Pitch

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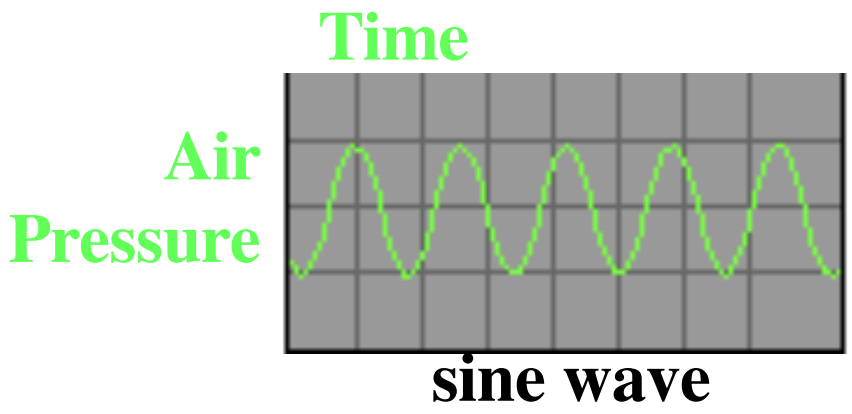
Disclaimer

This slide presentation is under development and will probably undergo some revision before its final posting. Study the contents with this in mind and be aware that updates are likely.

Frequency in Hertz

Frequency: rate of the periodicity of air pressure change.

Measured in cycles per second; labeled in Hertz (Hz).



sine wave

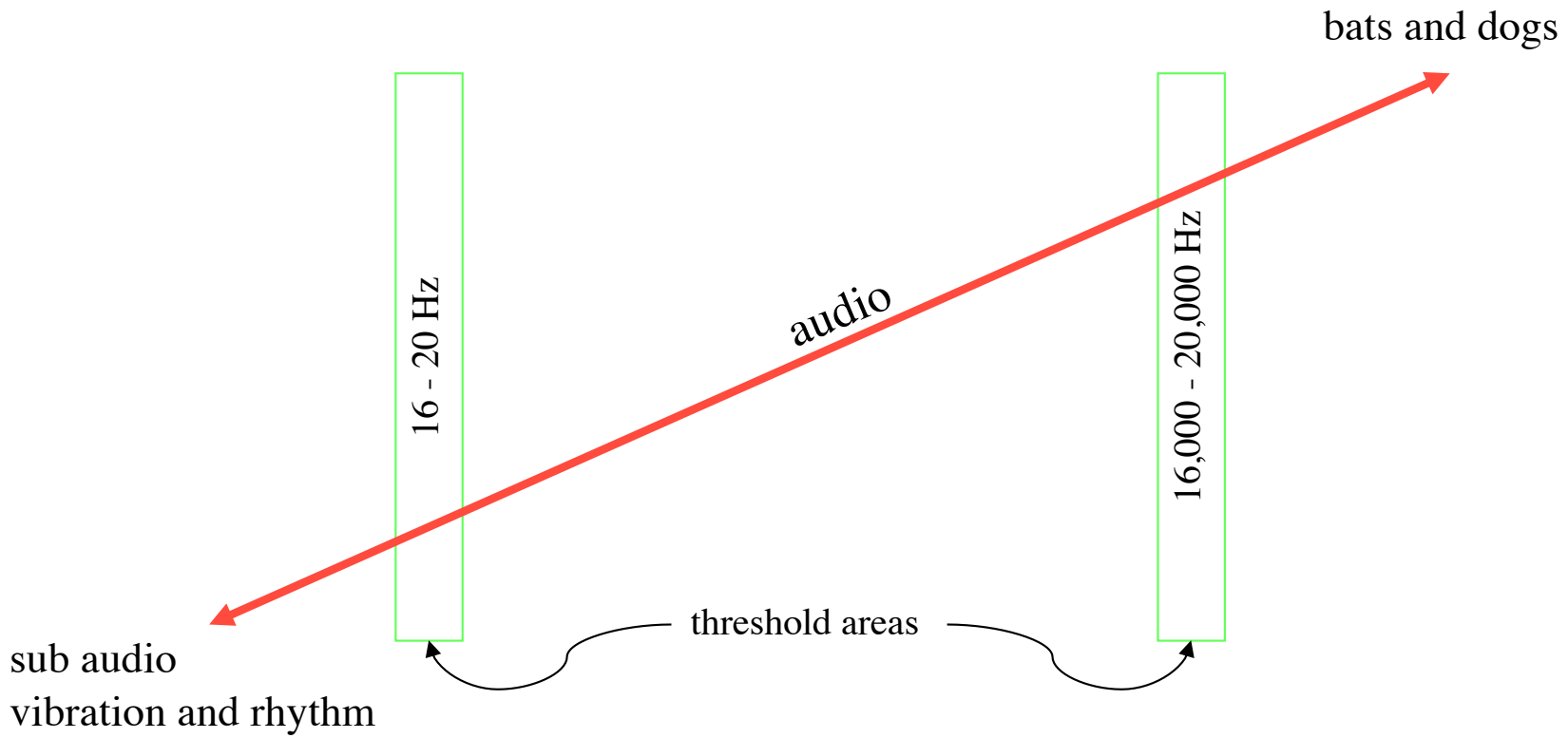
Example: 100 cycles per second is 100 Hz.

1,000 cycles per second is 1 KHz (one kilohertz).

A faster rate is heard as a higher pitch.

Frequency Range

Three general regions



Frequency and Pitch

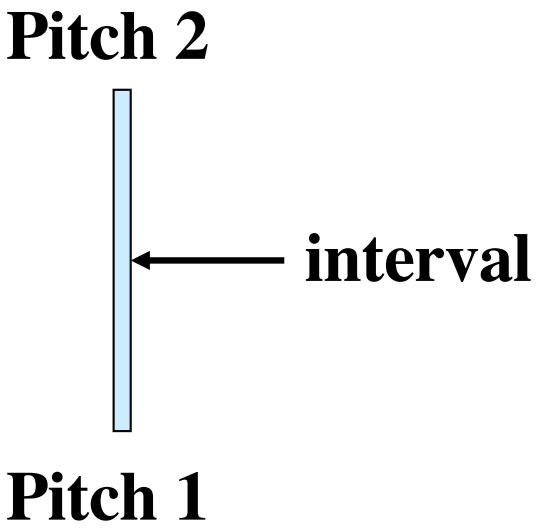
Frequency: rate of the periodicity of air pressure change.

Pitch: our perception of a sound at a certain frequency.

Our perception of frequency is logarithmic and therefore the mapping of pitch to frequency is logarithmic. The result is that our perception of pitch is linear.

Interval

The distance between two frequencies or pitches is called an interval



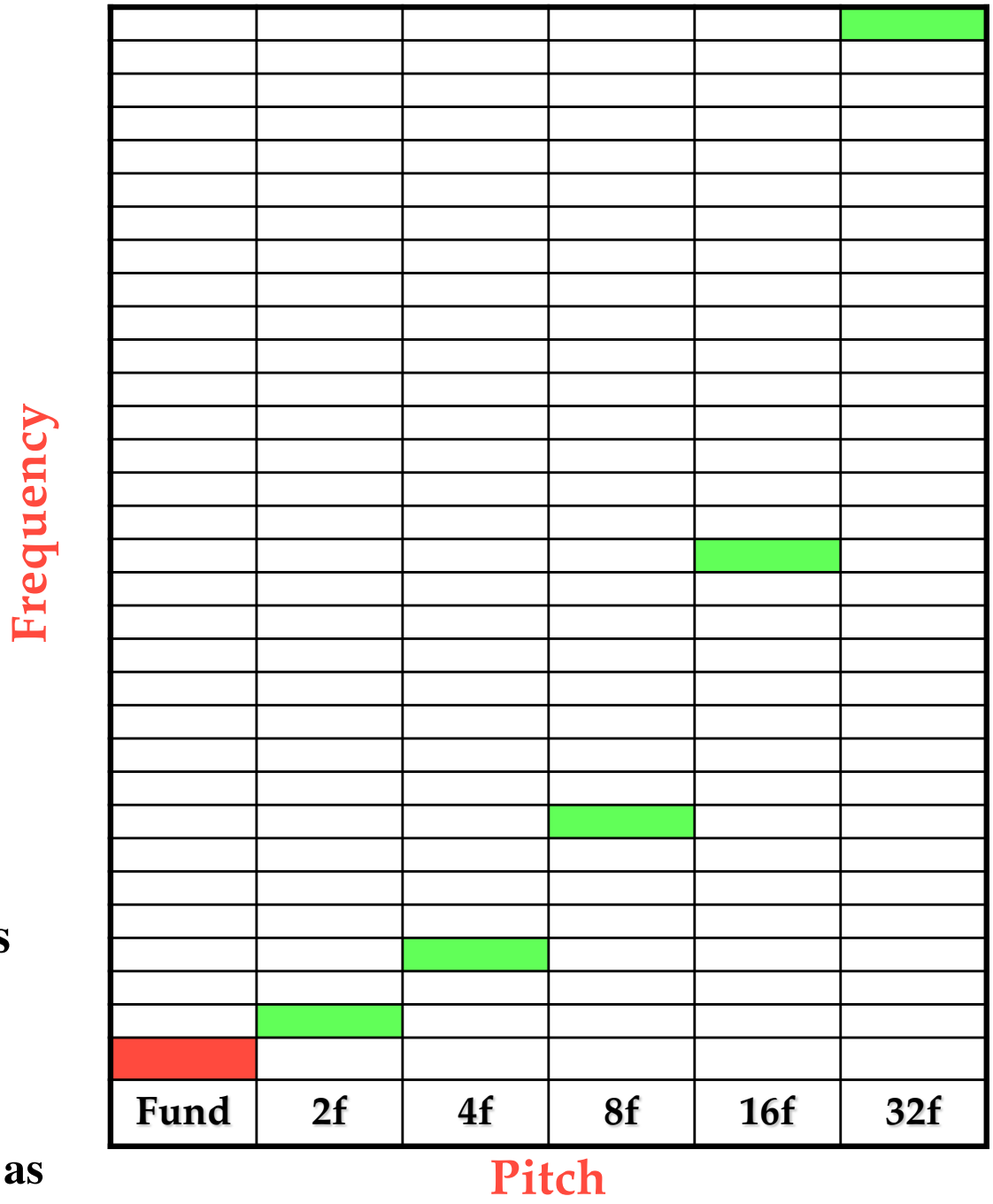
Octave

We perceive frequency logarithmically and map pitch to a linear scaling.

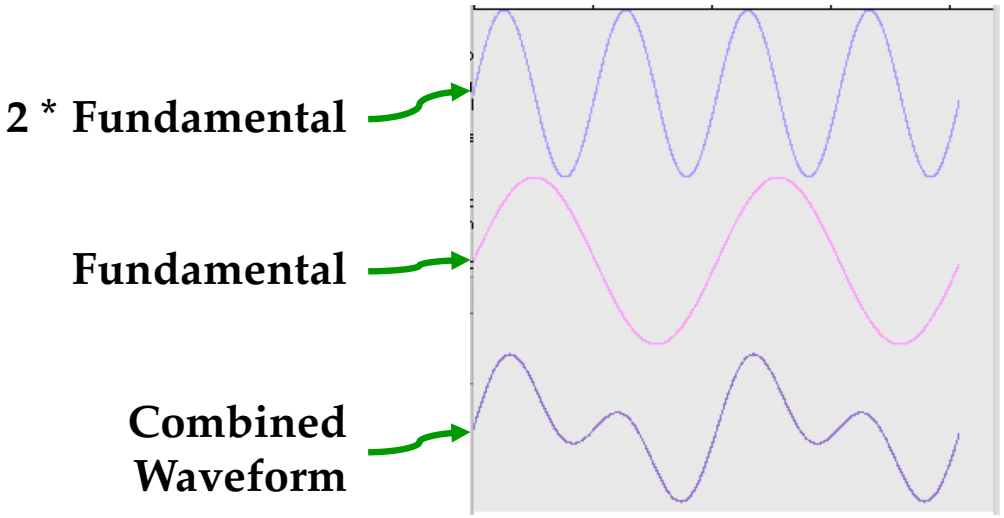
We call the distance between successive (f *2^n) an *octave*. The pitch space (interval) between octaves is called a *register*, or *octave register*.

The interval between octaves is a 2:1 frequency ratio.

We perceive the difference between successive 2^n frequencies (columns) as being equal.



Harmonics



Sound produced by a musical instrument produces a fundamental frequency that we perceive as the pitch.

It also produces integer multiples of the fundamental frequency.

It is the relative amplitudes (loudness) of the harmonics that give the instrument its color (timbre).

Harmonics

Fundamental

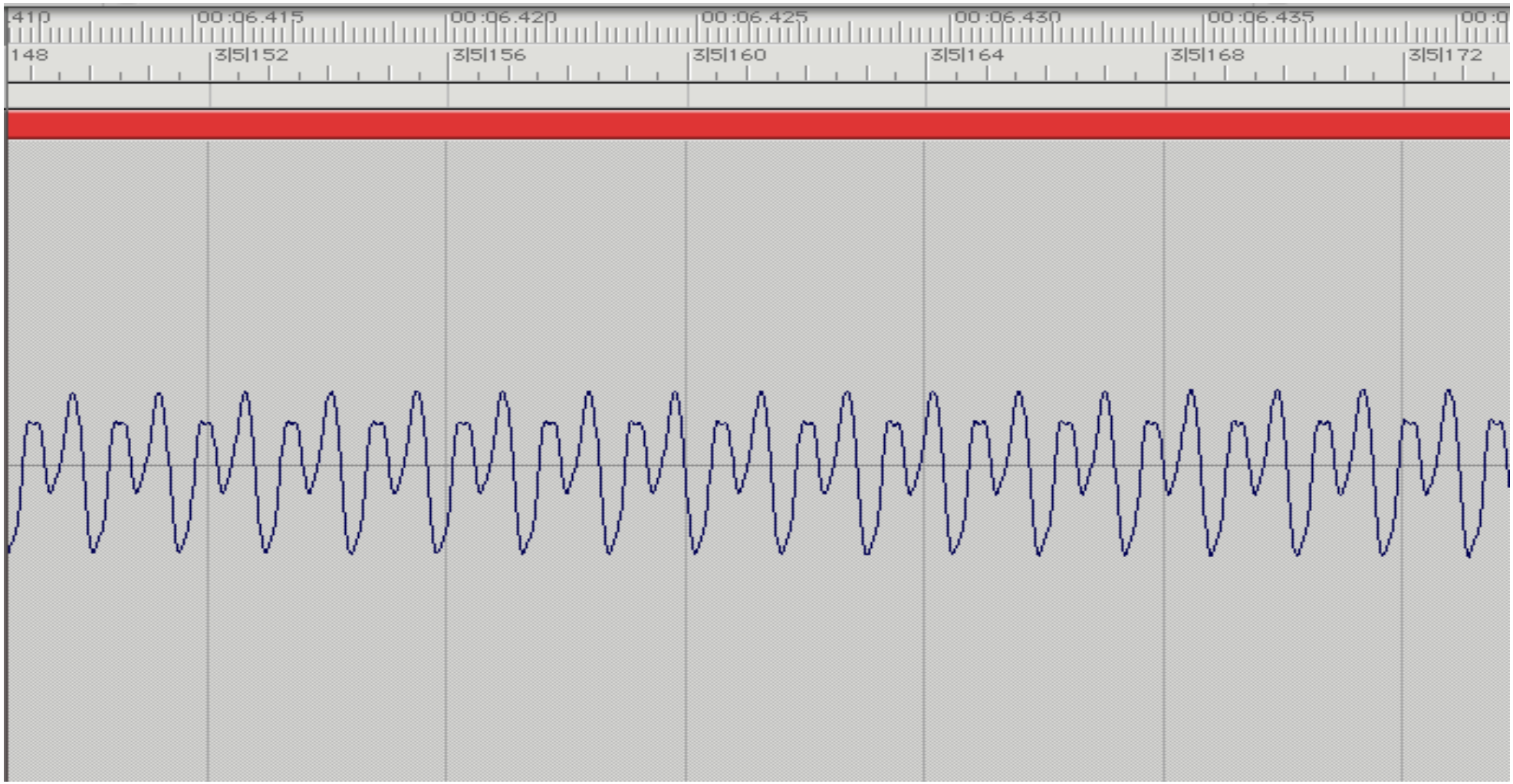
harmonic or partial	1st	2nd	3d	4th	5th	6th	7th	8th	n
freq.	1f	2f	3f	4f	5f	6f	7f	8f	n*f
Hz	20	40	60	80	100	120	140	160	n*20
Hz	100	200	300	400	500	600	700	800	n*100

We perceive frequency logarithmically and map pitch to a linear scaling.

Perceptually, we hear the difference between successive partials as smaller and smaller.

We perceive the difference between successive 2^n frequencies (red and green columns) as being equal.

Graphic Representation 2



Close-up of the waveform of a sampled oboe playing a phrase of music.

Intervals Between Harmonics

Fundamental

harmonic or partial	1st	2nd	3d	4th	5th	6th	7th	8th	n
freq.	1f	2f	3f	4f	5f	6f	7f	8f	n*f
ratio	1:1	2:1	3:2	4:3	5:4	6:5	7:6	8:7	n:(n-1)
Hz	20	40	60	80	100	120	140	160	n*20
Hz	100	200	300	400	500	600	700	800	n*100

Our perception of the interval between pitches is directly related to the ratio of frequencies, not the numeric difference.

A 1:1 relationship is called the unison. This represents two sounds at the same pitch (frequency).

The Western tuning system only approximates the ratios above.

Intervals Between Pitches

The interval between pitches at frequencies 440 Hz and 880 Hz are heard as the same interval as 8,000 Hz and 16,000 Hz. The ratios are both 1:2 while the differences are 440 and 8,000 respectively.

		Ratio	Difference
440	880	$880/440 = 2$	880 - 440=440
8,000	16,000	$16000/8000 = 2$	16000 - 8000 = 8000
16	24	$24/16 = 1.5$	24 - 16 = 8
16,000	16,008	$16008/16000 = 1.0005$	16008 - 16000 = 8

Pitch Names

There are two systems for naming pitches:

1. **fixed – pitches are assigned to particular frequencies regardless of musical function.**
2. **relative – pitches are assigned to particular frequencies according to their function in a musical context.**

Pitch Names

Musicians need a way to describe music and pitch, so names are given to pitches.

All pitches of octave equivalence are given the same name and this convention is called a *pitch class*.

Pitch Classes

Start with a pitch; let's call it *sa*. Associate *sa* with a particular frequency.

The pitch at a frequency of *sa* * 2 (one octave above *sa*), is also called *sa*.

Sa's may be distinguished from each other by register, as in *Sa* or *SA* or *sa4*, etc.

All pitches of the relationship ($sa * 2^n$) are all *sa*'s. They are thus considered all to be in the *sa* pitch class.

Octave	name	relation	freq.
4th octave above sa	sa5	$sa * 2^5$	1600
3rd octave above sa	sa4	$sa * 2^4$	800
2nd octave above sa	sa3	$sa * 2^3$	400
1st octave above sa	sa2	$sa * 2^2$	200
Fundamental Freq.	sa	$sa * 2^1$	100

Do C Do

In Western music we have two pitch naming systems:
one fixed and one relatively relative.

The fixed system names pitches as follows:
C D E F G A B C

The relative system is:
do re mi fa sol la ti do

The Western do, re, mi... system has several flavors. This maximizes division among musicians who favor their own flavor. The preferred flavor of Panaiotis is a movable *do* in which *do* is always the first note (tonic) of the scale regardless of the pitch key center and scale type (e.g. major, minor, dorian, etc.)

Chinese Kung

Chinese Pitches	Translated
Kung (gong)	Yellow bell
Shang	Forest Bell
Chiao (or Chueh or Jiao)	Lush Vegetation
Chih (Zhi)	Old Purifier
Yu	Equalizer
Pien Chih (or bien zhi)	*below Chih*
Pien Kung (or bien kung)	*below Kung*

This is a moveable system. If a different pitch is used as the tonic (First note of a scale), the pitch names shift to the new level.

Indian Svaras

Tonic	2	3	4	5	6	7	Tonic
sa	re	ga	ma	pa	dha	ni	sa

This is a moveable system. If a different pitch is used as the tonic, the pitch names shift to the new level.

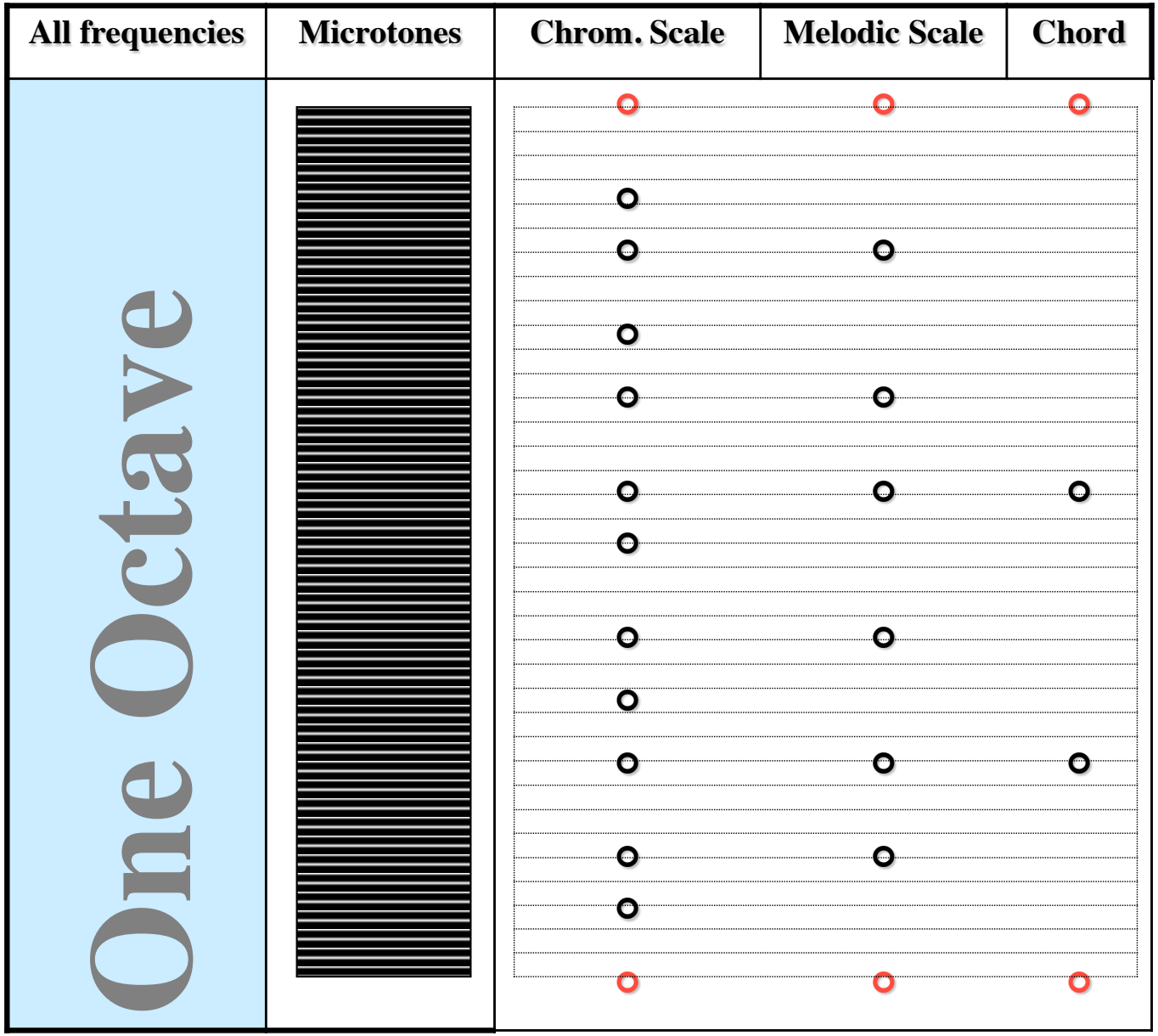
Byzantine Chant

Any of these can be the tonic							
ni	pa	vu	ga	thi	ke	zo	ni
Νη	Πα	Βου	Γα	Δι	Κε	Ζω	Νυ

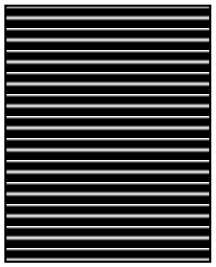
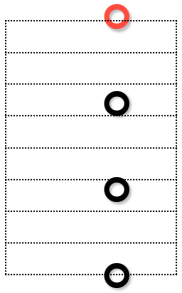
This is a moveable system. If a different pitch is used as the tonic, the pitch names shift to the new level. In addition, the tonic can be any of these pitch classes.

There are 72 micro steps in the tuning system. There are at least sixteen melodic systems. Each has its own tuning, although several share the same tuning.

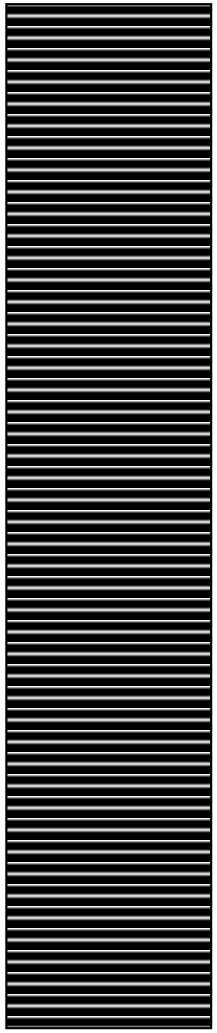
Infinity to Order



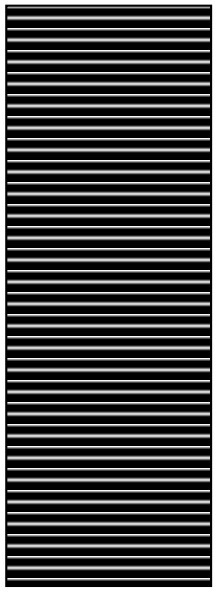
Steps

All frequencies	Microtones	Chrom. Scale	Melodic Scale	Tonic Chord
				
Continuous	Microtonal steps	Chromatic steps	Scale steps	Chord members
	Usually equal intervals	Sometimes equal	Very rarely equal	Usually skip steps
	from 22-1200	Typically 12	4 - 8 Most prominent are 5 and 7	Usually three. Range is 2-12

Western Tuning System

All frequencies	1200 Cents	Chrom. Scale	Melodic Scale		Tonic Chord
One Octave			C		
			B		
			A-440		
			G		
			F		
			E		
			D		
			C		

Western Tuning System

All frequencies	1200 Cents	Chrom. Scale	Melodic Scale		Tonic Chord
	100 cents between each chromatic step in the equal tempered scale 		C		
			B		
			A-440		
			G		
			F		
			E		
			D		
			C		