The Rast/Bayyati Matrix

Briefly;

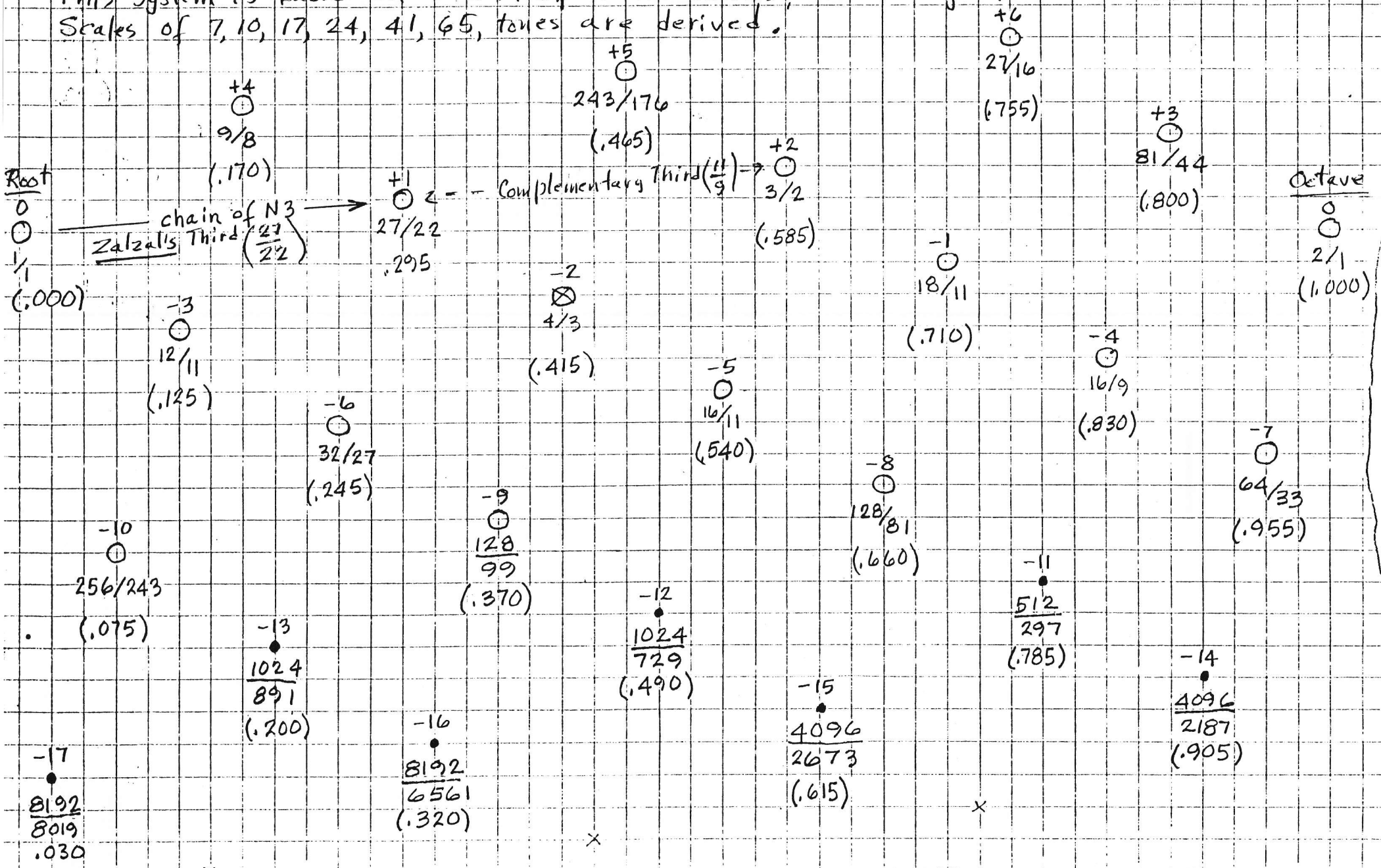
Zalzal is interesting because he places his third finger on the strings of the Ud at 22/27 of the string length. This makes a pitch a neutral third above that of the open string, and brings theory into alignment with popular practice. Consider the Rast tetrachord on string lengths on 108, 96, 88, 81. The melodic intervals in sequence are 9/8, 12/11, 88/81. The six permutations of this tetrachord are;

9/8	12/11	88/81	Rast
12/11	9/8	88/81	
12/11	88/81	9/8	Bayyati
88/81	12/11	9/8	
88/81	9/8	12/11	
9/8	88/81	12/11	

These tetrachords may be repeated to make scales, and chained to make modulations. The respective chains may be overlapped in a way to correspond with a chain of neutral thirds, of alternating 27/22 and 11/9. (27/22 x 11/9 = 3/2). This tonal system brings forth nested scales of 7, 10, 17, 24, 41, and 65 tones, as shown here in the following pages. The corresponding keyboard is also shown.

Further reading; Divisions of the Tetrachord.
John Chalmers 1993,
(available from Frog peak Music, Box A36, Hanover NH03755

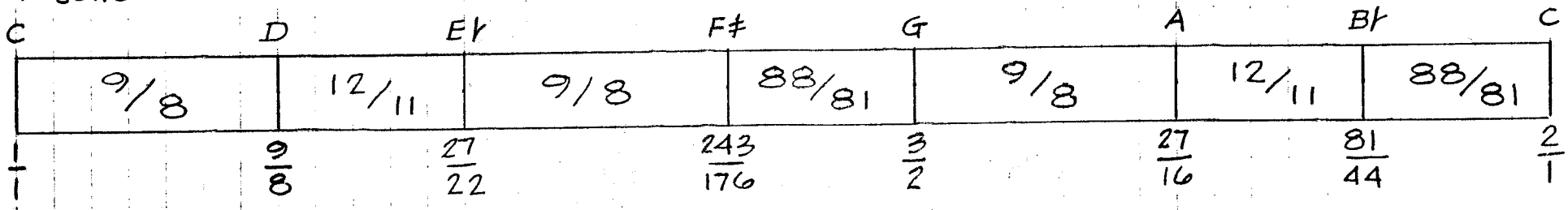
This system is based on a chain of neutral thirds, alternating 27/22 and 11/9.
Scales of 7, 10, 17, 24, 41, 65, tones are derived.



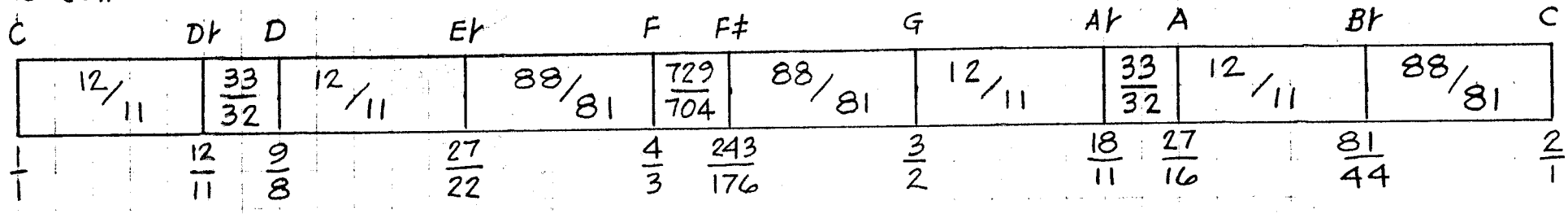
The Rast/Bayyati Matrix
(on the Zalzal Generalized Keyboard)

Scales made from a chain of neutral Thirds (C, E♭), alternating $^{27}/_{22}$ and $^{11}/_{9}$;

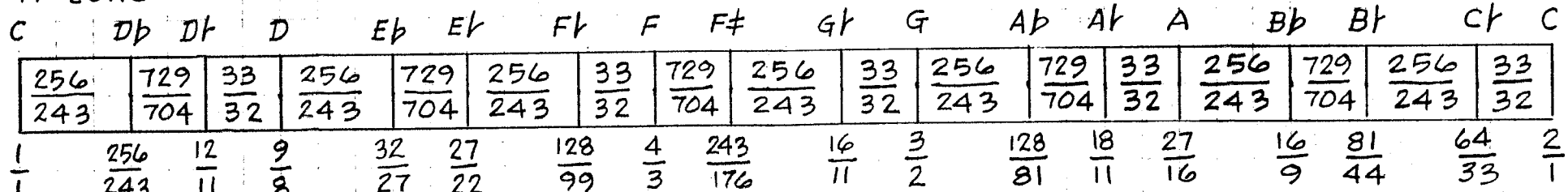
7-tone



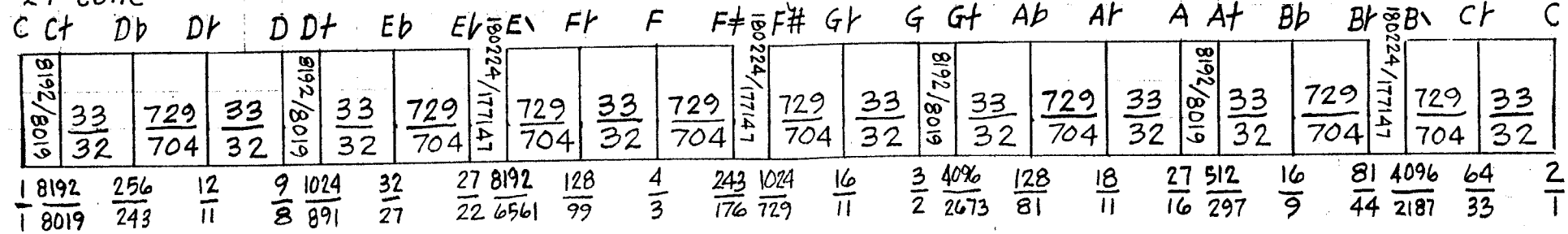
10-tone



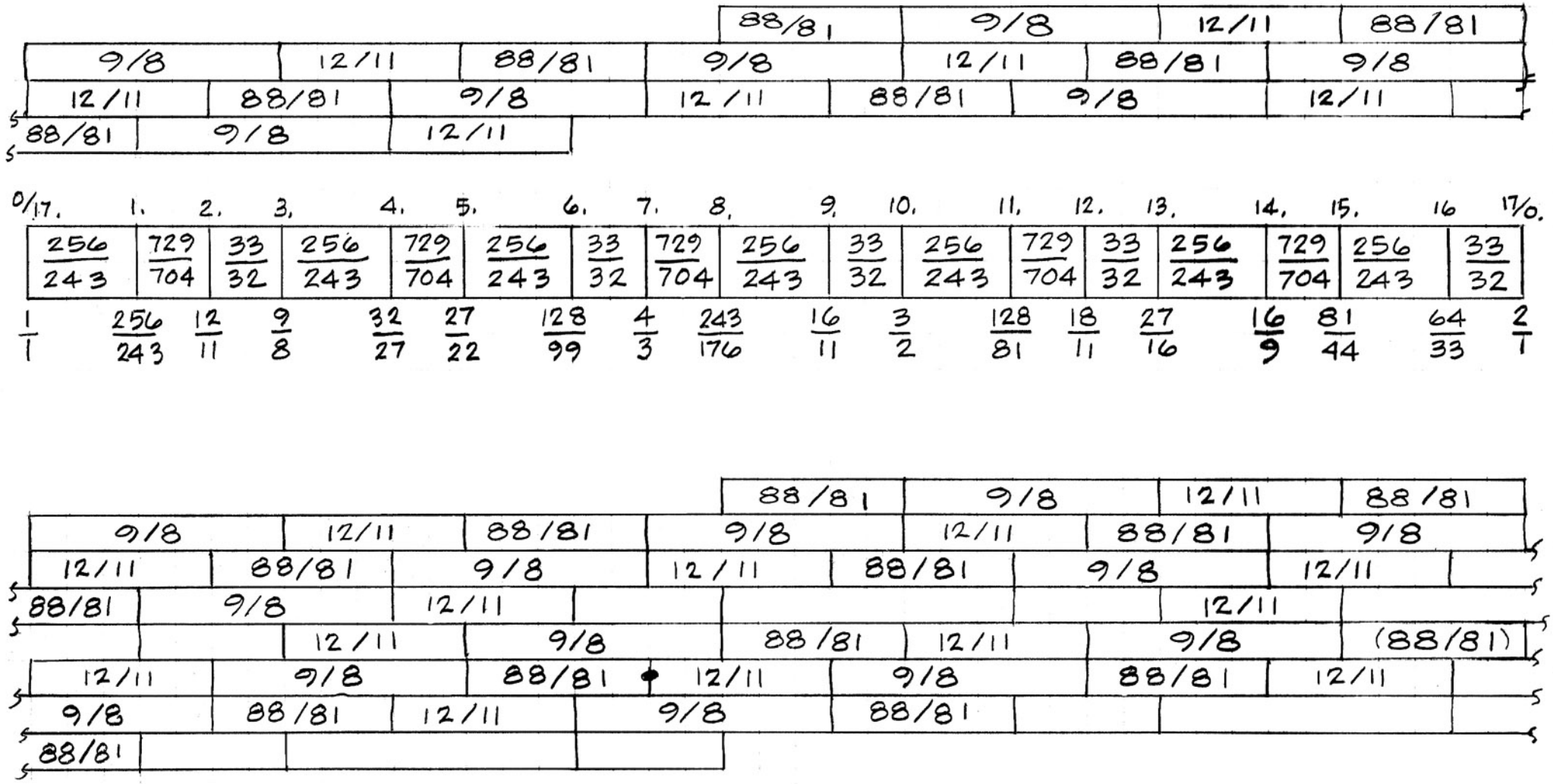
17-tone



24-tone



A chain of repeating tetrachords (88/81, 9/8, 12/11) will form a 17-tone Scale:



The Zalzal Generalized Kbd

7-tone basic scale

position in chain of neutral thirds

+7 729/704 0/7.	+4 9/8 1.	+1 27/22 2.	+5 243/176 3.	+2 3/2 4.	+6 27/16 5.	+3 81/44 6.
0 1/1 0/7.	-3 12/11 1.	-2 4/3 3.	-1 18/11 5.	0 2/1 7/0.		
-7 64/33 0/7.	-6 32/27 2.	-5 16/11 4.	-4 16/9 6.	-7 63/33 7/0.		

6.

chain Position

scale degree

1.

10-tone scale

+7 729/704 1.	+4 9/8 2.	+8 81/64 4.	+5 243/176 5.	+9 2187/1408 7.	+6 27/16 8.	+10 243/128 10/0.	+7 729/704 1.		
0 1/1 0/10.	-3 12/11 1.	+1 27/22 3.	-2 4/3 4.	+2 3/2 6.	-1 18/11 7.	+3 81/44 9.	0 2/1 10/0.		
-7 64/33 9.	-10 256/243 0/10.	-6 32/27 2.	-9 128/99 3.	-5 16/11 5.	-8 128/81 6.	-4 16/9 8.	-7 64/33 9.		

9.

2.

1.

17-tone Scale

+14
2187/2048
(77/72)
2.

+11
6561/5632
(7/6)
4.

+15
59049/45056
(21/16)
7.

+12
729/512
(77/54)
9.

+16
6561/4096
(231/144)
12.

+13
19683/11264
(7/4)
14.

+17
177147/90112
(63/32)
17/0.

+14
2187/2048
(77/72)
2.

+7
729/704
(28/27)
1.

+4
9/8
3.

+8
81/64
(308/243)
6.

+5
243/176
8.

+9
2187/1408
(14/9)
11.

+6
27/16
13.

+10
243/128
(154/81)
16.

+7
729/704
(28/27)
1.

0
1/1
0/17.

+1
27/22
5.

+2
3/2
10.

+3
81/44
15.

0
2/1
17/0.

-7
64/33
16.

-3
12/11
2.

-6
32/27
4.

-2
4/3
7.

-5
16/11
9.

-1
18/11
12.

-4
16/9
14.

-7
64/33
16.

-14
4096/2187
(15/8)
15.

-10
256/243
1.

-13
1024/891
(405/352)
3.

-9
128/99
6.

-12
1024/729
(45/32)
8.

-8
128/81
11.

-11
512/297
(1215/705)
13.

-14
4096/2187
(15/8)
15.

-17
8192/8019
(45/44)
0/17.

-16
8192/6561
(5/4)
5.

-15
4096/2673
(135/88)
10.

24 tone Scale

+21
1594323/1441792
(243/220)
3.

+22
177147/131072
(27/20)
10.

+23
4782969/2883584
(729/440)
17.

+24
531441/524288
(81/80)
24/0.

+21
1594323/1441792
(243/220)
3.

+18
19683/16384
(6/5)
6.

+19
531441/360448
(81/55)
13.

+20
59049/32768
(9/5)
20.

+17
177147/90112
(108/55)
23.

+14
2187/2048
(16/15)
2.

+15
59049/45056
(21/16)
9.

+16
6561/4096
(8/5)
16.

+13
19683/11264
(7/4)
19.

+14
2187/2048
(16/15)
2.

+11
6561/5632
(7/6)
5.

+12
729/512
(77/54)
12.

+10
243/128
(154/81)
22.

+7
729/704
(28/27)
1.

+8
81/64
(308/243)
8.

+9
2187/1408
(14/9)
15.

+7
729/704
(28/27)
1.

+4
9/8
4.

+5
243/176
11.

+6
27/16
18.

+3
81/44
21.

0
1/1
0/24.

+1
27/22
7.

+2
3/2
14.

0
2/1
24/0.

-3
12/11
3.

-2
4/3
10.

-1
18/11
17.

-4
16/9
20.

-7
64/33
23.

-6
32/27
6.

-5
16/11
13.

-7
64/33
23.

-10
256/243
2.

-9
128/99
9.

-8
128/81
16.

-11
512/297
(1215/705)
19.

-14
4096/2187
(15/8)
22.

-13
1024/891
(405/352)
5.

-12
1024/729
(45/32)
12.

-14
4096/2187
(15/8)
22.

-17
8192/8019
(45/44)
1.

-16
8192/6561
(5/4)
8.

-15
4096/2673
(135/88)
15.

-18
32768/19683
(5/3)
18.

-21
1179648/649539
(20/11)
21.

-20
65536/59049
(10/9)
4.

-19
294912/216513
(15/11)
11.

-21
1179648/649539
(20/11)
21.

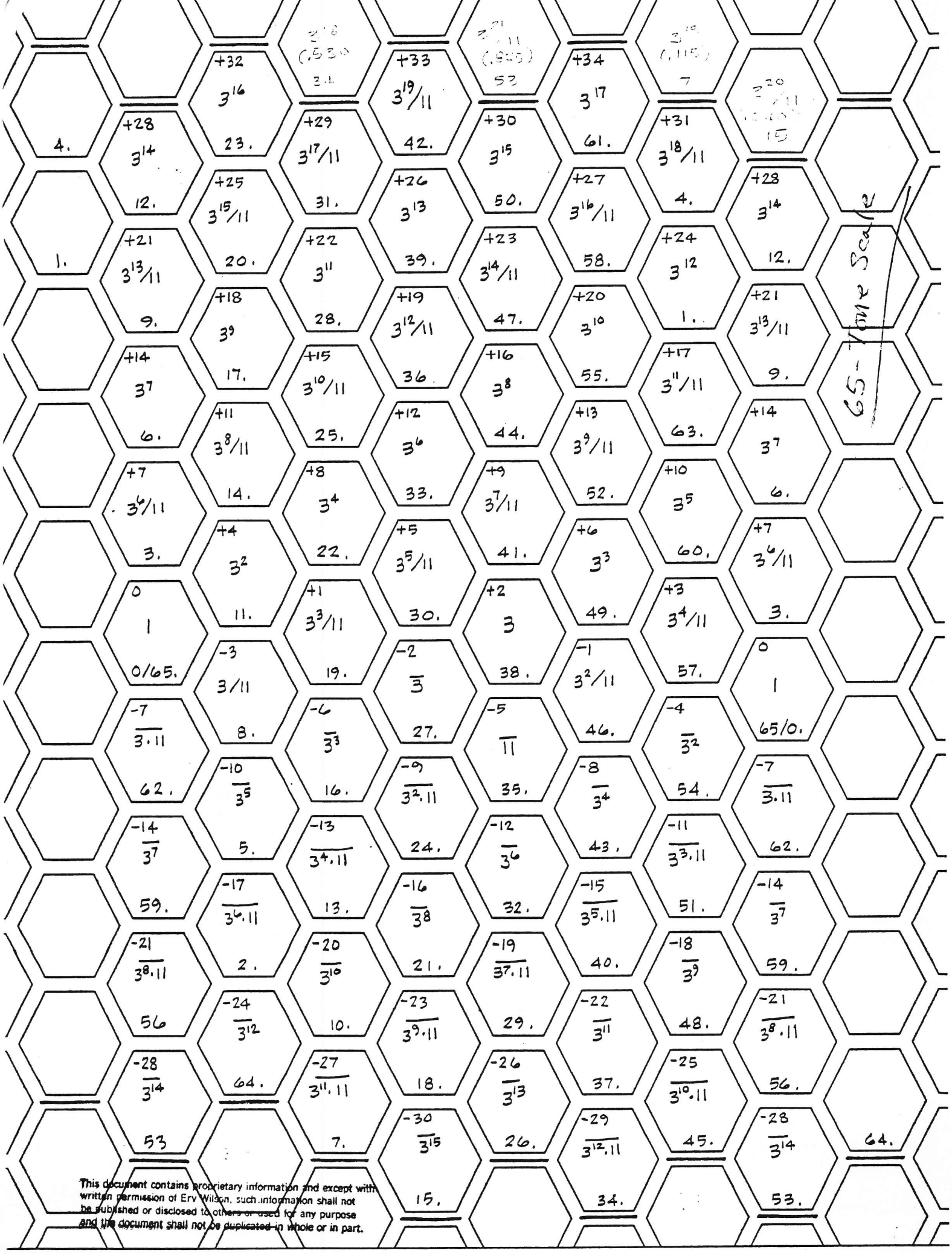
-24
1048576/531441
(160/81)
0/24

-23
2359296/1948417
(40/33)
7.

-22
262144/177147
(40/27)
14.

41-Tone Scale

		+18 19683/16384 (6/5) 11.		+19 531441/360448 (81/55) 23.		+20 59049/32768 (9/5) 35.			
	+14 2187/2048 (16/15) 4.		+15 59049/45056 (72/55) 16.		+16 6561/4096 (8/5) 28		+17 177147/90112 (108/55) 40.		
		+11 6561/5632 (7/6) 9.		+12 729/512 (77/54) 21.		+13 19683/11264 (7/4) 33.		+14 2187/2048 (16/15) 4.	
	+7 729/704 (28/27) 2.		+8 81/64 (308/243) 14.		+9 2187/1408 (14/9) 26.		+10 243/128 (154/81) 38.		
		+4 9/8 7.		+5 243/176 19.		+6 27/16 31.		+7 729/704 (28/27) 2.	
	0 1/1 0/41.		+1 27/22 12.		+2 3/2 24.		+3 81/44 36.		
		-3 12/11 5.		-2 4/3 17.		-1 18/11 29.		0 2/1 41/0.	
	-7 64/33 39.		-6 32/27 10.		-5 16/11 22.		-4 16/9 34.		
		-10 256/243 3.		-9 128/99 15.		-8 128/81 27.		-7 64/33 39.	
	-14 4096/2187 (15/8) 37.		-13 1024/891 (405/352) 8.		-12 1024/729 (45/32) 20.		-11 512/297 (1215/705) 32.		
		-17 8192/8019 (45/44) 1.		-16 8192/6561 (5/4) 13.		-15 4096/2673 (135/88) 25.		-14 4096/2187 (15/8) 37.	
			-20 65536/59049 (10/9) 6.		-19 294912/216513 (15/11) 18.		-18 32768/19683 (5/3) 30.		


65-Tone Scale
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.024844111
.019550009
.030793377
.019550009
.024844111
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.019550009
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.019550009
.024844111
.019550009
.030793377

All-tone Scale

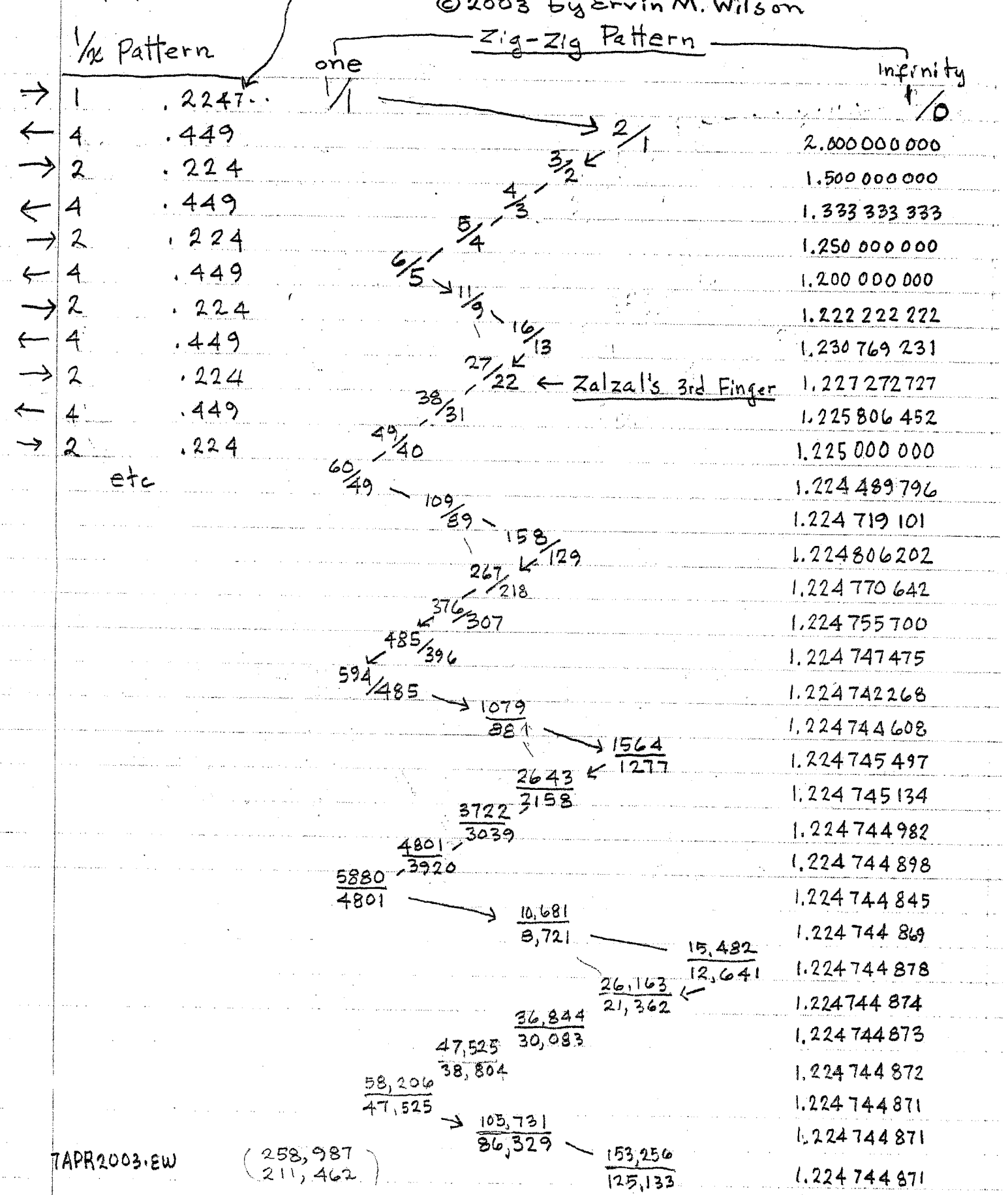
C	2/1	1.000000000
	177147/90112	.975155889
Cr	64/33	.95560588
	243/128	.924812503
B\	4096/2187	.905262495
Br	81/44	.880418384
	59049/32768	.849625007
Bb	16/9	.830074998
	19683/11264	.805230887
At	512/297	.785680879
A	27/16	.754887502
	32768/19683	.735337493
Ar	18/11	.710493382
	6561/4096	.679700005
Ab	128/81	.660149997
	2187/1408	.635305886
Gt	4096/2673	.615755877
G	3/2	.5849625
	531441/360448	.56011839
Gr	16/11	.540568381
	729/512	.509775004
F#	1024/729	.490224995
F‡	243/176	.465380885
	294912/216513	.445830876
F	4/3	.41503749
	59049/45056	.390193388
Fr	128/99	.370643379
	81/64	.339850002
E\	8192/6561	.320299994
Er	27/22	.295455883
	19683/16384	.264662506
Eb	32/27	.245112497
	6561/5632	.220268387
Dt	1024/891	.200718378
D	9/8	.169925001
	65536/59049	.150374992
Dr	12/11	.125530882
	2187/2048	.094737505
Db	256/243	.075187496
	729/704	.050343385
Ct	8192/8019	.030793377
C	1/1	.000000000

65-tone scale

this diagram shows the nested scales of 17, 24, 41, and 65 tones.

Scale Degree		Chain Position 17	24	41	65	Factor	Log base 2
C	65.	0	0	0	0	1	1.000000000
C↖	64.				-24	$/3^{12}$	.980449991
	63.			+17	+17	$3^{11}/11$	.975155889
	62.	-7	-7	-7	-7	$/3.11$	.95560588
B↓	61.				+34	3^{17}	.944362512
B	60.			+10	+10	3^5	.924812503
B↖	59.		-14	-14	-14	$/3^7$	.905262494
	58.				+27	$3^{16}/11$	.899968392
	57.	+3	+3	+3	+3	$3^4/11$	.880418384
	56.				-21	$/3^{8.}11$	.860868375
B𝄫	55.			+20	+20	3^{10}	.849625007
B𝄫	54.	-4	-4	-4	-4	$/3^2$	.830074998
B𝄪	53.				-28	$/3^{14}$	.810524989
	52.			+13	+13	$3^9/11$	.805230887
	51.		-11	-11	-11	$/3^{3.}11$	.785680879
A↓	50.				+30	3^{15}	.774437 51
A	49.	+6	+6	+6	+6	3^3	.754887502
A↖	48.			-18	-18	$/3^9$	.735337493
	47.				+23	$3^{14}/11$	.730043391
	46.	-1	-1	-1	-1	$3^2/11$	.710493382
	45.				-25	$/3^{10.}11$	.690943374
A𝄫	44.			+16	+16	3^8	.679700005
A𝄫	43.	-8	-8	-8	-8	$/3^4$	.660149997
	42.				+33	$3^{19}/11$	.654855895
	41.			+9	+9	$3^7/11$	.635305886
	40		-15	-15	-15	$/3^{5.}11$	.615755877
G↓	39.				+26	3^{13}	.604512509
G	38	+2	+2	+2	+2	3	.5849625
G↖	37.				-22	$/3^{11}$	.565412492
	36.			+19	+19	$3^{12}/11$	.560118390
	35.	-5	-5	-5	-5	/11	.540568381
	34.				-20	$/3^{12.}11$	.521018372
G𝄫	33.			+12	+12	3^6	.509775004
G𝄫	32.		-12	-12	-12	$/3^6$	.490224995
	31.				+29	$3^{17}/11$	.484930893
	30.	+5	+5	+5	+5	$3^5/11$	.465380885
	29.			-19	-19	$/3^{7.}11$	.445830876
F↓	28.				+22	3^{11}	.434587507
F	27.	-2	-2	-2	-2	/3	.41503749 9
F↖	26.				-26	$/3^{13}$	.39548749
	25.			+15	+15	$3^{10}/11$	.390193388
	24.	-9	-9	-9	-9	$/3^{2.}11$	.370643379
E↓	23.				+32	3^{16}	.359400011
E	22.			+8	+8	3^4	.339850002
E↖	21.		-16	-16	-16	$/3^8$	.320299994
E𝄪	20.				+25	$3^{15}/11$	.315005892
E𝄫	19.	+1	+1	+1	+1	$3^3/11$	.295455883
E𝄪	18.				-23	$/3^{9.}11$	.275905874
E𝄫	17.			+18	+18	3^9	.264662506
E𝄫	16.	-6	-6	-6	-6	$/3^3$	.245112497
E𝄪	15.				-30	$/3^{15}$	.225562489
	14.			+11	+11	$3^8/11$	.220268387
	13.		-13	-13	-13	$/3^{4.}11$	.200718378
D↓	12.				+28	3^{14}	.18947501
D	11.	+4	+4	+4	+4	3^2	.169925001
D↖	10.			-20	-20	$/3^{10}$	.150374992
	9.				+21	$3^{13}/11$	.14508089
	8.	-3	-3	-3	-3	3/11	.125530882
	7.				-27	$/3^{11.}11$	.105980873
D𝄫	6.			+14	+14	3^7	.094737505
D𝄫	5.	-10	-10	-10	-10	$/3^5$	.075187496
	4.				+31	$3^{18}/11$	.069893394
	3.			+7	+7	$3^6/11$	.050343385
	2.		-17	-17	-17	$/3^{6.}11$	.030793377
C↓	1.				+24	3^{12}	.019550008
C	0.	0	0	0	0	1	.000000000

"$\sqrt{\left(\frac{3}{2}\right)}$ = 1.224744871391..." and Zalzal's Third Finger



7APR2003.EW

$\text{Log}_2 \sqrt{\frac{3}{2}} = .292481250359\ldots$, Moments of Symetry (MOS)

1/x Pattern

		.292...
←	3	.419
→	2	.386
←	2	.587
→	1	.702
←	1	.422
→	2	.364
←	2	.744
→	1	.342
←	2	.918
→	1	.089
?	11	.208

Zig-Zag Pattern

$\frac{0}{1}$ $\frac{1}{1}$ $\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$ $\frac{2}{7}$ $\frac{3}{10}$ $\frac{5}{17}$ $\frac{7}{24}$ $\frac{12}{41}$ $\frac{19}{65}$ $\frac{31}{106}$ $\frac{43}{147}$ $\frac{74}{253}$ $\frac{105}{359}$ $\frac{179}{612}$! $\frac{284}{971}$ $\frac{389}{1,330}$ $\frac{673}{2,301}$

C1 ※

295,245

262,144

(297.34)

3. ⊗

C#

2,187

2,048

(281.92)

2.

C1#

135/128

(278.43)

1. 0

0 C

1/1

(264)

0/17. •

C1

160

81

16.

D#

19,683

16,384

(317.16)

5.

D1#

1215

1024

(313.24)

4. 0

+4 D

9/8

(297)

3. •

D1

10/9

(293.33)

2.

Db

256

243

(278.12)

1. •

E#

177,147

131,072

(356.80)

8.

E1#

10,935

8,192

(352.40)

7. 0

E

81/64

(334.12)

6.

+1 E1

5/4

(330)

5.

Eb

32/27

(312.89)

4. •

F※

98,415

65,536

(396.45)

10. 0

F#

729

512

(375.90)

9.

+5 F1#

45/32

(371.25)

8. ⊗

F

4/3

(352)

7. •

empty

6.

G1※

885,735

524,288

13.(446)

G#

6561

4096

(422.88)

12.

G1#

405/256

(417.66)

11. ⊗

+2 G

3/2

(396)

10. •

G1

40/27

(391.11)

9.

Gb

1024

729

(370.83)

8. •

A#

59,049

32,768

(475.74)

15.

A1#

3645

2048

(469.86)

14. ⊗

+6 A

27/16

(445.5)

13. •

A1

5/3

(440)

12.

Ab

128

81

(417.19)

11. •

B1#

32,805

32,768

(528.60)

17/0. ⊗

B

243/128

(501.19)

16. •

+3 B1

15/8

(495)

15.

Bb

16/9

(469.33)

14. •

empty

13.

C1※

295,245

262,144

(594.67)

3. ⊗

C#

2,187

2,048

(563.84)

2. •

C1#

135/128

(556.87)

1.

0. C

2/1

(528)

0/17. •

C1

160

81

(521.48)

16.

17 24 41 65 106

17-tone Scale by a Chain of Neutral Thirds, $\sqrt{\frac{3}{2}}$

Plot	Chain	Pitch	YU	1024
— 0	0	2,000000000	0/17. (768)	
— +10	+10	1.898437500	16. 710	
— +3	+3	1.837117307	15. 674	
— +13	+13	1.743826194	14. 616	821.51
— +6	+6	1,687500000	13. 580	
— +16	+16	1.601806641	12. 522	
— +9	+9	1.550067728	11. 486	
— +2	+2	1.500000000	10. 449	
— +12	+12	1.423828125	9. 392	
— +5	+5	1.377837980	8. 355	
— +15	+15	1.307869645	7. 297	
— +8	+8	1.265625000	6. 261	
— +1	+1	1.224744871	5. 225	
— +11	+11	1.162550796	4. 169	
— +4	+4	1.125000000	3. 130	
— +14	+14	1.067871094	2. 73	
— +7	+7	1.033378485	1. 36	
— 0	0	1.000000000	0. 000	

Modeled after Baglama Scale

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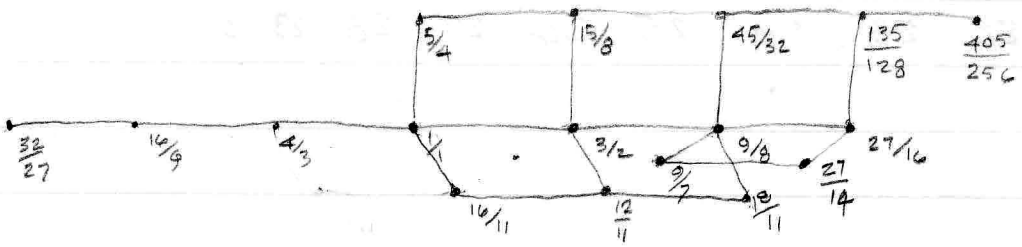
$\frac{1}{1}$ $\frac{256}{243}$ $\frac{12}{11}$ $\frac{9}{8}$ $\frac{32}{27}$ $\frac{5}{4}$ $\frac{9}{7}$ $\frac{4}{3}$ $\frac{1024}{729}$ $\frac{16}{11}$ $\frac{3}{2}$ $\frac{128}{81}$ $\frac{18}{11}$ $\frac{27}{16}$ $\frac{16}{9}$ $\frac{15}{8}$ $\frac{27}{14}$ $\frac{2}{1}$

$\left(\frac{135}{128}\right)$ $\left(\frac{45}{32}\right)$ $\left(\frac{405}{256}\right)$



$\frac{3}{2} \times \frac{6}{11} = \frac{18}{11}$

~~4~~ $\frac{18}{11} \times \frac{4}{5} = \frac{72}{55}$ (.38856)

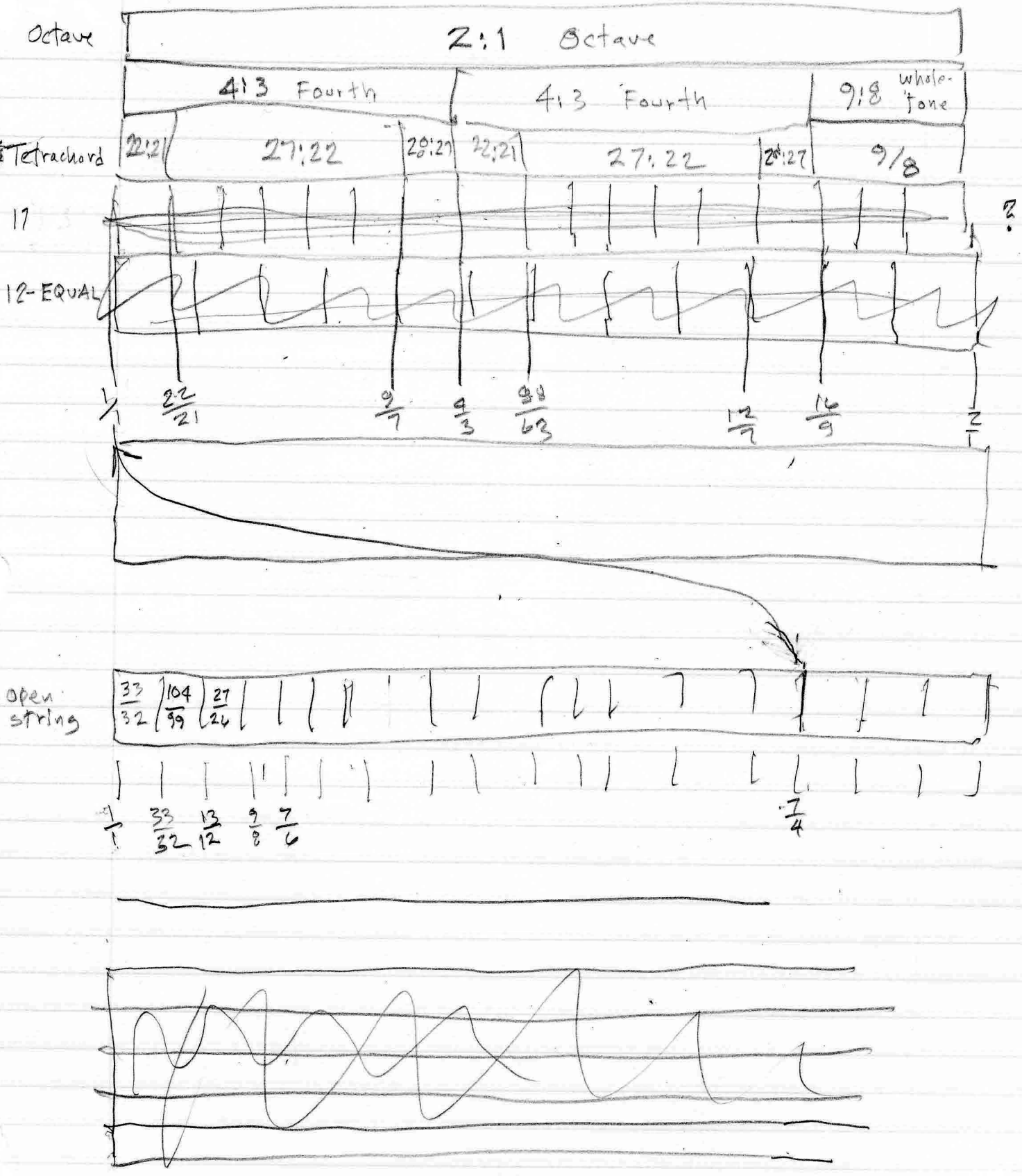
$\frac{27}{14} \times \frac{11}{16} = \frac{297}{224}$ (.40696)

$\frac{3}{\cancel{27}\ 9} \times \frac{7}{\cancel{9}\ 3} = \left(= \frac{21}{16}\right.$ (.392317)

$\frac{11}{11}$ $\frac{11}{9}$ $\frac{11}{8}$ $\frac{11}{7}$ $\frac{11}{6}$ $\frac{22}{11}$

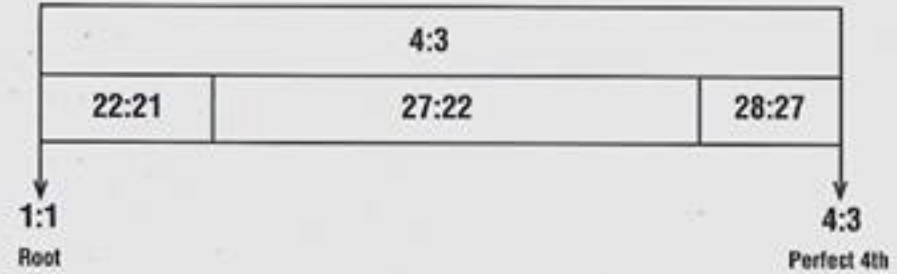
$\frac{1}{1}$ $\frac{32}{27}$ $\frac{4}{3}$ $\frac{16}{11}$ $\frac{16}{9}$ $\frac{2}{1}$

32 27 22


Octave
2:1 Octave
4:3 Fourth
4:3 Fourth
9:8 whole-tone
Tetrachord
22:21
27:22
20:27
22:21
27:22
20:27
9/8
17
12-EQUAL
?
1/1
22/21
9/7
4/3
81/63
12/7
16/9
2/1
open string
33/32
104/99
27/26
1/1
33/32
13/12
9/8
7/6
7/4

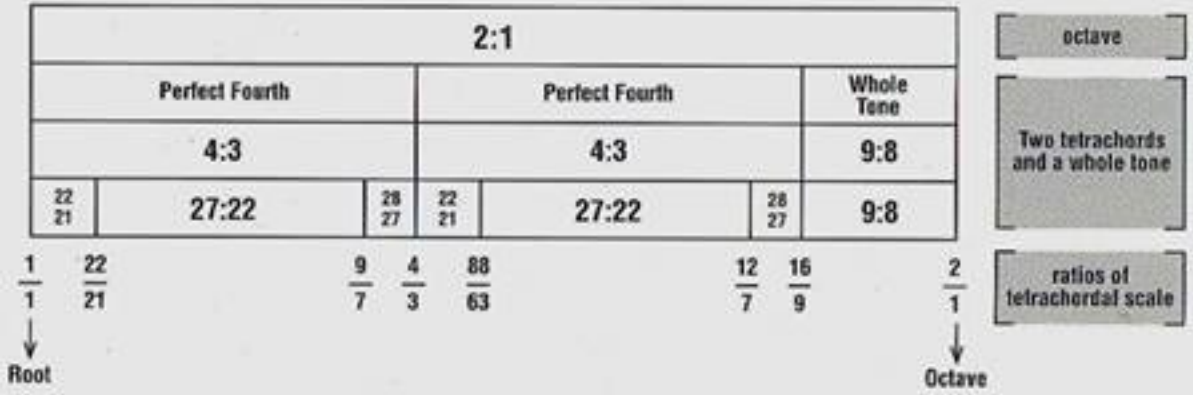
The Death Adder/December 96 began life as an enharmonic, tetrachordal scale. The tetrachord (a perfect fourth) is two unevenly-sized, small half-steps, 22:21 and 28:27, separated by a neutral third, 27:22, the Wosta of Zalzal*.

EXAMPLE ONE



An octave can be seen as two tetrachords and a whole tone in any one of three permutations. The Death Adder/December 96 uses the following example.

EXAMPLE TWO

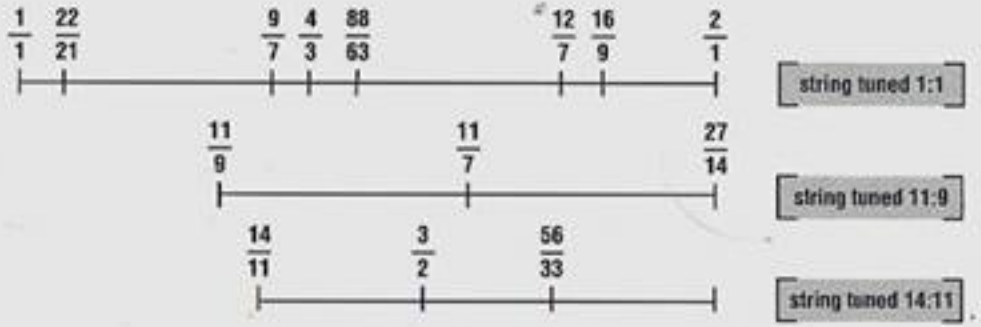


Six more tones have been added to this tetrachordal scale creating a 13-tone structure.

EXAMPLE THREE

Example Three shows the tetrachordal scale (upper) and the additional tones (lower) that make up the 13-tone expanded scale. The guitar does not accommodate a fretting system to allow these pitches to be played one after another on a single string moving up the fretboard. The scale is constructed from three strings tuned to each other by the ratios: 1:1, 11:9, and 14:11.

EXAMPLE FOUR



My work in alternate tunings for the guitar deals specifically with just intonation. This tuning is a natural expansion of the possibilities of consonance and dissonance, which can be seen in terms of mood and feeling as they relate to the properties of sound. For me, the mood and feeling of music is of great importance because it expresses quality of performance on an intuitive level.

What excites me about the process of playing is the realization of a finely tuned tonality that allows personal emotion to shape the course of the improvisation, creating a structural continuity based on sound, silence, timbre, and dynamics. This approach allows musical structures to be recorded and released in multiple versions – all of which have the capacity to be distinctly different from each other.

—ROD POOLE

*Wosta is the middle finger. Zalzal was an Eastern theorist (720–791 a.d.).