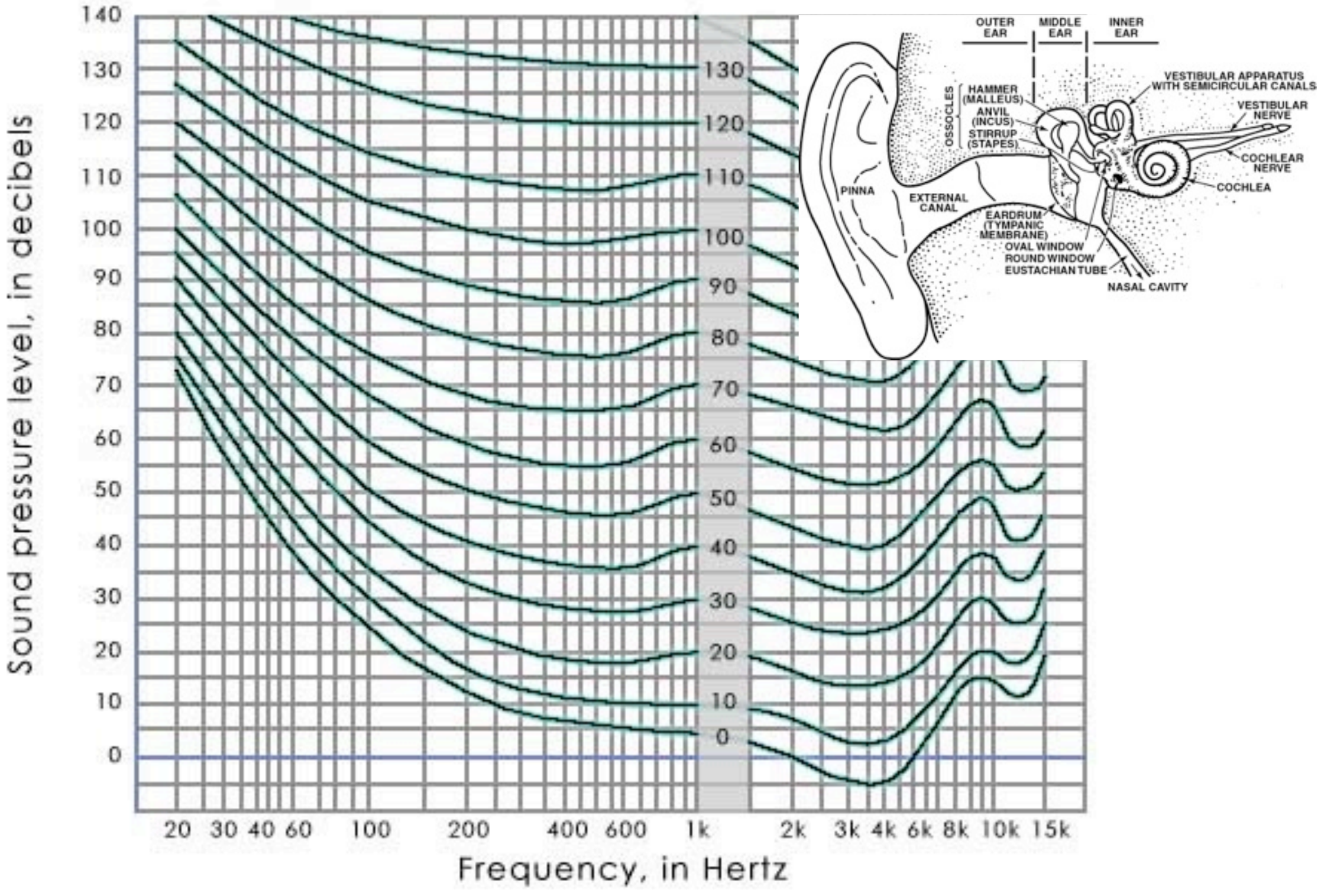
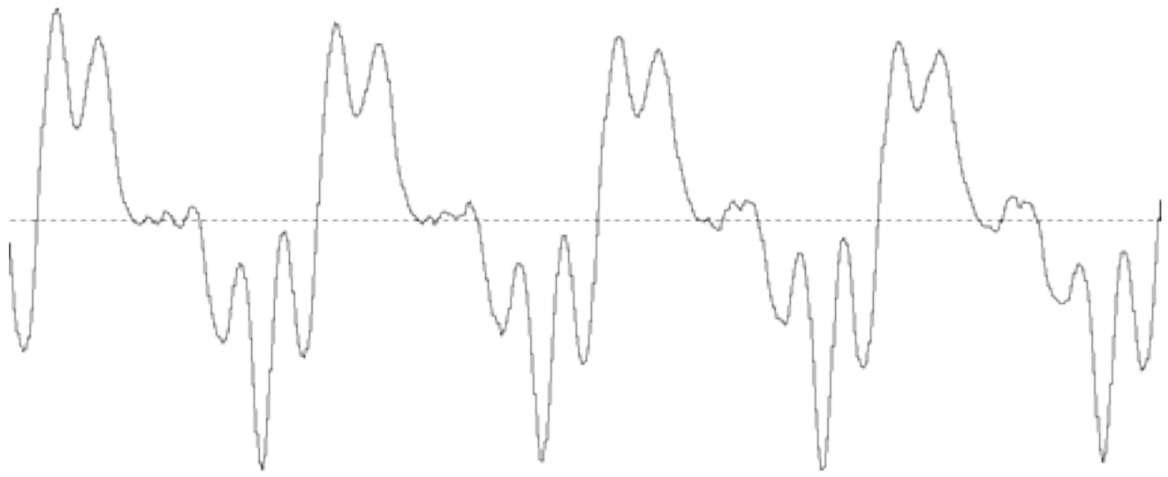
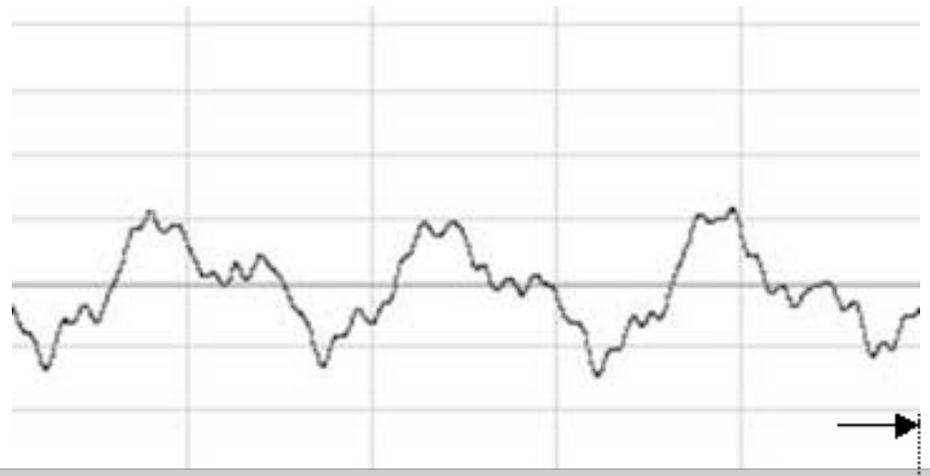
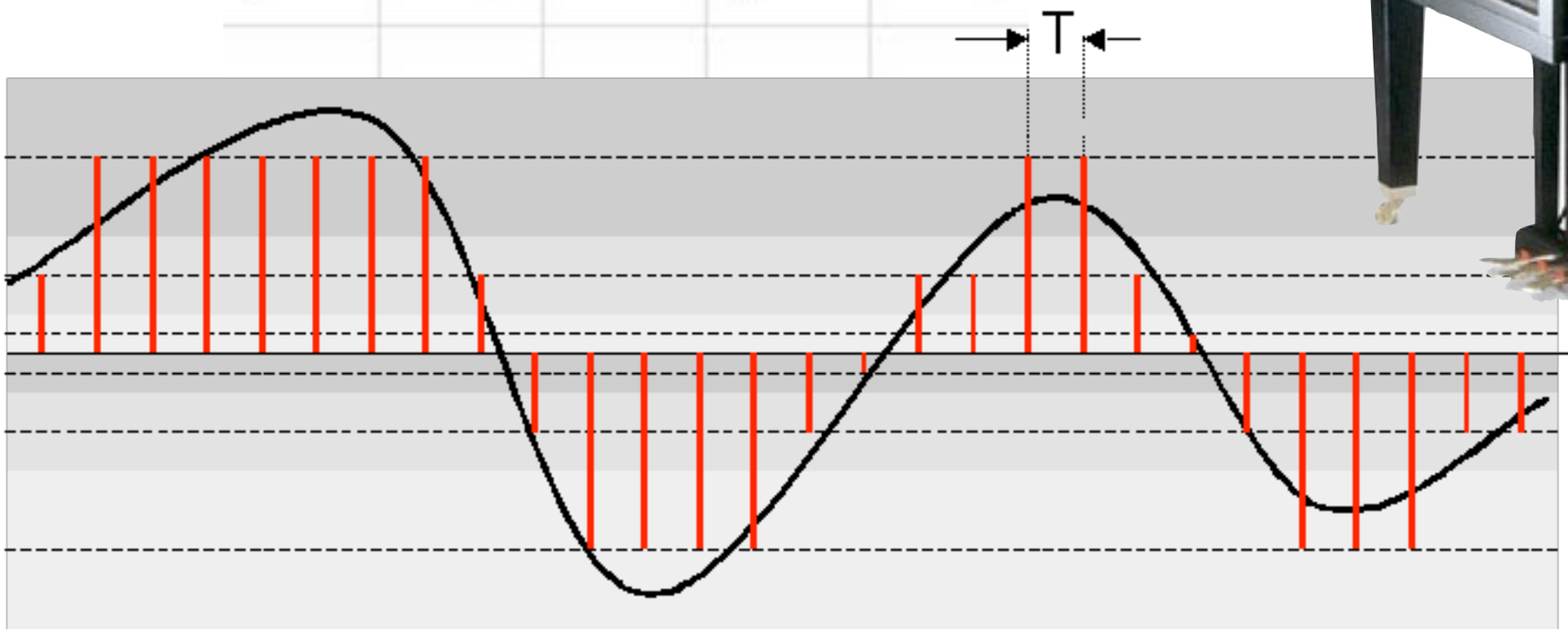
Sound

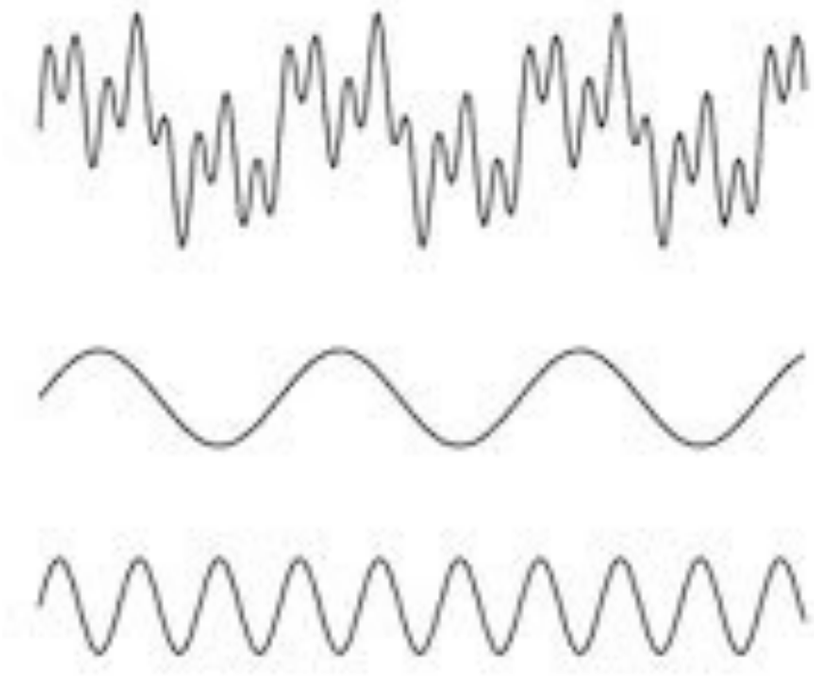

Sound pressure level, in decibels
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
20 30 40 60 100 200 400 600 1k 2k 3k 4k 6k 8k 10k 15k
Frequency, in Hertz
OUTER EAR
MIDDLE EAR
INNER EAR
OSSICLES
HAMMER (MALLEUS)
ANVIL (INCUS)
STIRRUP (STAPES)
VESTIBULAR APPARATUS WITH SEMICIRCULAR CANALS
VESTIBULAR NERVE
COCHLEAR NERVE
COCHLEA
PINNA
EXTERNAL CANAL
EARDRUM (TYMPANIC MEMBRANE)
OVAL WINDOW
ROUND WINDOW
EUSTACHIAN TUBE
NASAL CAVITY

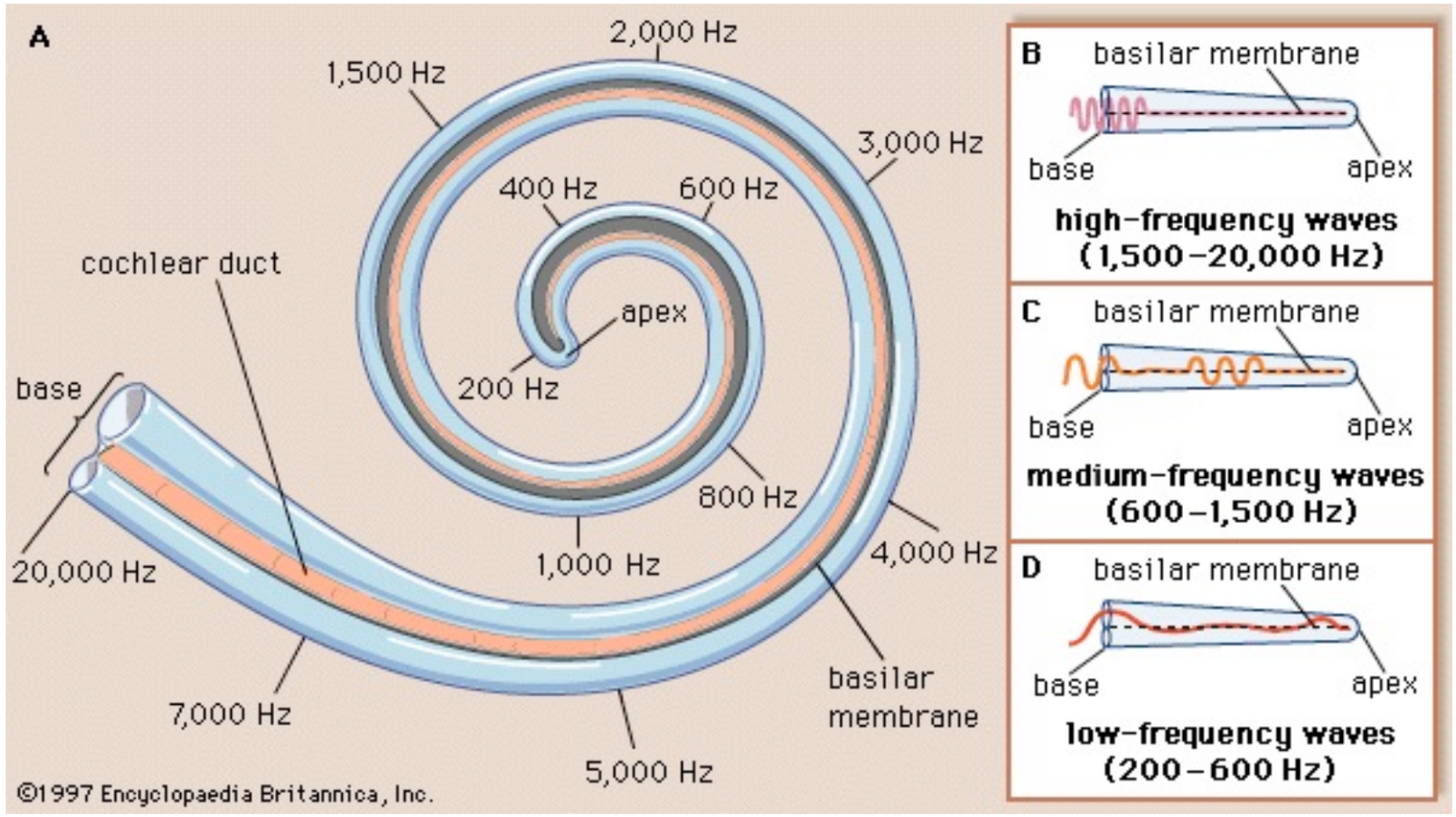


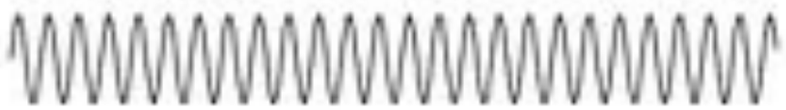
CD quality 44.1 kHz, 16-bit, stereo



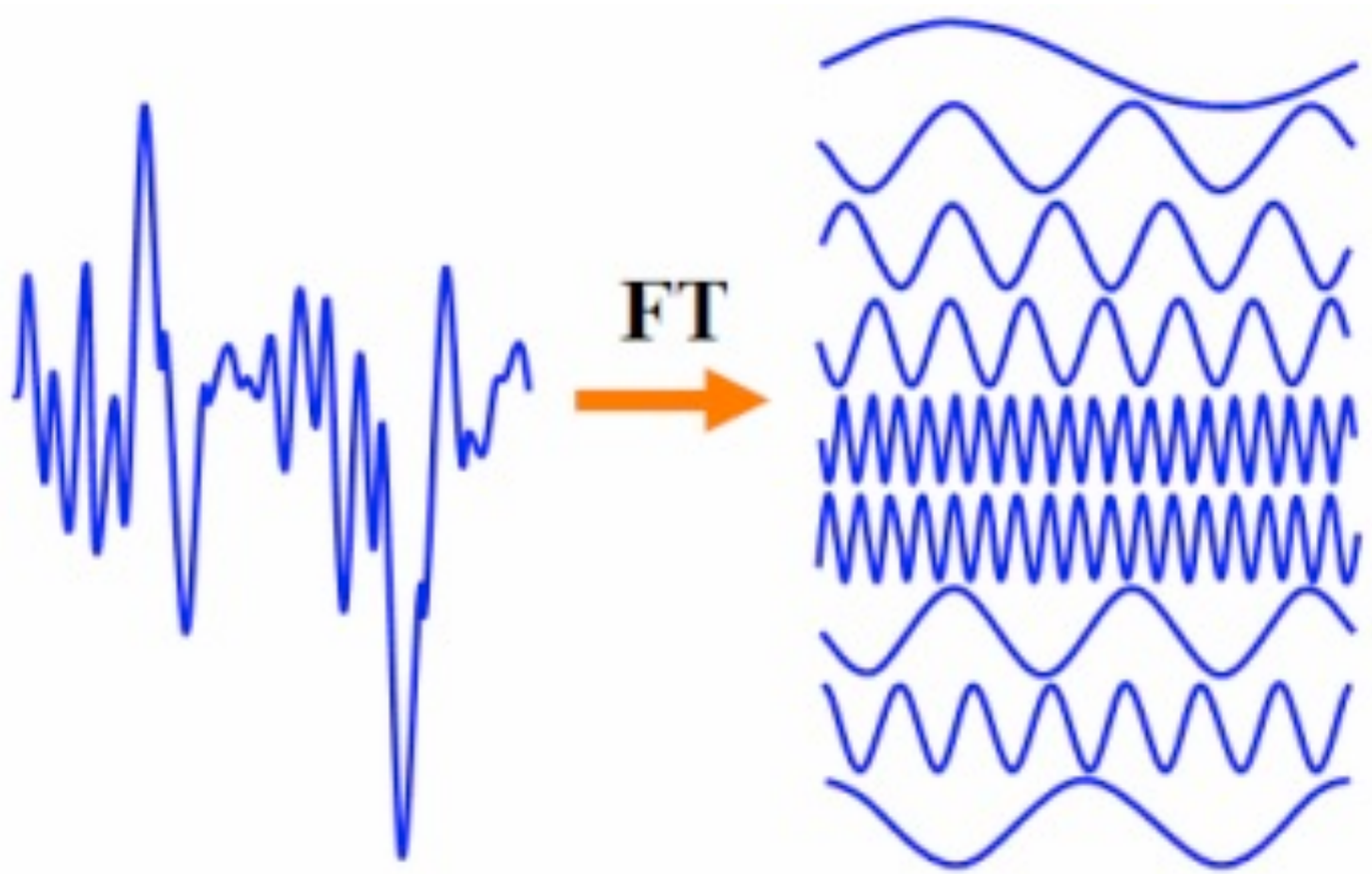


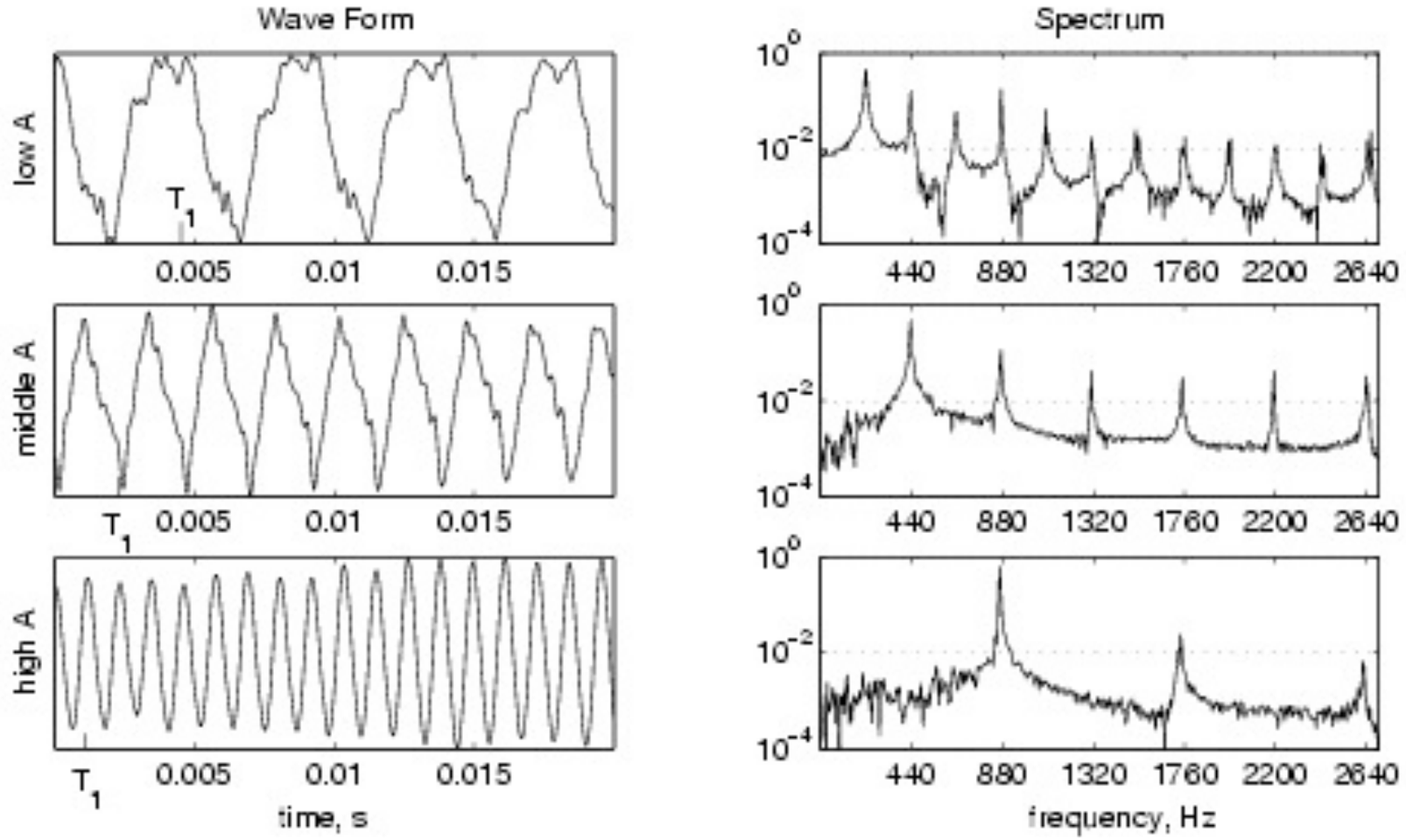


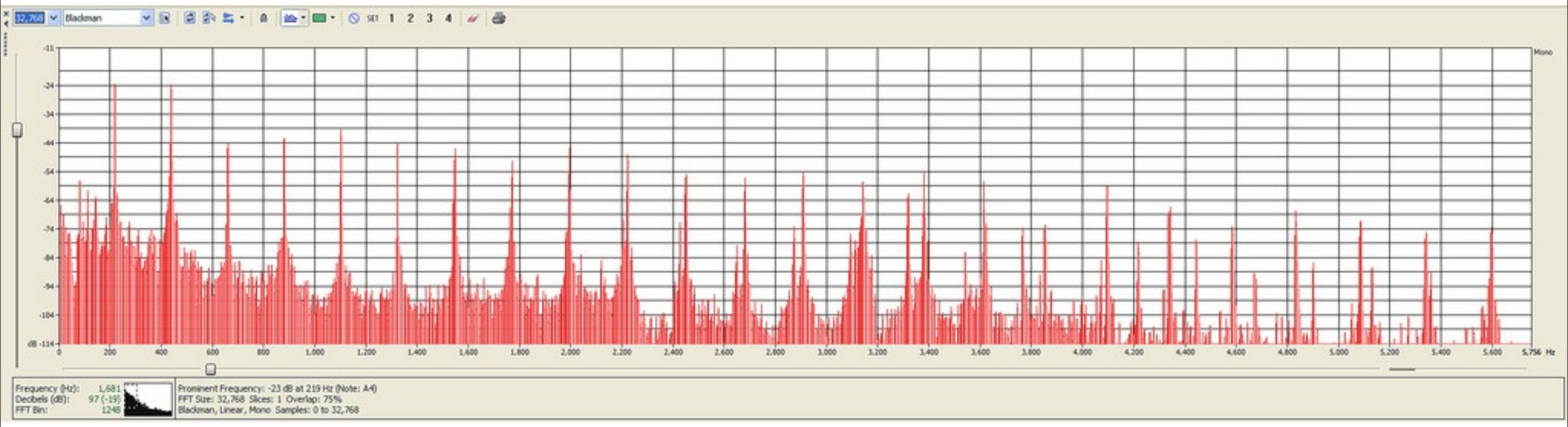


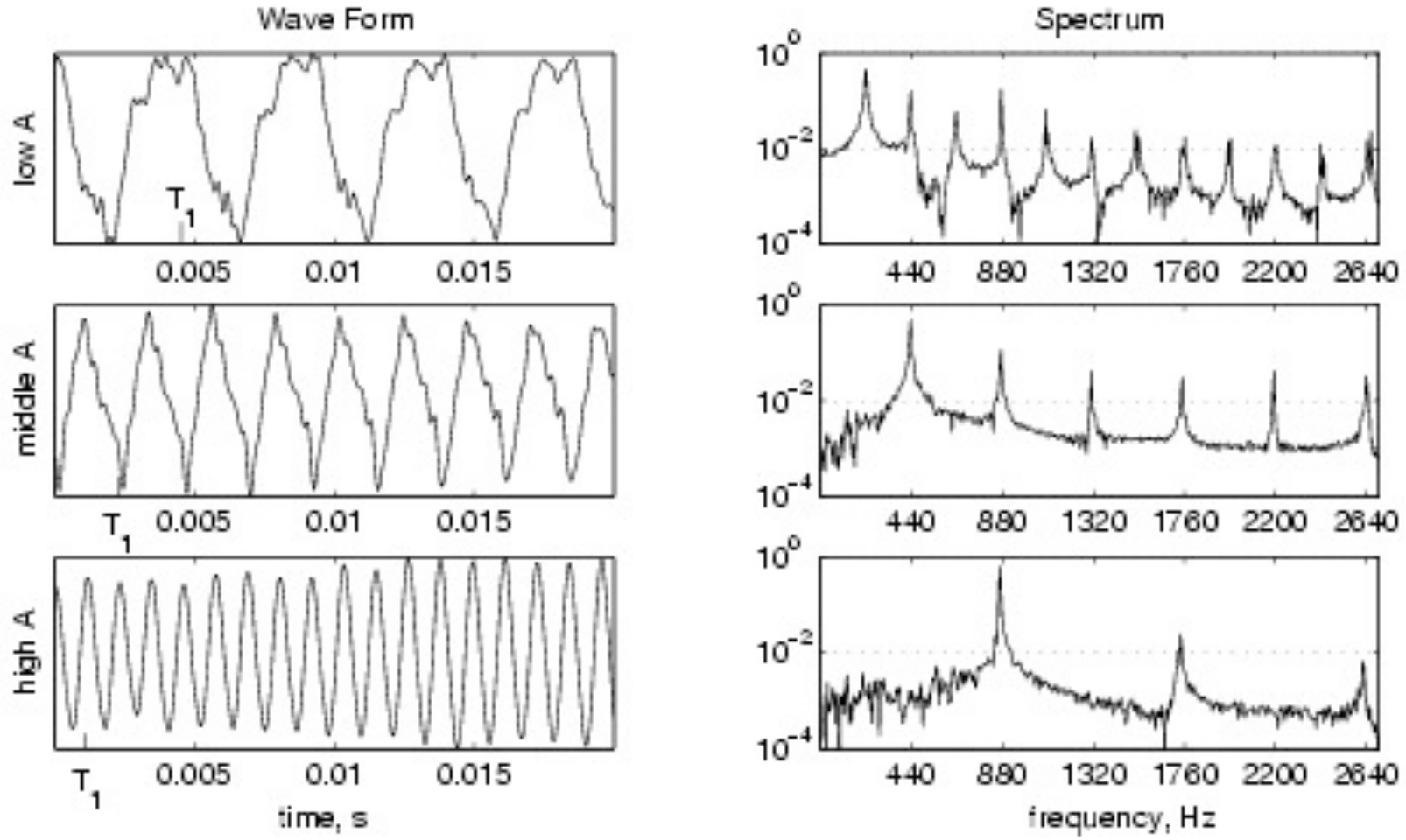


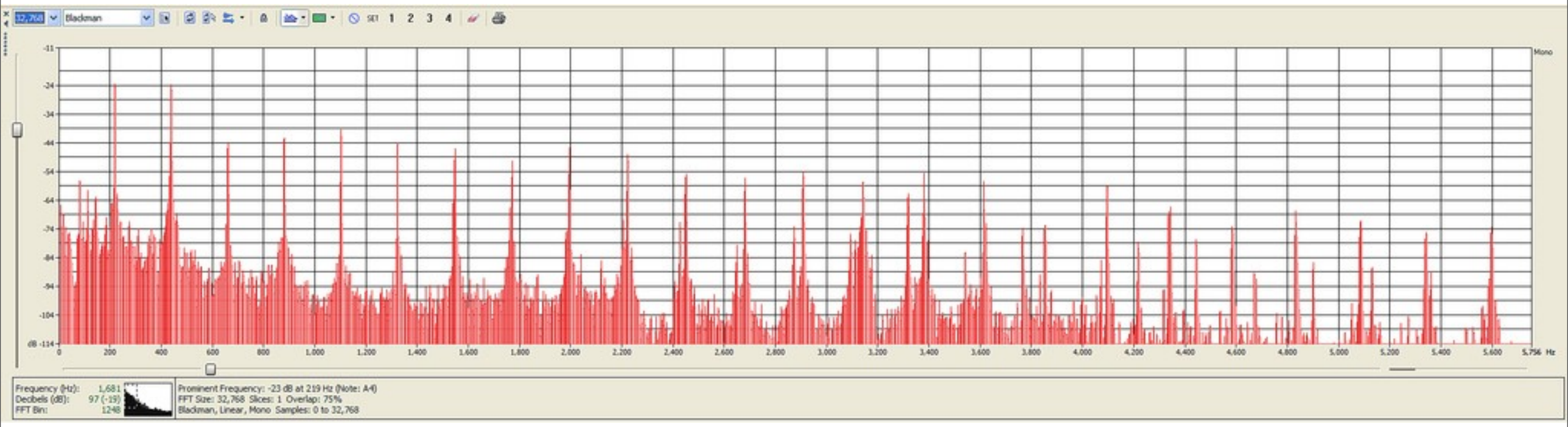
Fourier Analysis: the complex wave at the top can be decomposed into the sum of the three simple waves shown below.




Wave Form
Spectrum
low A
middle A
high A
T1
0.005
0.01
0.015
440
880
1320
1760
2200
2640
time, s
frequency, Hz


Blackman
Mono
Frequency (Hz): 1,681
Decibels (dB): 97 (-19)
FFT Bin: 1248
Prominent Frequency: -23 dB at 219 Hz (Note: A4)
FFT Size: 32,768 Slices: 1 Overlap: 75%
Blackman, Linear, Mono Samples: 0 to 32,768


Wave Form
Spectrum
low A
middle A
high A
T1
0.005
0.01
0.015
440
880
1320
1760
2200
2640
time, s
frequency, Hz


Blackman
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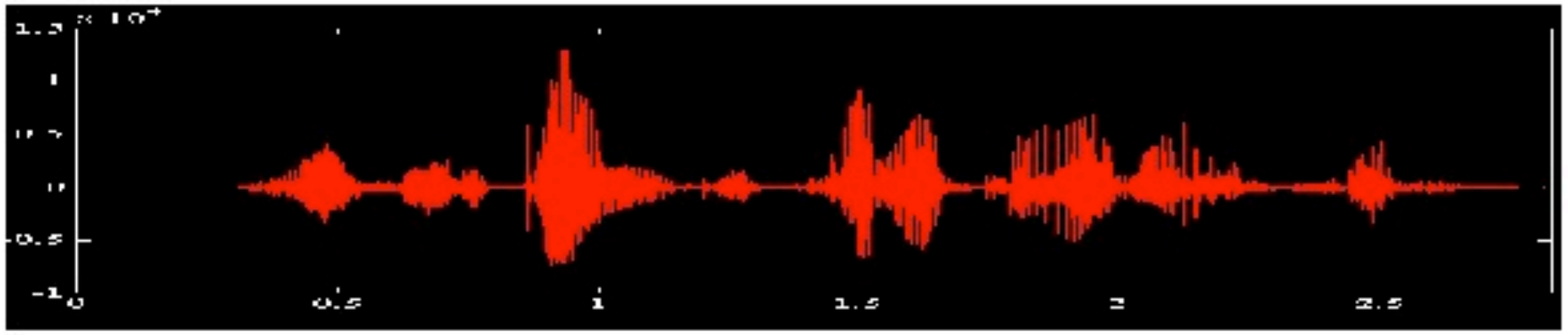
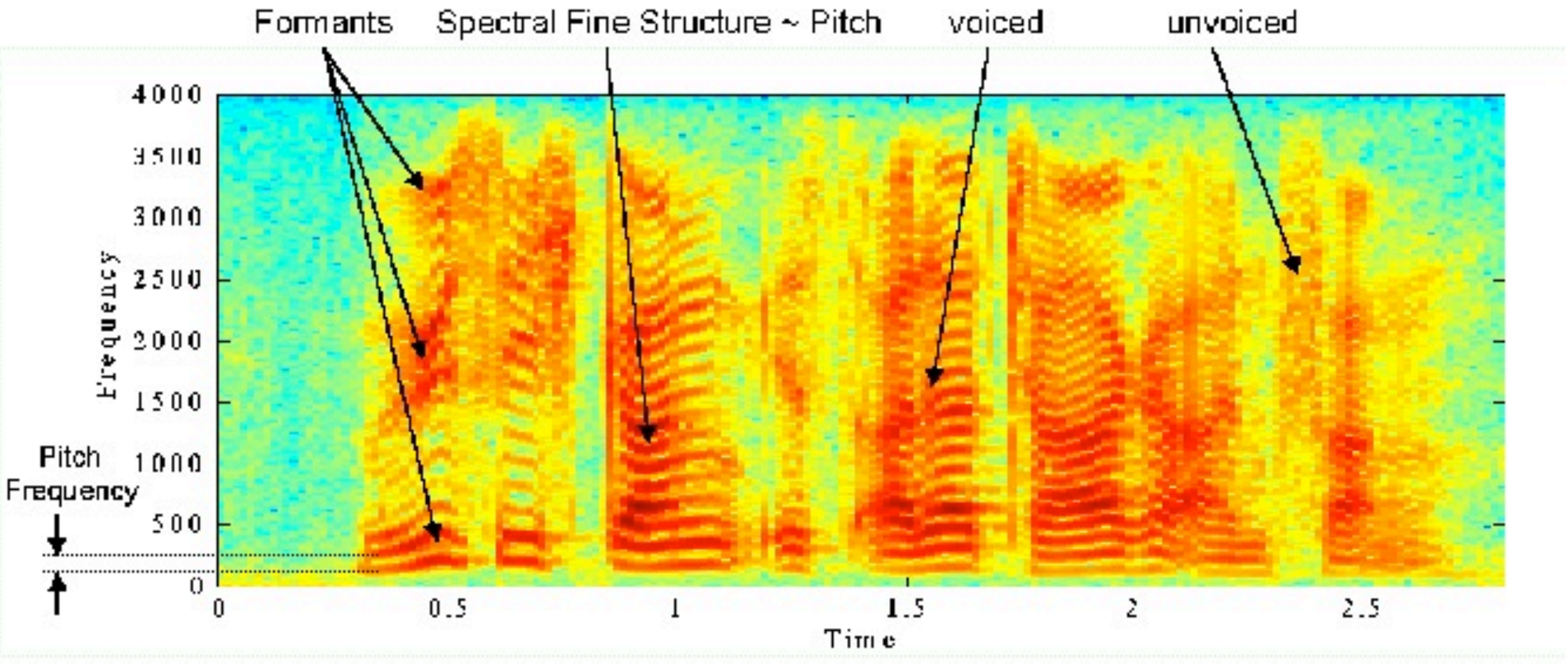
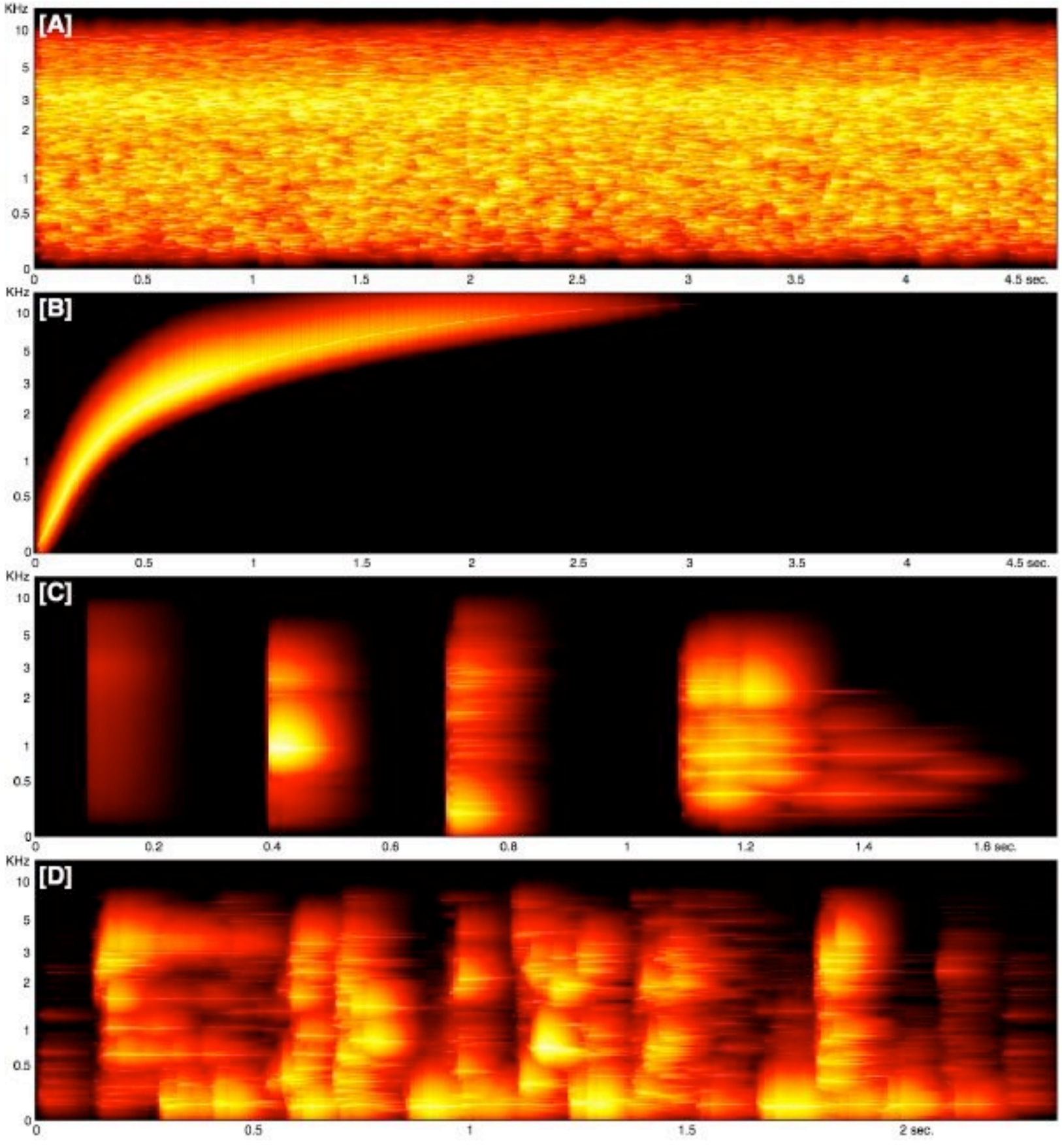

1.5
1
0.5
0
-1
0
0.5
1
1.5
2
2.5


Formants
Spectral Fine Structure ~ Pitch
voiced
unvoiced
4000
3500
3000
2500
2000
1500
1000
500
0
Frequency
Pitch
Frequency
0
0.5
1
1.5
2
2.5
Time



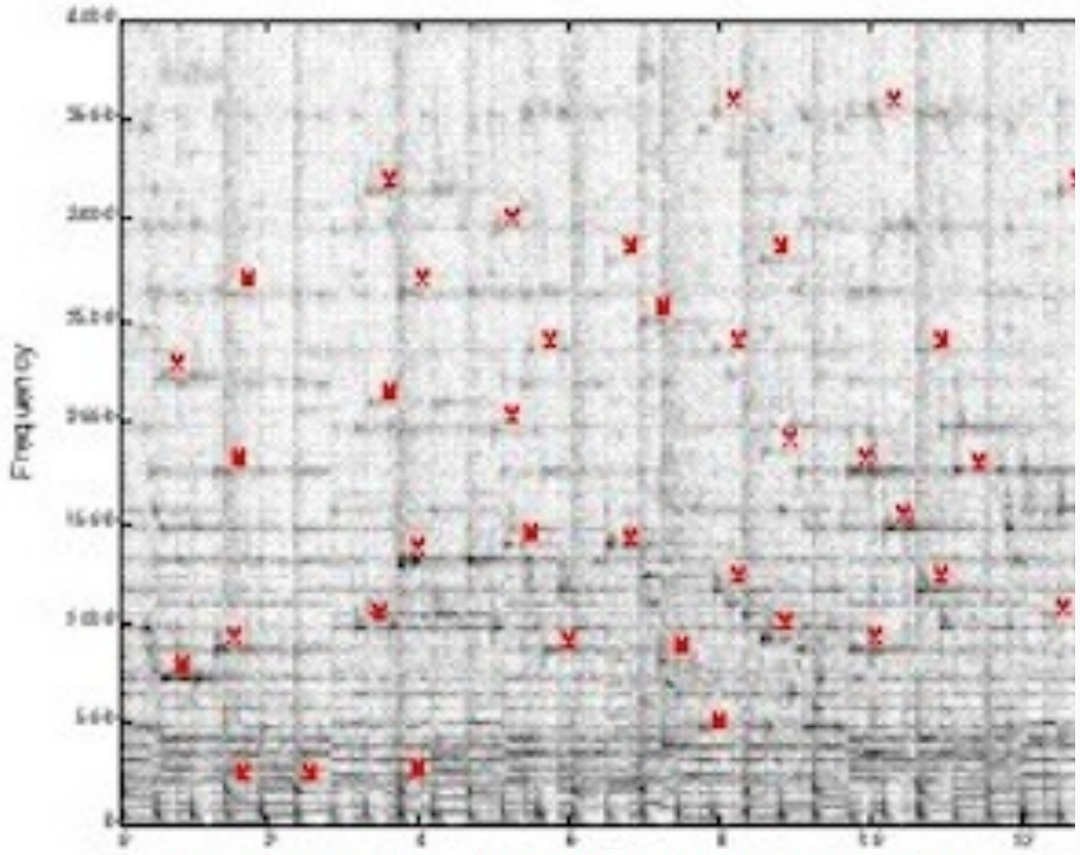
Auditory spectrogram of

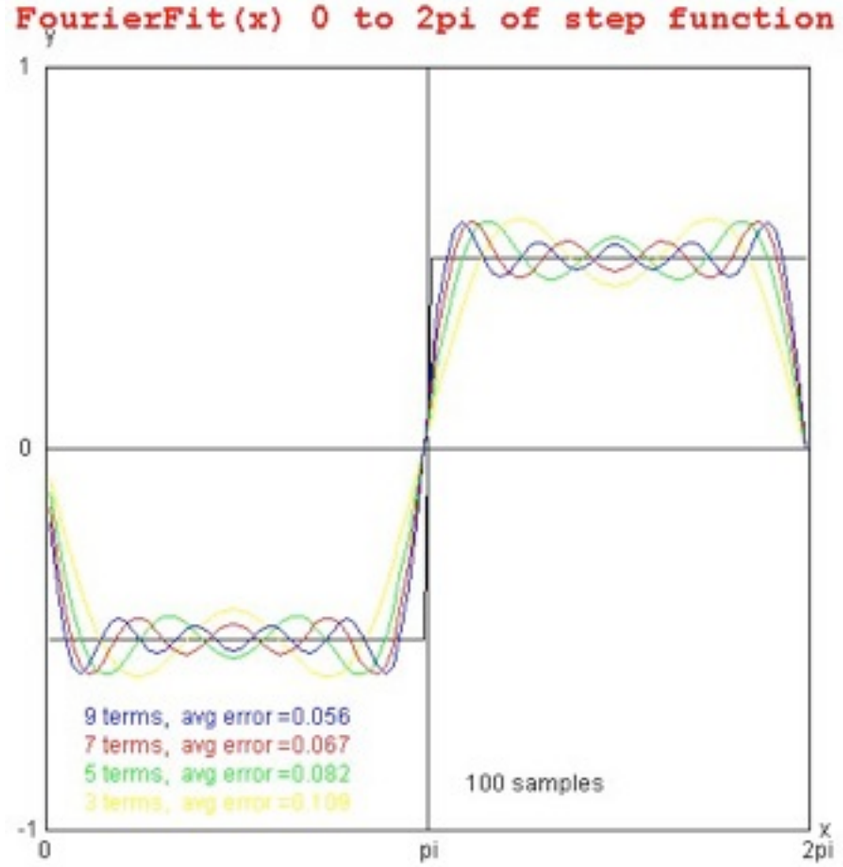
[A] white noise;

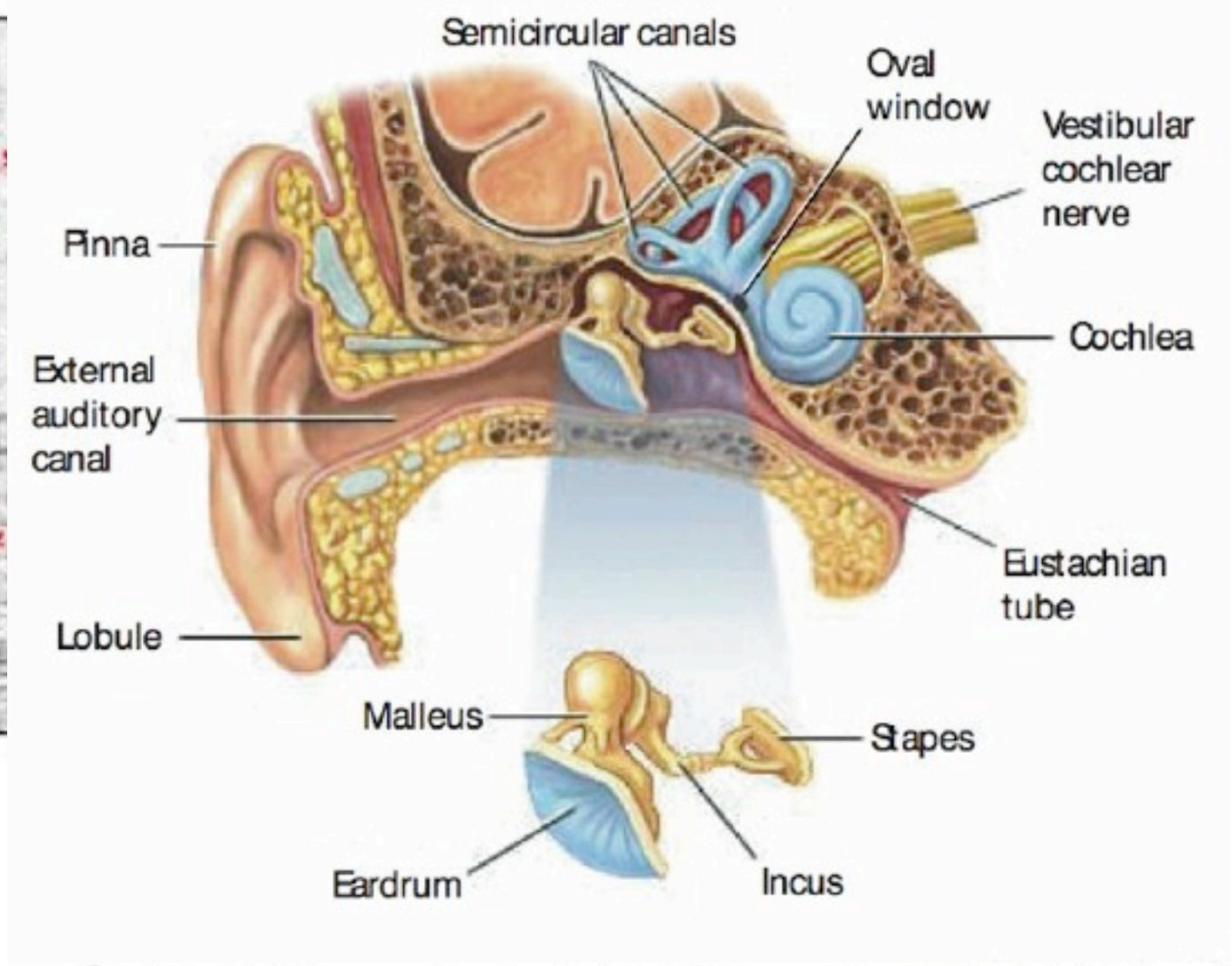
[B] a pure tone sweeping linearly from 20 to 20K Hz;

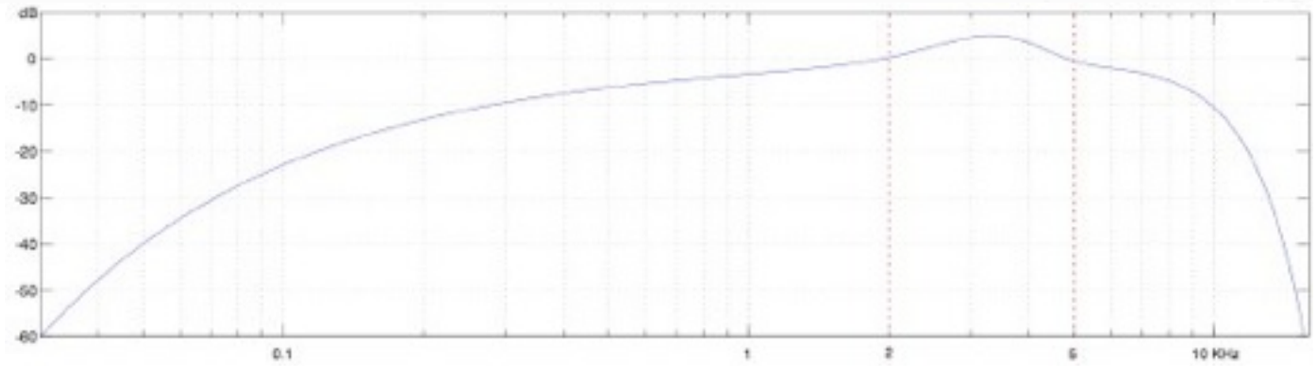
[C] four short sounds, including a digital click, a clave, a snare drum, and a staccato violin sound;

[D] a short excerpt of James Brown's "Sex machine."




FourierFit(x) 0 to 2pi of step function
y
1
0
-1
0
pi
2pi
x
9 terms, avg error =0.056
7 terms, avg error =0.067
5 terms, avg error =0.082
3 terms, avg error =0.109
100 samples


Semicircular canals
Oval window
Vestibular cochlear nerve
Pinna
Cochlea
External auditory canal
Eustachian tube
Lobule
Malleus
Stapes
Eardrum
Incus


dB
0
-10
-20
-30
-40
-50
-60
0.1
1
2
5
10 KHz

Hi, Dr. Elizabeth?
Yeah, uh... I accidentally took the Fourier transform of my cat...