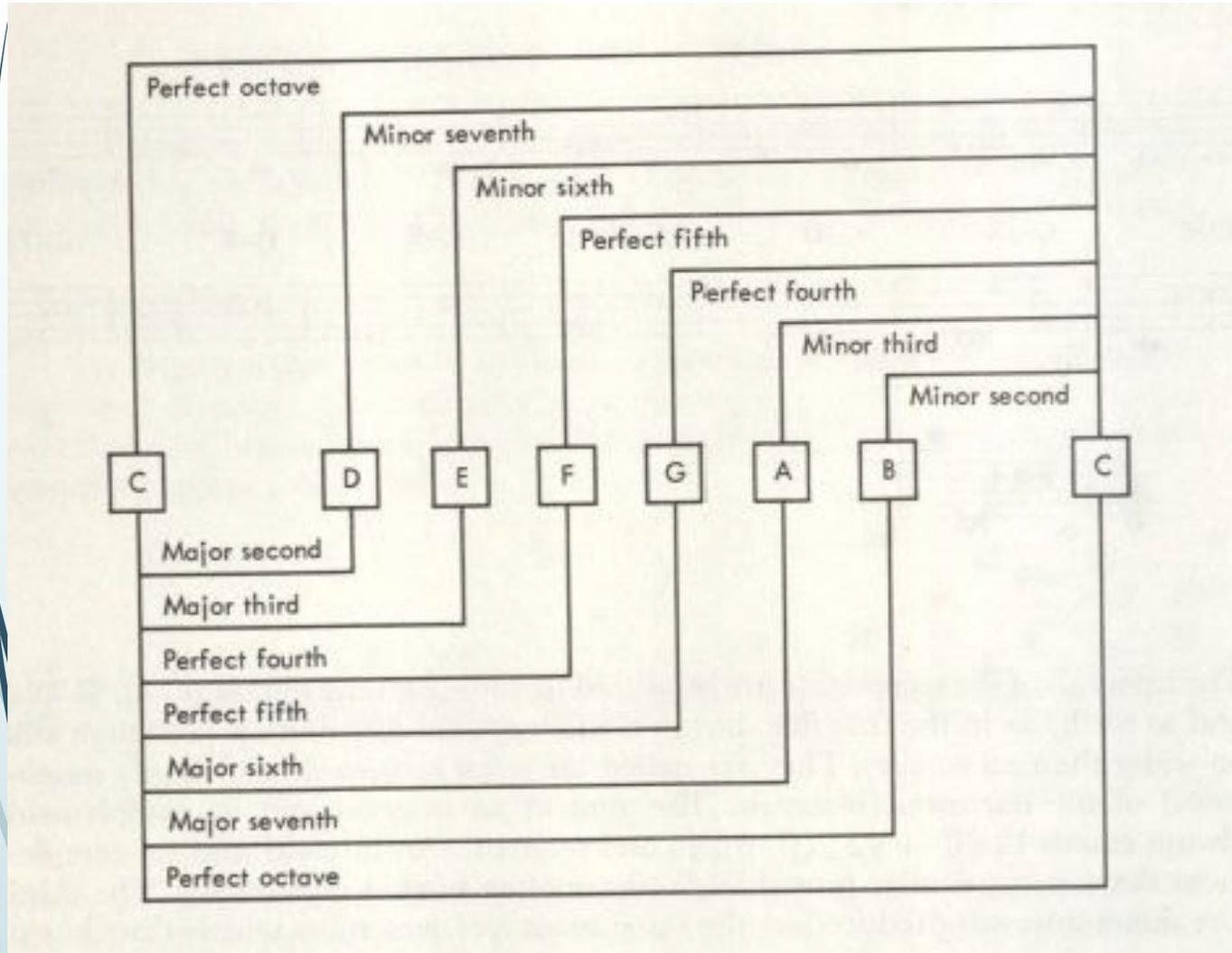
Registers and Intervals



Registers divide the audible range into broad areas the size of octaves
Intervals are a more exact measure of point-to-point distances throughout a range



Intervals – cont'd



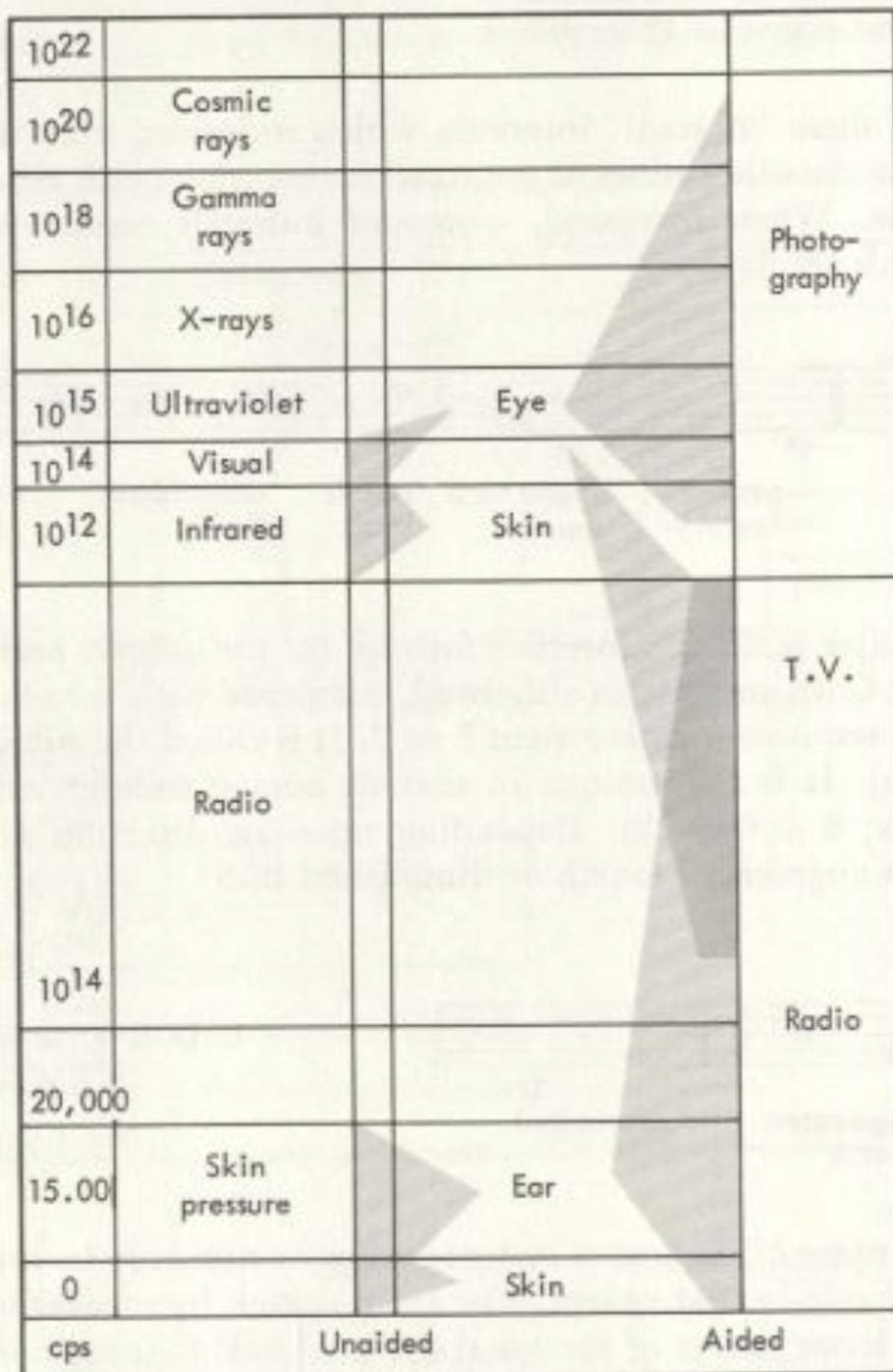
Tonal interval numbering system

[identical notes (C-C) = a unison]
adjacent notes (C-D) = a second
notes spanning three scale steps (C-E) = a third
notes spanning four scale steps (C-F) = a fourth
notes spanning five scale steps (C-G) = a fifth
notes spanning six scale steps (C-A) = a sixth
notes spanning seven scale steps (C-B) = a seventh
notes spanning eight scale steps (C-C) = an octave

A dark blue arrow points to the right at the top left. Below it, several thin, curved lines in shades of blue and grey sweep across the left side of the slide.

Psychophysics of Sound - Overview

- ▶ Sound wave
 - ▶ Compound sound waves
 - ▶ Vibration in partials
 - ▶ Complex waves/noise
- ▶ Audible range – “what we can hear”
 - ▶ Intensity and loudness
- ▶ Tuning systems
 - ▶ Interval ratio theory of consonance and dissonance
 - ▶ Tone color
- ▶ Electronic music

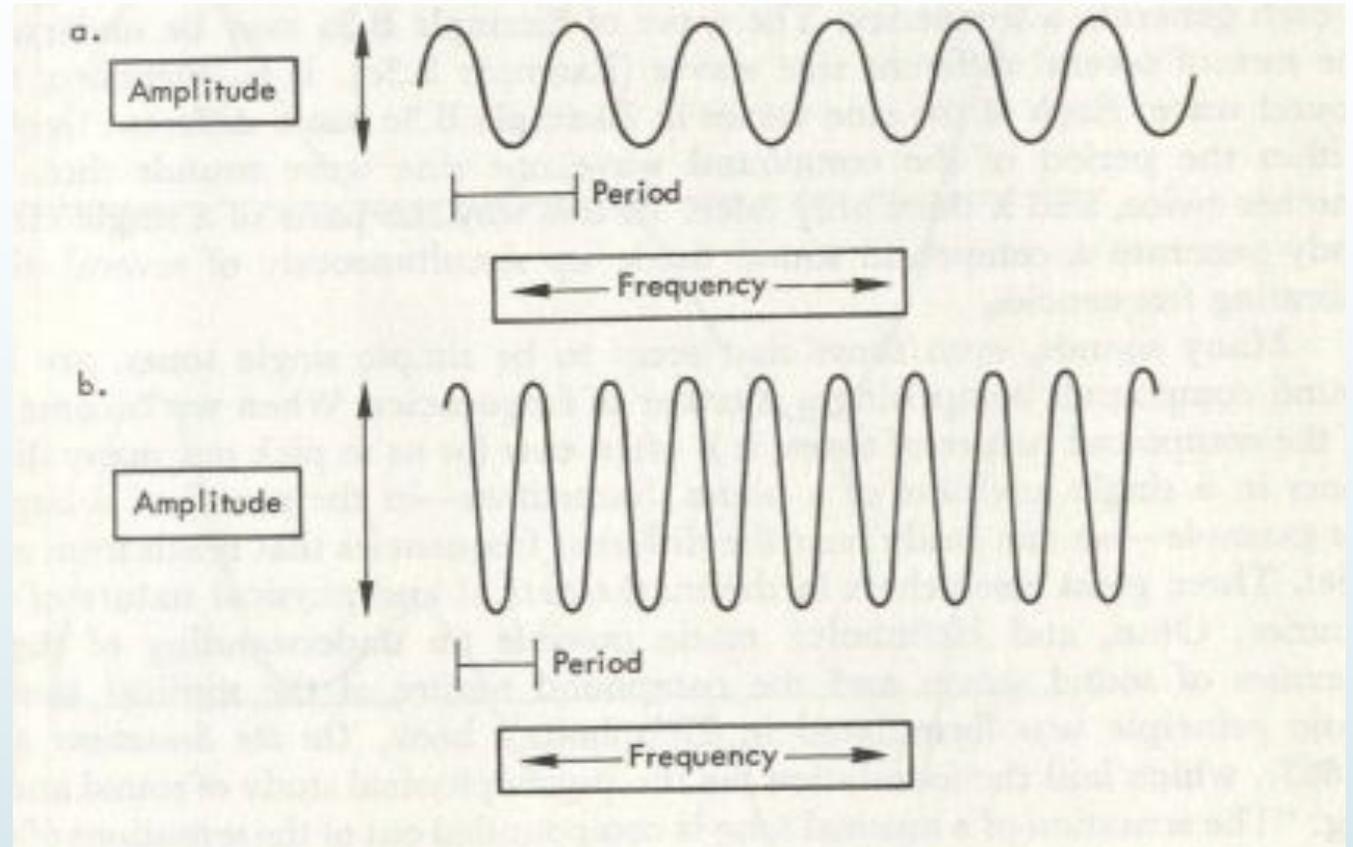


Relationship of human beings to electromagnetic spectrum

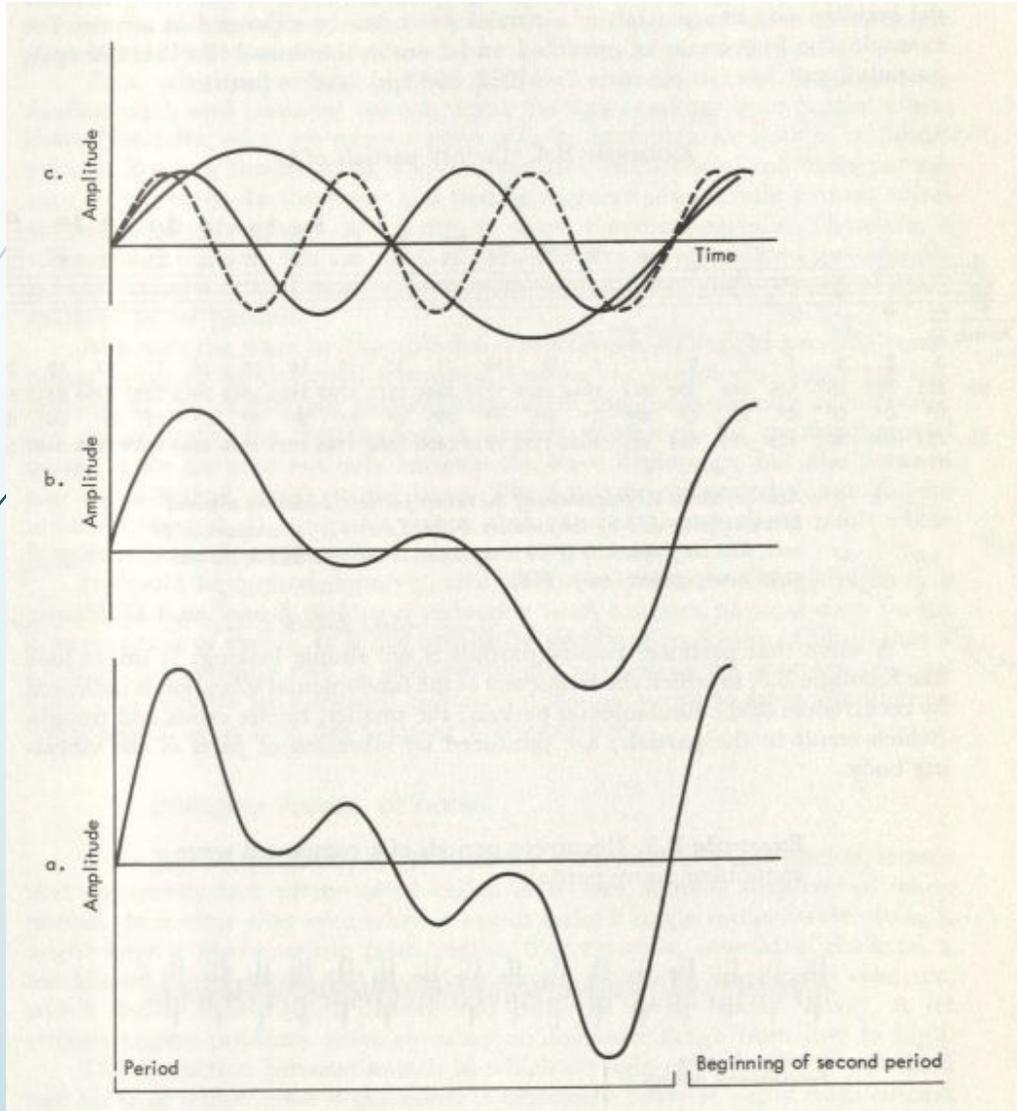
Interactions between waves, skin and eyes yields the term *psychophysics*

Sound wave

Simple sine waves displaying relationship between the variable properties of amplitude and frequency

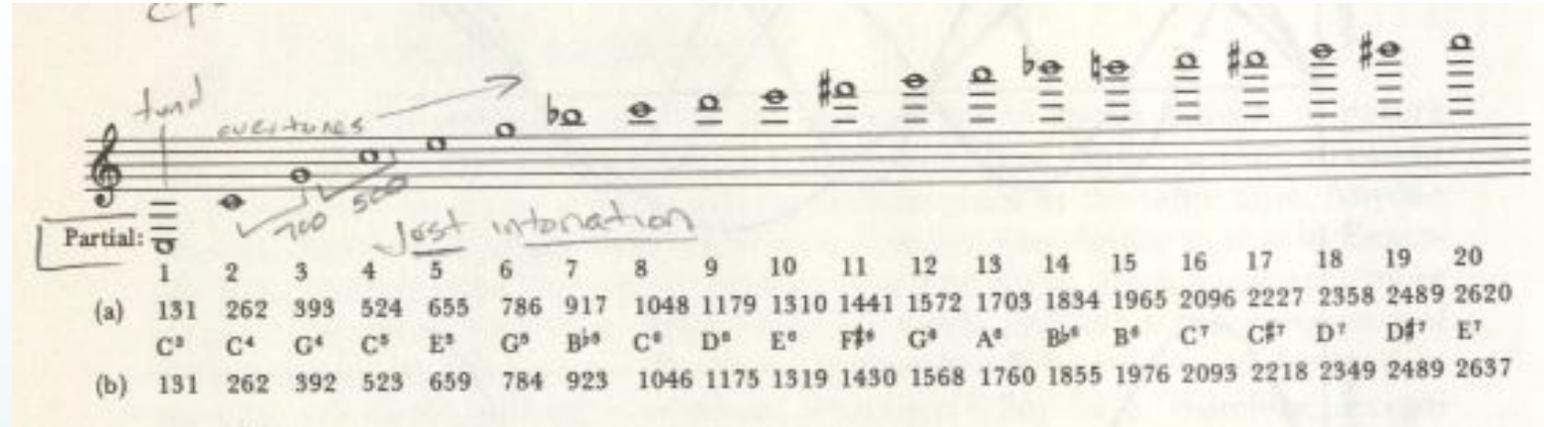


Compound sound waves



Analysis of a compound wave into its component sine waves

Vibrations in partials

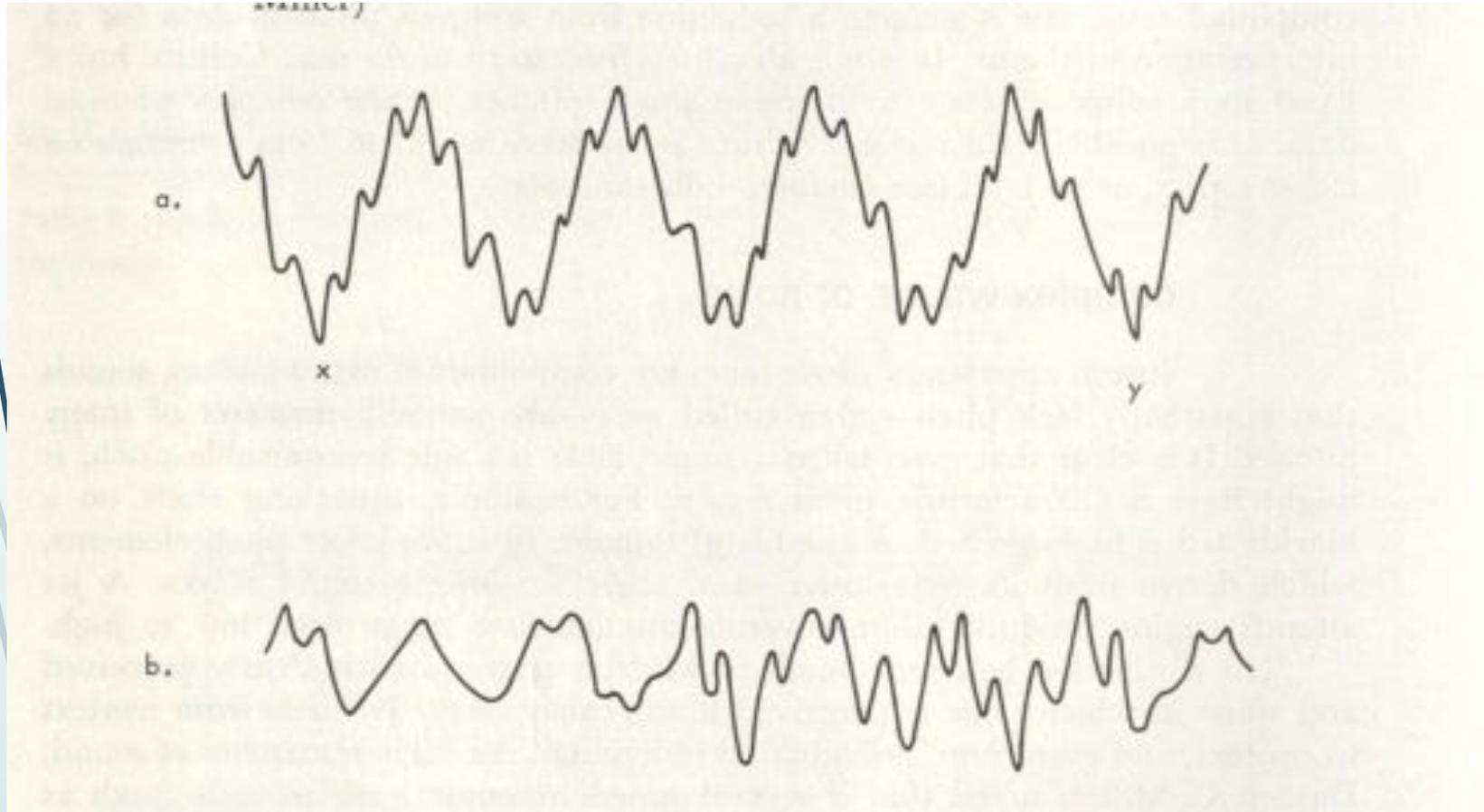


Line (a) shows the frequencies of the twenty partials, which are obtained by multiplying 131 by the numbers 1-20. Line (b), for comparison's sake, lists the frequencies of the notes closest to these partials in the tempered tuning system (see p. 452).

500-502

What recurring periods of a compound wave with many partials may look like

Complex waves, or noise

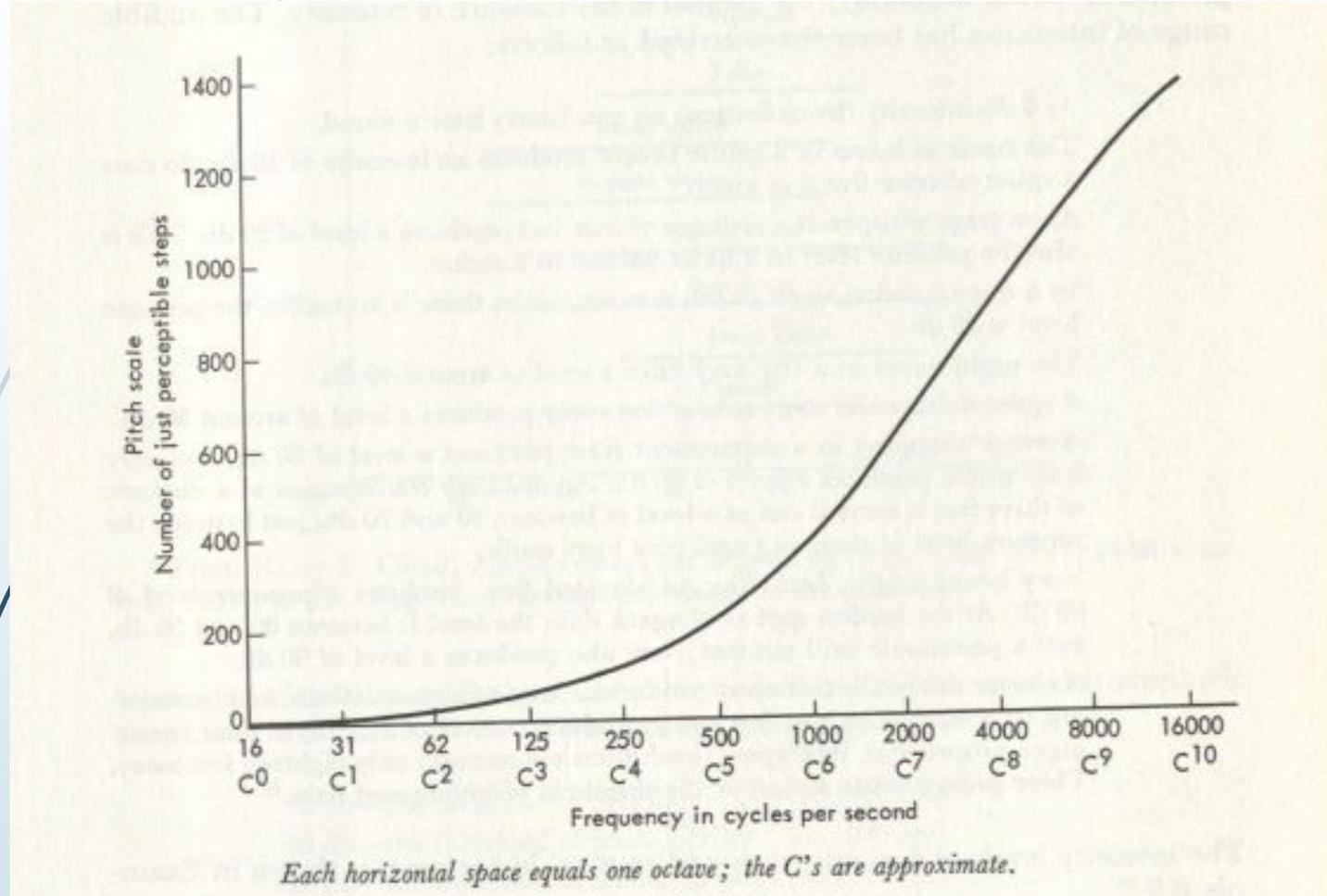


Example a. is a tuning fork being struck by a wooden mallet

Example b. is a bell. Importantly, none of the overlapping frequencies reinforce a fundamental, causing the perception of noise

Different forms of noise: white, colored

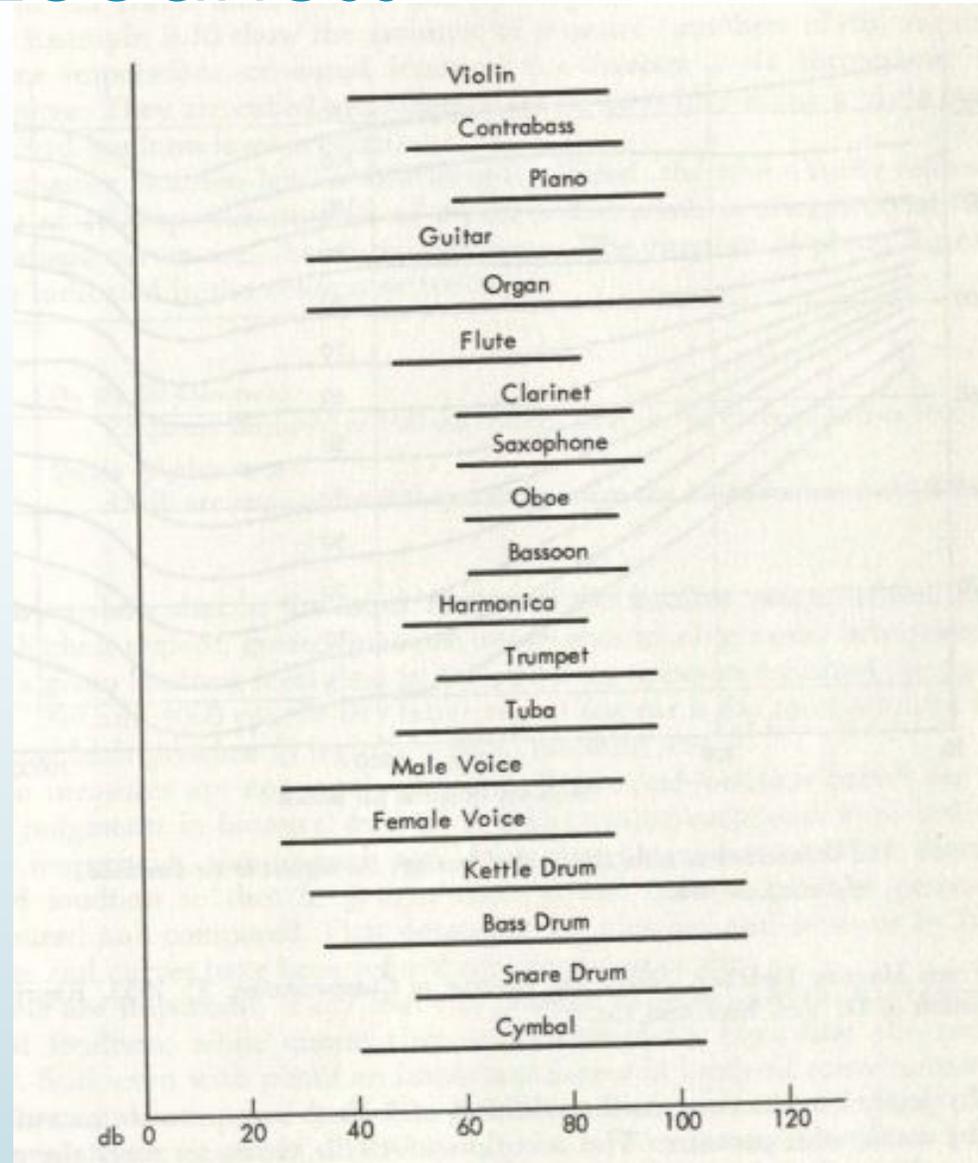
Audible range



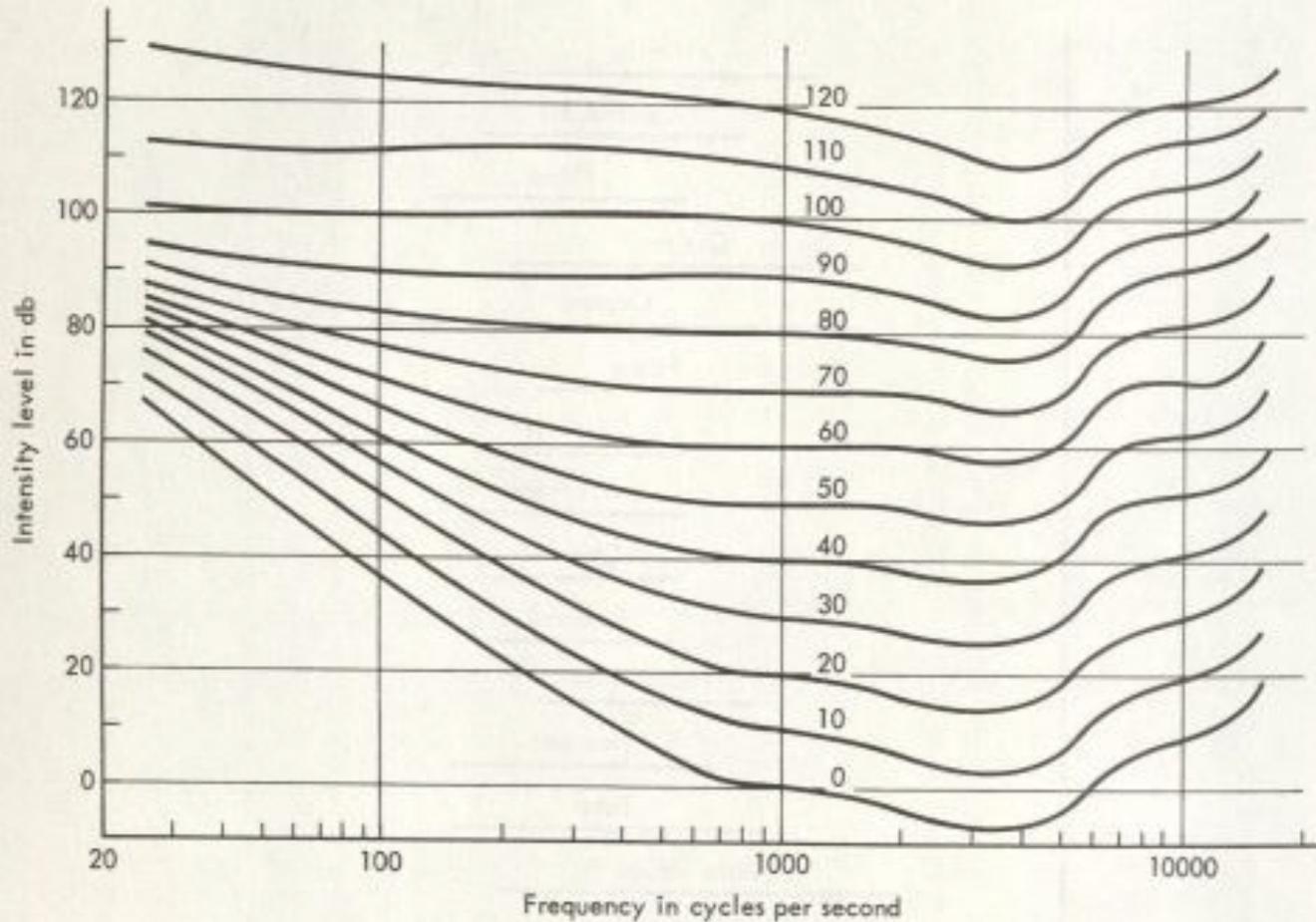
Traces the "just noticeable differences" in pitch throughout the audible range of most ears

Intensity and Loudness

If you were standing 10 feet away from any of these instruments, the relative intensity and loudness would be perceived as displayed on the right



Intensity and loudness cont'd



The lowest curve is the threshold of hearing; the highest is the threshold of feeling, or pain.

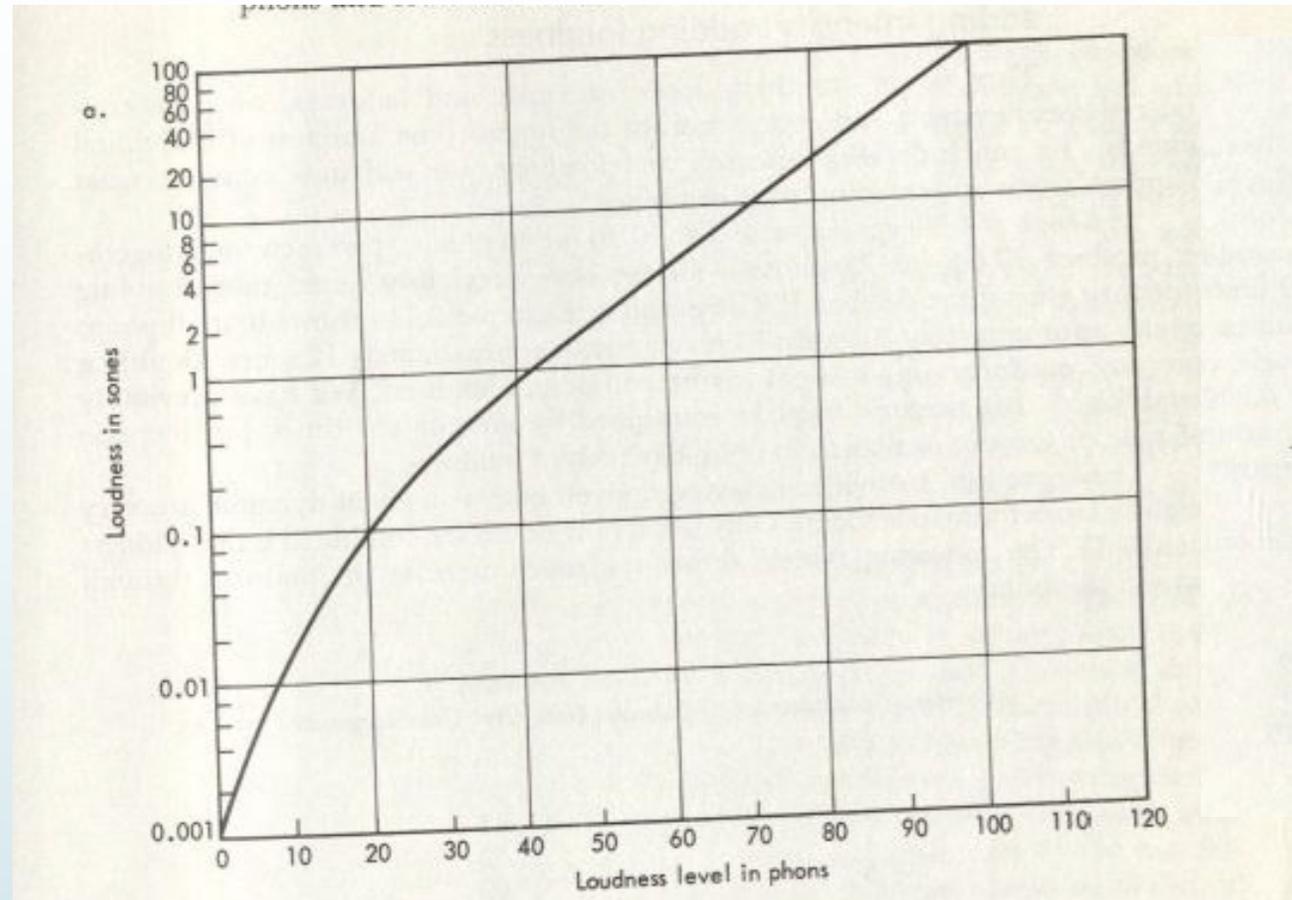
Threshold curves

Lowest is threshold for hearing in decibels and highest is threshold for feeling/pain

Intensity and loudness cont'd

Phons: measure equal loudness between sounds and make it possible to relate physical pressure to perceived loudness

Sones: make it possible to measure unequal loudness between sounds and is equal to 40 phons, placing it at the threshold of intelligibility



sones	phons
512	121
256	112
128	103
64	94
32	85
16	76
8	67
4	58
2	49
1	40
<hr/>	
.5	32.2
.25	25.6
.125	20.2
.062	15.8
.031	12.0
.016	8.9
.008	6.3
.004	4.0
.002	2.0
.001	0.0

Tuning systems

	C	C#	D	D#	E	F	F#	G	G#	A	A#	B
REG 0	16	17	18	19	21	22	23	24	26	28	29	31
REG 1	33	35	37	39	41	44	46	49	52	55	58	62
REG 2	65	69	73	78	82	87	92	98	104	110	117	123
REG 3	131	139	147	156	165	175	185	196	208	220	233	247
REG 4	262	277	294	311	330	349	370	392	415	440	466	494
REG 5	523	554	587	622	659	698	740	784	831	880	932	988
REG 6	1047	1109	1174	1245	1319	1397	1480	1568	1661	1760	1865	1976
REG 7	2093	2217	2349	2489	2637	2794	2960	3136	3322	3520	3729	3951
REG 8	4186	4435	4699	4978	5274	5588	5920	6271	6645	7040	7459	7902
REG 9	8372	8870	9397	9956	10,548	11,175	11,840	12,542	13,290	14,080	14,917	15,804

Displays frequencies of the equal-tempered system through ten octaves in Herz

Interval ratio theory

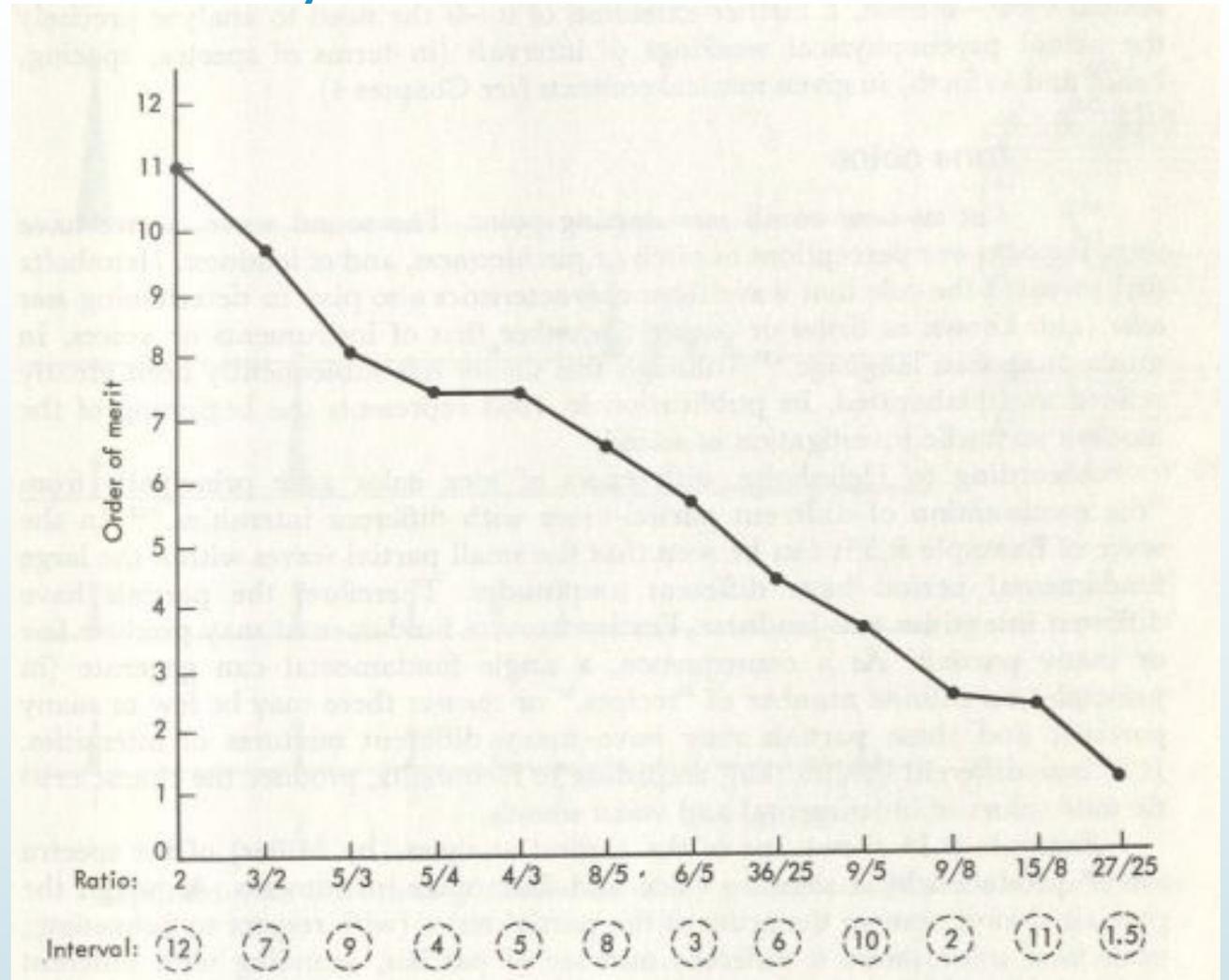
⑦ perfect fifth	(C-G)	2 : 3	
⑤ perfect fourth	(G-C)	3 : 4	
⑨ major sixth	(G-E)	3 : 5	(however B \flat -G is 7 : 12; C-A is 8 : 13)
④ major third	(C-E)	4 : 5	(however B \flat -D is 7 : 9; D-F \sharp is 9 : 11)
③ minor third	(E-G)	5 : 6	(however G-B \flat is 6 : 7; A-C is 13 : 16)
⑩ minor seventh	(C-B \flat)	4 : 7	(however E-D is 5 : 9)
⑥ tritone	(E-B \flat)	5 : 7	(however F-C \sharp is 11 : 16)
⑧ minor sixth	(E-C)	5 : 8	(however D-B \flat is 9 : 14)
② major second	(B \flat -C)	7 : 8	(however C-D is 8 : 9; D-E is 9 : 10; E-F \sharp is 10 : 11; and so on)
⑪ major seventh	(G-F \sharp)	6 : 11	(however B \flat -A is 7 : 13; C-B is 8 : 15)
① minor second	(F \sharp -G)	11 : 12	(however A-B \flat is 13 : 14; B \flat -B is 14 : 15; B-C is 15 : 16; and so on)

Displays intervals in the partial series as whole-number ratios

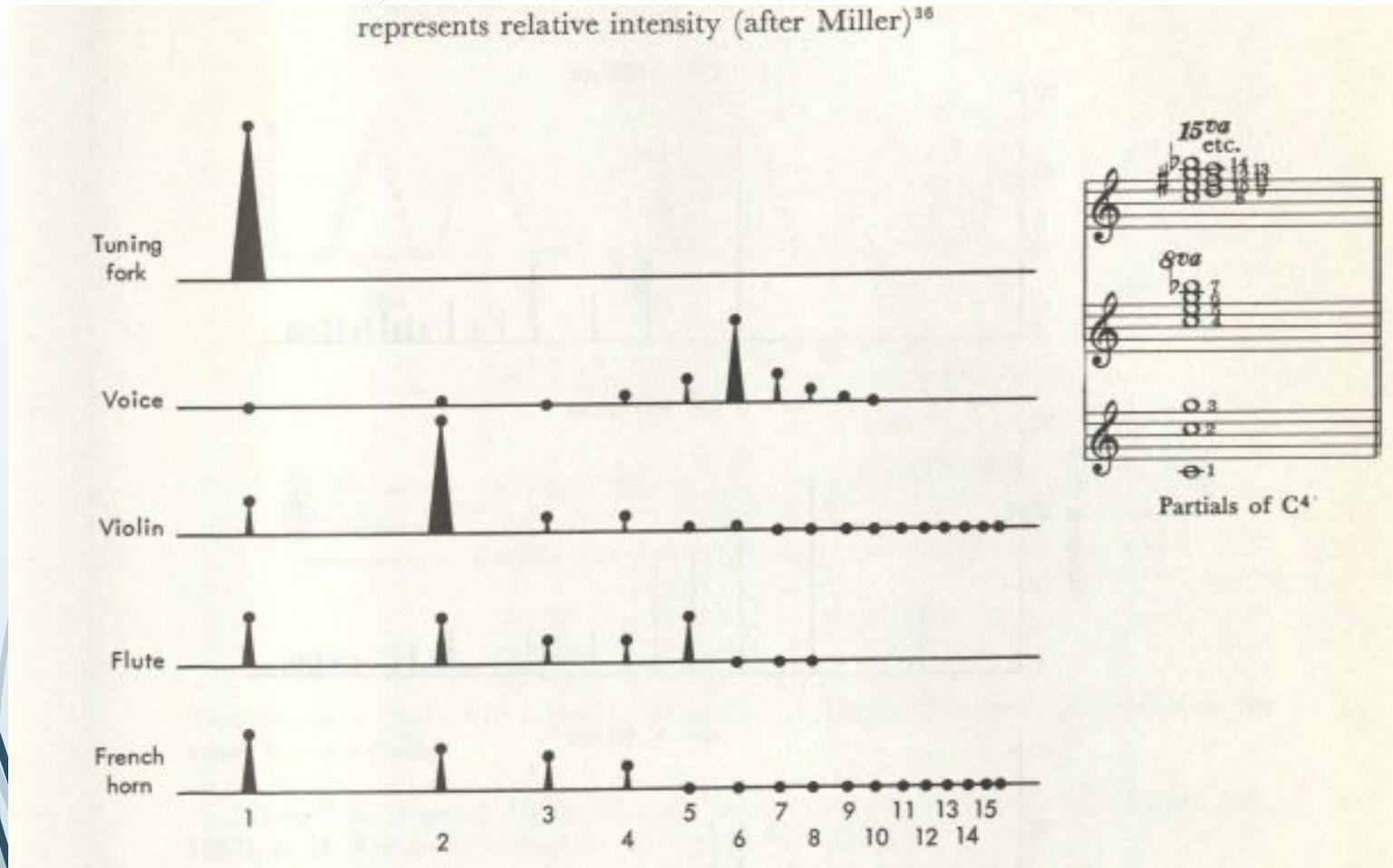
Principles of consonance and dissonance have been attributed throughout history: Pythagoras, Rameau or Hindemith

Interval ratio theory cont'd

Attempt made to plot
consonant-dissonant
characteristics of
various interval ratios



Tone color



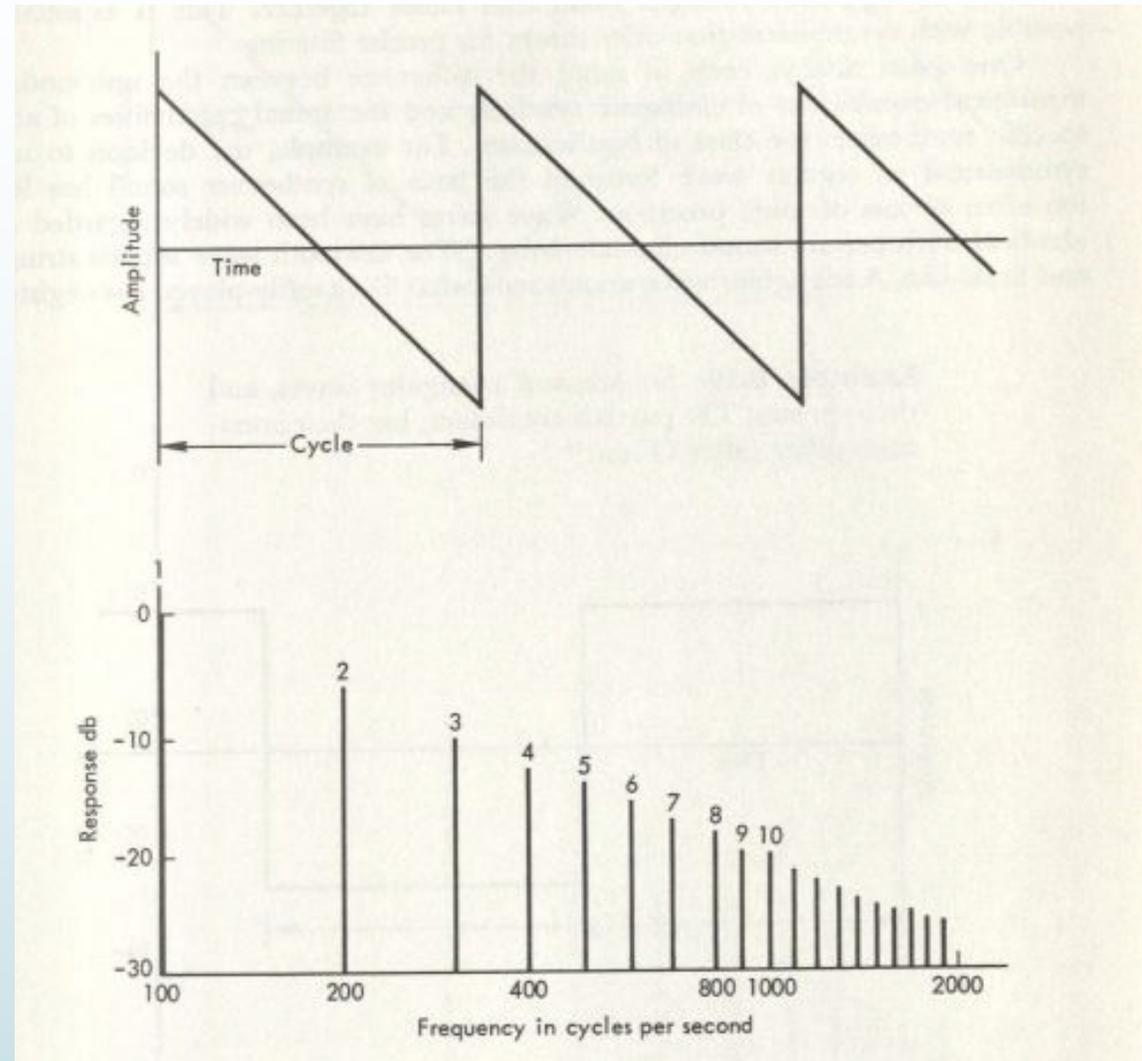
According to Helmholtz, tone color is defined by "the combination of different partial tones with different intensities" equating to varying spectra of sound

Example to left shows spectra of C⁴ and height of wedges indicates relative intensity

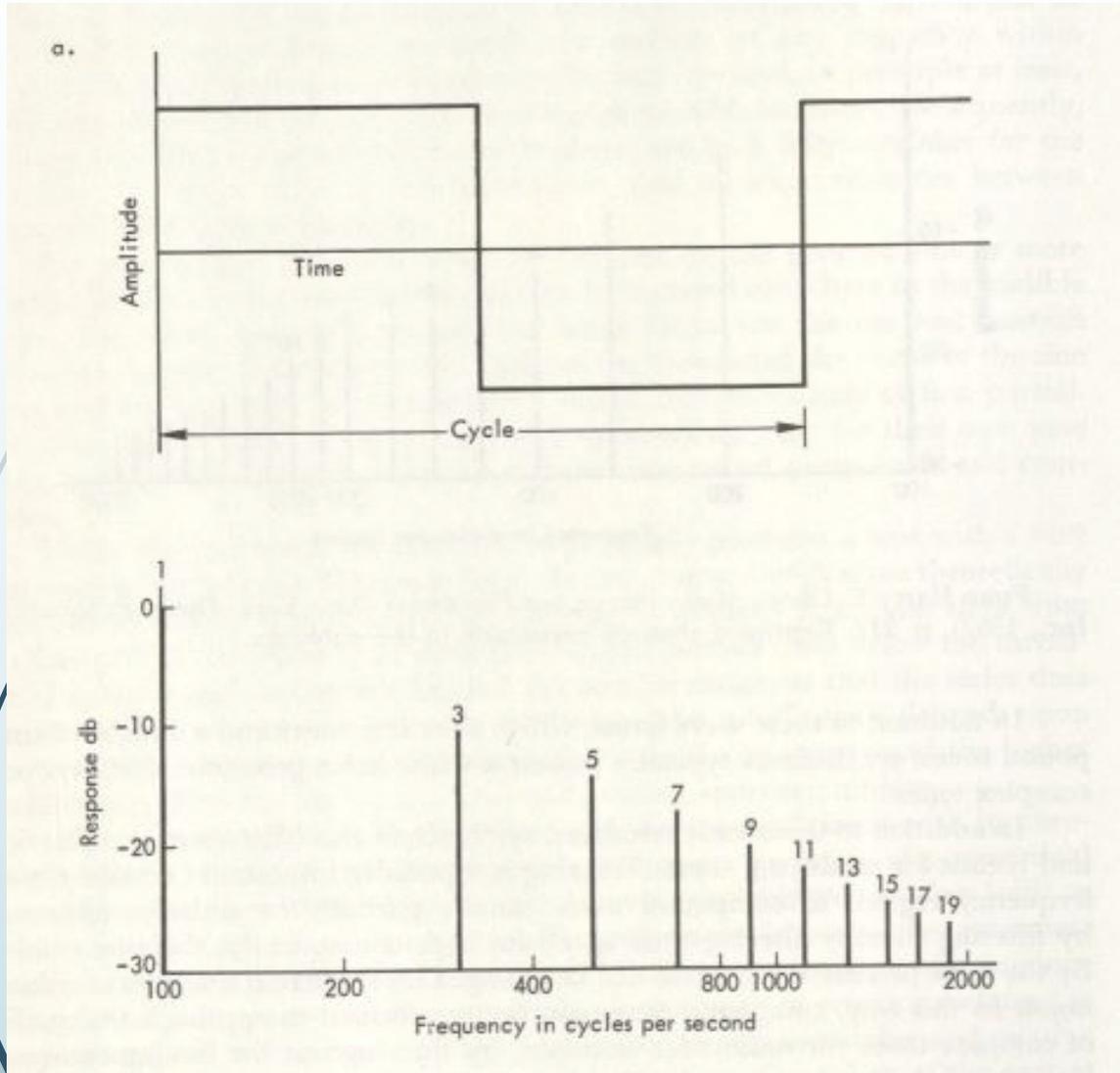
Electronic music

Sawtooth wave form
and its spectrum

Combinations of
simple, complex, and
compound tones
available through a
variety of synthesized
sounds



Electronic music cont'd

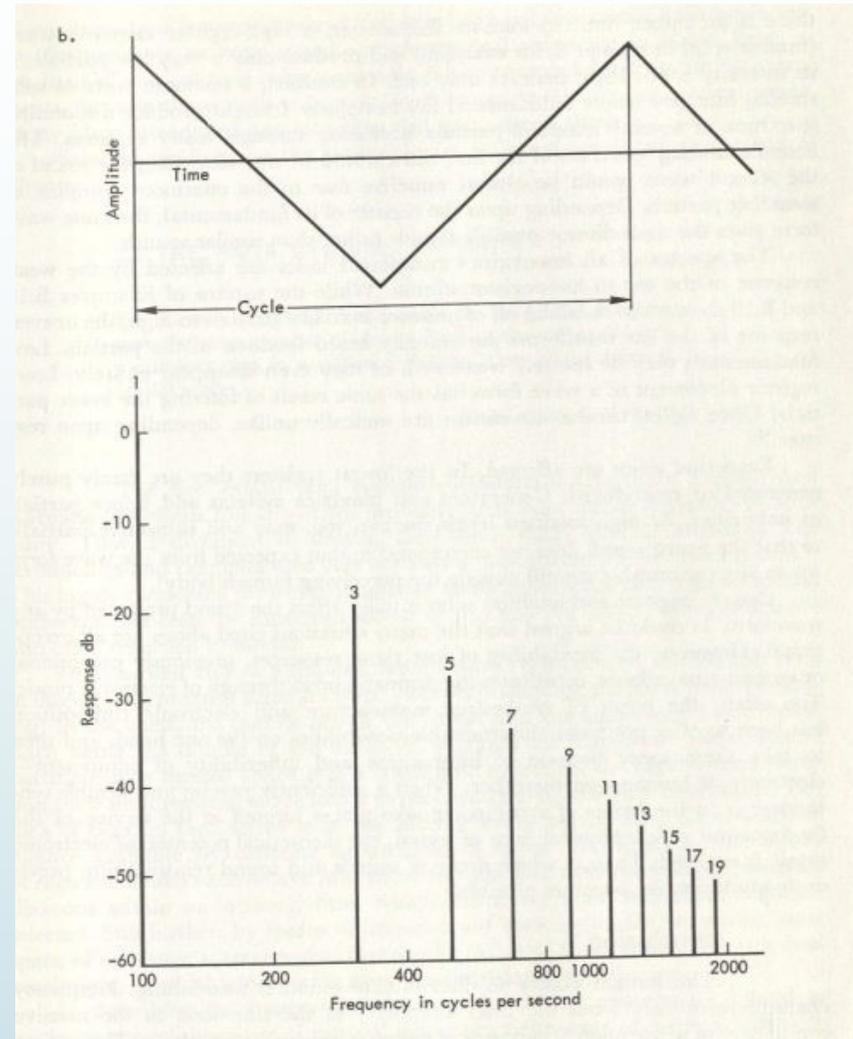


Square and triangular waves and their spectra; similar partials but different intensities

Electronic music – cont'd

Enlarged response
decibel level

Further variance in
cycle size

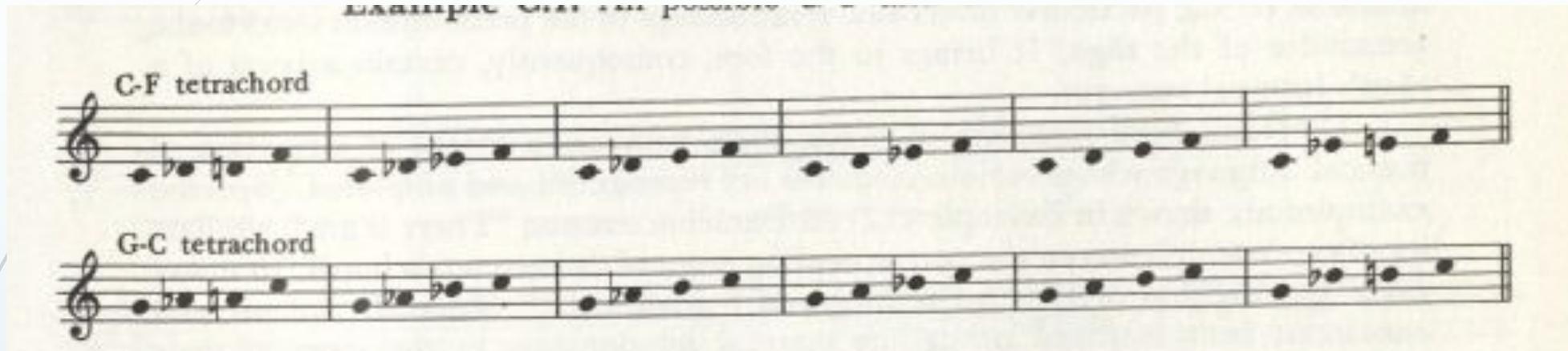


Rāga systems of India

Sa	Re	Ga	Ma	Pa	Dha	Ni
C	D	E	F	G	A	B
(in earlier times:		E \flat				B \flat)

Chromaticism allowed, but variability in pitch choice is largely determined by the raga being performed

Raga cont'd

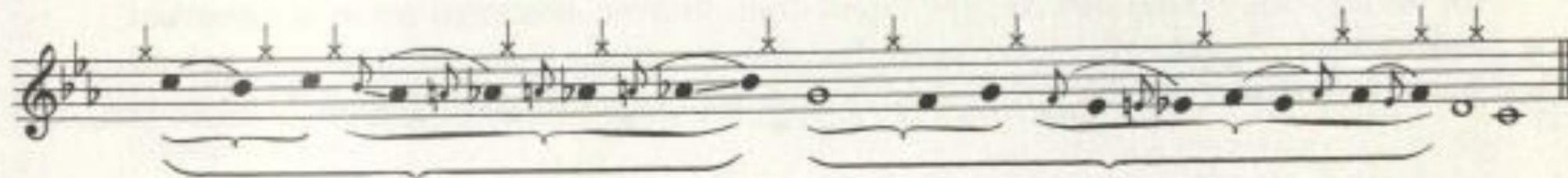
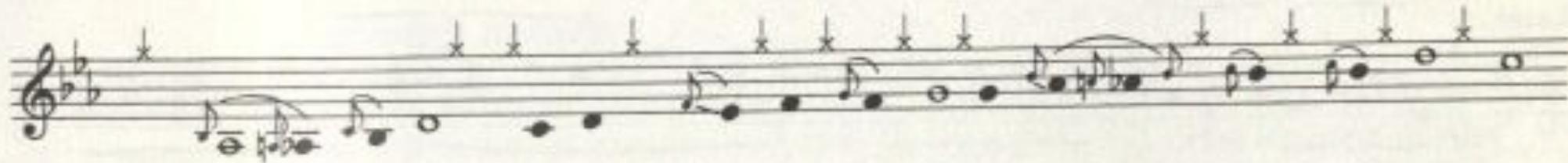
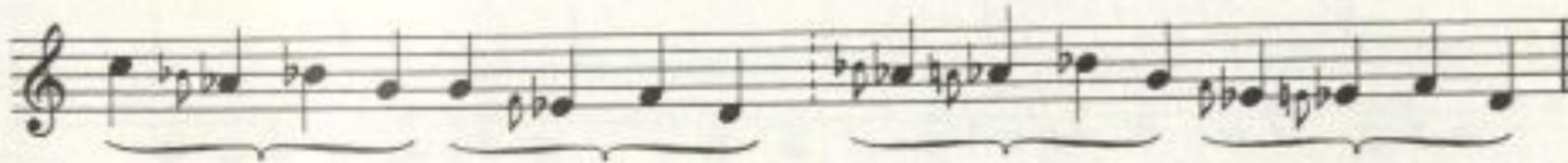
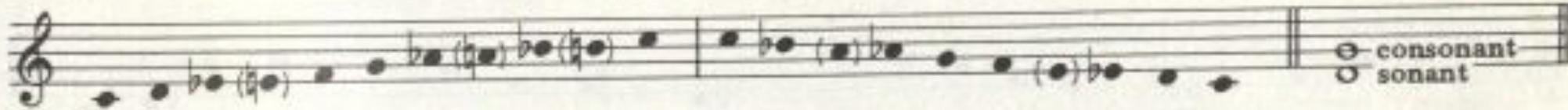


72 combinations of tetrachords exist, which are subject to chromatic or other alterations yielding an infinite number of available options

Assonances: emphasized tones; and dissonances: tones unavailable to a raga

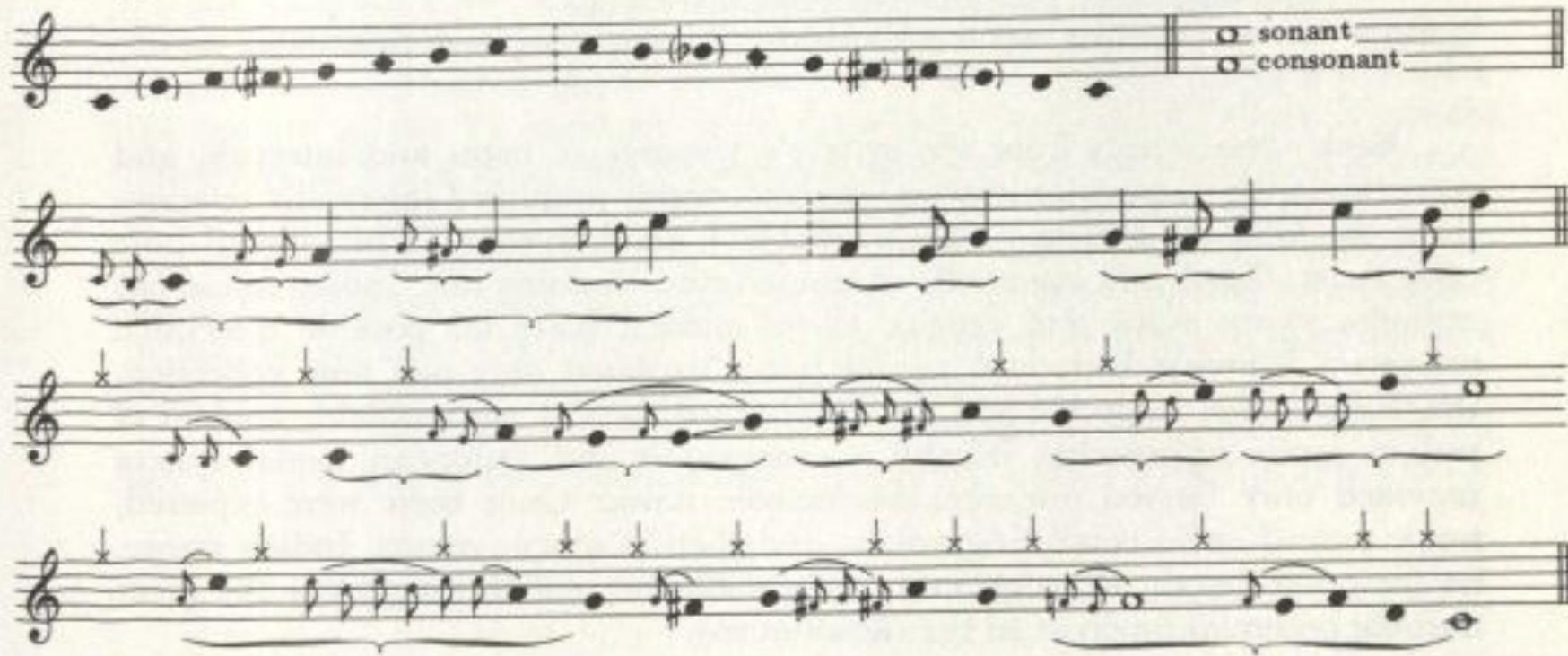
Raga cont'd

a. Rāga Darbārī



Raga cont'd

b. Rāga Kedār



The image displays a page of musical notation for Raga Kedār. It features four staves of music in a single system, all written on a treble clef. The first staff shows a sequence of notes with some accidentals (sharps and naturals) and a legend on the right side of the staff: an open circle for 'sonant' and a solid circle for 'consonant'. The second staff contains a melodic line with various note values and slurs. The third and fourth staves show more complex rhythmic patterns with slurs and small 'x' marks above the notes, likely indicating specific rhythmic or performance instructions. The notation is a mix of whole, half, quarter, and eighth notes, along with rests and accidentals.

A dark blue arrow points to the right from the left edge of the slide. Below it, several thin, curved lines in shades of blue and grey sweep across the left side of the slide, creating a sense of movement and design.

Tonal extensions - overview

- ▶ Seventh Chords
- ▶ Inversions of triads
- ▶ Local linear elaboration of harmonies
- ▶ Chromaticism – elaborating, tonicism, and modulating
- ▶ Linear harmonies

Seventh chords

The image displays a musical score with four examples, labeled a, b, c, and d, illustrating seventh chords and their resolutions. The score is written for piano in C major, with a common time signature (C). Example a shows a V7 chord (F7) with a 'plus' sign above it, indicating a specific voicing. Example b shows a V7 chord (F7) resolving to a I chord (C). Example c shows a V7 chord (F7) resolving to a I chord (C). Example d shows a I chord (C) resolving to a II7 chord (D7), which then resolves to a V7 chord (F7), which finally resolves to a I chord (C). The chord symbols are: a. V 7; b. V⁷ I; c. V⁷ I; d. I II⁷ V⁷ I.

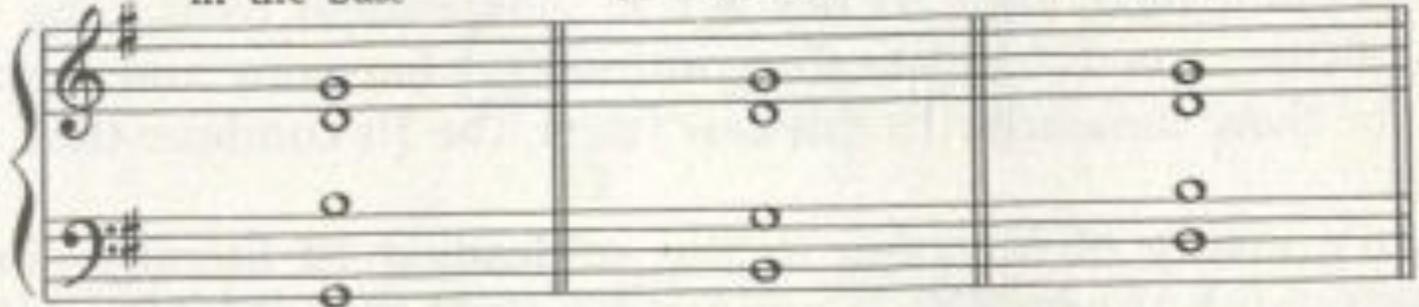
Examples of tonal suspense through prolongation

Inversions of triads

a. *Root position:*
root of the triad
in the bass

b. *1st inversion:*
third of the triad
in the bass

c. *2nd inversion:*
fifth of the triad
in the bass



The image shows three musical staves, each representing a different inversion of a G major triad. The key signature has one sharp (F#).
- Staff (a) shows the root position: G (bass), B (treble), D (treble).
- Staff (b) shows the first inversion: B (bass), G (treble), D (treble).
- Staff (c) shows the second inversion: D (bass), G (treble), B (treble).

G I (I⁶) (I⁴)

Chromaticism – elaborating, tonicism, and modulating

- Elaboration: use of passing, returning, and neighbor tones, appoggiaturas, suspensions, and anticipations
- Tonicism: members of the tonal progression are treated as if they were tonic

a. * b. * *

□ indicates a tonicized harmony

C II₇[♯] V I VI₇[♭] II₇[♯] V₇ I

- Modulation: a harmony other than tonic is treated as if it were tonic

Linear harmonies

- ▶ Tonality results from linear harmonic progression to a tonic
 - ▶ As harmonies with tonal functions: e.g. various linear elaborations previously discussed
 - ▶ Or as simultaneous linear motion in several voices

The image shows a musical score for Mozart's Fantasy in d minor. The score is in 3/4 time and features a piano accompaniment. The first part of the score, marked 'm. 1', shows a harmonic progression from I to IV to V to I. The IV chord is labeled as a 'passing' chord, and the V chord is also labeled as a 'passing' chord. The IV and V chords are enclosed in dashed boxes, with the text 'register and texture change' written below them. The second part of the score, marked 'Adagio', shows a cell derived from the preceding soprano descent. The score is written in a single system with a grand staff (treble and bass clefs).

m. 1 7 8 9 Adagio

cell derived from preceding soprano descent

[d] I — (passing) — IV — (passing) — V — I

register and texture change register and texture change

Mozart's Fantasy in d minor