

traditional European idioms of a 13th-14th century variety, the equable and neutral cadences augment this melodic and harmonic vocabulary with a wealth of intermediate steps and intervals.

Here we have touched on some of the main permutations and possibilities, considering only stepwise progressions where all unstable intervals resolve in the same manner. Cadences in “mixed” manners, for example those involving vertical diminished fifths ( $8^{\circ}17$ ) or augmented fourths ( $9^{\circ}17$ ), further multiply the range of choices (see Sections 4, 5.3, 7.3).

Equable and neutral cadences take center stage in another kind of neo-medievalism fusing together some elements of Gothic polyphony with Near Eastern scales and modes, an approach to which we now turn.

#### **4. Neo-medieval fusion: Zalzal and a symmetrical scale**

IN HIS VERY FIRST LETTER TO ME, George Secor drew my attention to a fertile theme for “cross-pollination” possibly realized in certain localities in actual as well as alternate history. Remarking on the many neutral intervals of 17-WT, I had mentioned in my opening letter that I had read a report on Usenet that an ensemble performing music from the French court of Cyprus around 1400 had used certain “half-sharped” sonorities. He replied (Letter, 10 September 2001):

The occurrence of neutral intervals in connection with a 17-tone octave reminded me of the references in both Helmholtz’s *Sensations of Tone* and Harry Partch’s *Genesis of a Music* to the Arabian theorist Zalzal, who changed the fretting of the lute to include certain quarter tones (which would approximate ratios of 11), but this appears to have occurred at a time when the Arabian scale had not yet been expanded to include 17 (Pythagorean) tones in the octave. Partch reports that, in the interim, others had made efforts to undo Zalzal’s innovations, while continuing to honor the memory of his name. Perhaps there is a Zalzal-Cyprus connection that you might be able to uncover.

In another letter of 26 September, he again mentioned Helmholtz and Partch, citing specific pages; now I checked out these references<sup>49</sup>, and quickly realized, as I wrote in reply within a few days, “Your letter of Thursday has set off what I’m calling a ‘Zalzal Revolution’ adding a whole new world to my outlook on neo-medieval music and tunings” (29 September 2001).

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<sup>49</sup>Hermann von Helmholtz, *On the Sensations of Tone as a Physiological Basis for the Theory of Music*, 2nd English ed., tr. Alexander Ellis 1885 (New York: Dover Publications, 1954), pp. 515–517, tunings numbered 39–51, 53–72; and Partch, see n. 43, at pp. 425–426.

During those same days, we were exchanging notes about a “harmonically based heptatonic scale” which Secor had used in sharing some very effective cadences along neo-18th-century European lines, and I changed one note to come up with a “symmetrical tetrachord” variation which, as I noted in that same letter, “draws me in.” A bit of research would later reveal that this scale, or more specifically its just intonation interpretation as suggested by Secor in reply, was almost identical to a soft diatonic tuning of Ibn Sina of about a thousand years earlier.

Both types of Near Eastern scales lend themselves to a kind of “neo-medieval fusion” style combining a rich assortment of intermediate or neutral steps and intervals with harmonic progressions along 13th-14th century European lines. From the latter perspective, these scales are notable for their absence of any steps of  $1^\circ 17'$ , and thus of any intensive or remissive cadences (Section 3.1) unless we introduce added or altered degrees.

The result is a new kind of musical world filled with cadences of the equable and neutral types (Sections 3.2, 3.5), along with omnitonal cadences of a kind popular in 13th-century Europe (Section 3.4). The range of variety is further enhanced in a tuning system such as 17-WT, where the color or mood of melodic and vertical intervals alike subtly shifts in different regions of the tuning circle.

Like the 12th-century Renaissance of Gothic Europe in which Islamic civilization played a central role, this 21st-century Renaissance represents a meeting of cultures and traditions. It is appropriate that Ibn Sina, an important influence on medieval European philosophy, should be a central figure in this new musical current also with his use of 13-based ratios and divisions such as 14:13:12.

#### 4.1. A Zalzal revolution: steps, modes, and cadences

Whether or not Zalzal’s tuning may have influenced the intonation of music around 1400 at the French court of Cyprus, it has a rich history in the Near Eastern tradition, its just ratios also approximated in the 24-ET system advocated in the 19th century by the Syrian theorist Michael Meshagah, as Partch notes<sup>50</sup> and Secor mentions in our correspondence (Letter, 26 September 2001).

Zalzal’s 8th-century scale is a fascinating combination of Pythagorean intervals with neutral second steps of 12:11 and 88:81, here shown in fractional and Pythagorean styles of notation in an octave of C-C:

C	D	D#	F	G	G#	Bb	C
C	D	Ed	F	G	Ad	Bb	C
1:1	9:8	27:22	4:3	3:2	18:11	16:9	2:1
0	203.91	354.55	498.04	701.96	852.59	996.09	1200
	9:8	12:11	88:81	9:8	12:11	88:81	9:8
	203.91	150.64	143.50	203.91	150.64	143.50	203.91

<sup>50</sup>Partch, *ibid.*, pp. 425–426.

The Pythagorean intervals represented by the second, fourth, fifth, and seventh degrees (3:2, 4:3, 9:8, 16:9) are common to Near Eastern and Gothic European theory, while the third and sixth degrees are at neutral intervals of 27:22 (~354.55 cents) and 18:11 (~852.59 cents). In certain places we also find related neutral thirds and sixths at 11:9 (~347.41 cents, e.g. Ed3-G3) and 44:27 (e.g. G3-Ed4), as well as Pythagorean thirds at 81:64 (e.g. Bb3-D4) and 32:27 (e.g. D4-F4), and sixths at 27:16 (e.g. F3-D4) and 128:81 (e.g. D4-Bb4).

As it happens, a C-C version in 17-WT gives one of the best approximations of these just ratios, or more specifically of the 27:22 third and 18:11 sixth above the lowest note (at 353.61 cents and 849.23 cents, the former within one cent of pure). In this and other 17-WT transpositions, 9:8 steps are represented as 3°17, and 12:11 or 88:81 steps as 2°17, with various nuances and shadings.

On my 17-WT keyboard arrangement using two conventional 12-note manuals, I find the transpositions to D and G especially convenient because they require only two accidentals each, all available on the upper manual (Gb/F# and A#/Bd for D; A#/Bd and D#/Ed for G). Here I focus on a D-D version, illustrating one type of “key color” or “modal color.” This scale is shown in fractional and Pythagorean spellings:

D	E	Gb	G	A	A#	C	D
D	E	F#	G	A	Bd	C	D
0°17	3°17	5°17	7°17	10°17	12°17	14°17	17°17
0	214.44	347.923	492.78	707.22	843.55	985.56	1200
	3°17	2°17	2°17	3°17	2°17	2°17	3°17
	214.44	133.48	144.86	214.44	136.33	142.01	214.44

In 17-WT, the third and sixth degrees of Zalzal may in different transpositions approach such ratios 11:9 and 44:27 (~347.41 and ~845.45 cents, as here, or 27:22 and 18:11 (~354.55 and ~852.59 cents).<sup>51</sup>

In a system such as 17-WT, the “refinement” or complication of double accidentals may express certain fine distinctions of interval color or cadential affinity, albeit often highly subjective ones. Thus to me, in this D-D transposition, the cadence I am wont to spell Bb#4-D5-G5 (i.e. Bd4-D5-G5) to A4-E5-A5 suggests a rather “remissive-like” affinity (see Section 3.5). In what follows,

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<sup>51</sup>Secor (Personal correspondence, 28 December 2001 and 17 May 2002) notes that a finer system of notation might distinguish 11:9 and 44:27, respectively larger by a diesis of 33:32 (~53.27 cents) than the Pythagorean minor third and sixth 32:27 and 128:81 (~294.13 cents, ~792.18 cents), from 27:22 and 18:11, respectively smaller by the same diesis than the Pythagorean major third and sixth at 81:64 and 27:16 (~407.82 cents, ~905.87 cents). The ratios 11:9 and 27:22, and likewise 44:27 and 18:11, differ by what Secor terms a “mini-comma” of 243:242, ~7.14 cents. Adding the 33:32 diesis and 243:242 mini-comma gives a larger diesis of 729:704, ~60.41 cents, the amount by which 81:64 and 27:16 exceed 11:9 and 44:27, or by which 27:22 and 18:11 exceed 32:27 and 128:81.

when using these alternative spellings I also give conventional fractional equivalents, for example indicating the cadential sonority last mentioned as B $\flat$ 4/B $\flat$  $\neq$ 4-D5-G5.

In this transposition, 17-WT versions of the Pythagorean intervals often have the near-7 approximations of the Ab-B portion of the circle (e.g. C4-E4 as  $\sim$ 7:9, E4-G4 as  $\sim$ 6:7, C4-B $\flat$ 4 as  $\sim$ 4:7), while some of the 2 $^{\circ}$ 17 steps (e.g. E-F $\neq$ ) are closer to a “2/3-tone” effect than to Zalzal’s “3/4-tones” of 12:11 or 88:81. The third and sixth steps are close to 11:9 ( $\sim$ 347.41 cents) and 13:8 (840.53 cents), with the latter especially a different shading than Zalzal’s 27:22 and 18:11.

As we explore some of the patterns of this transposition, we should keep in mind that it is only one of 17 variations on the Zalzal theme available in 17-WT. Kaleidoscopic shifts in modal color, and in the qualities of the equable and neutral cadences so vital to this kind of style (Sections 3.3, 3.5), may predictably give rise to quite different patterns as we move around the circle.

Our D-D scale, like a Zalzal scale generally, includes five “modes” with a stable fifth (10 $^{\circ}$ 17) above the final: they occur on degrees 1, 4, 5, 6, and 7. These degrees can serve as goals for cadences to a tempered 2:3:4 in a usual neo-medieval setting.

On D, or degree 1, we have available omnitonal cadences of the usual 13th-century European variety (Section 3.4), with each part moving by 3 $^{\circ}$ 17. In the first example we resolutions from minor third to fifth (4 $^{\circ}$ 17-10 $^{\circ}$ 17) and minor sixth to octave (11 $^{\circ}$ 17-17 $^{\circ}$ 17), and in the second from major third to unison (6 $^{\circ}$ 17-0 $^{\circ}$ 17) and minor third to fifth (4 $^{\circ}$ 17-10 $^{\circ}$ 17):

C4	D4	G4	A4
G3	A4	E4	D4
E3	D3	C4	D4
(m6-8 + m3-5)		(M3-1 + m3-5)	

On G, or degree 4, we have cadences in a “mixed” manner featuring “superfourths”<sup>52</sup> or small tritones of 8 $^{\circ}$ 17, which Secor noted in discussing another scale “can functionally harmonically as 8:11 or 13:18, depending on context, and I don’t think they sound out of place” (Letter, 26 September 2001). Her the lower pair of voices resolve omnitonally from minor third to fifth (4 $^{\circ}$ 17-10 $^{\circ}$ 17), and the outer pair from neutral sixth to octave (12 $^{\circ}$ 17-17 $^{\circ}$ 17):

F $\neq$ 4	G4
C4	D4
A3	G3
(m3-5 + N6-8)	

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<sup>52</sup>“Superfourth” is the term suggested for the 8:11 ( $\sim$ 551.32 cents) by Dave Keenan, <http://www.uq.net.au/~zzdkeena/Music/IntervalNaming.htm>.

In the D-D scale, the tritone or superfourth between the upper voices has a size of about 562.36 cents, very close to 13:18 (~563.38 cents). A cadence of the omnitonal type common in 13th-century Europe is also available on this degree, with the minor third of a near-6:7:9 sonority resolving to a fifth and the upper major third to a unison:

E4	D4
C4	D4
A3	G3

(M3-1 + m3-5)

These two cadences can be combined in a four-voice cadence adding a resolution between the upper pair of voices from neutral second to fourth (2°17-7°17), and increasing the level of sonority and tension:

F#4	G4
E4	D4
C4	D4
A3	G3

(N6-8 + m3-5 + M3-1 + N2-4)

On A or degree 5, we find a neutral cadence with a strong remissive affinity: the resolutions of neutral third to fifth (5°17-10°17) and neutral sixth to octave (12°17-17°17) recall for me a 13th-14th century European progression with major third and sixth, while the descending step Bd/Bb#-A in the lowest voice might suggest a “1°17-like” quality:

G4	A4
D4	E4
Bd3/Bb#3	A3

(N6-8 + N3-5)

On Bd/Bb#3 or degree 6, we have an equable cadence which for me has very convincing “intensive” qualities, and could satisfyingly serve as a final cadence in a “neo-14th-century” type of Gothic-like style. Here are two sonorous four-voice forms:

<table style="margin-left: auto; margin-right: auto;"> <tr> <td>A4</td> <td>Bd4/Bb#4</td> </tr> <tr> <td>G4</td> <td>F#4</td> </tr> <tr> <td>E4</td> <td>F#4</td> </tr> <tr> <td>C4</td> <td>Bd3/Bb#3</td> </tr> </table> <p style="text-align: center;">(M6-8 + M3-5 + m3-1 + M2-4)</p>	A4	Bd4/Bb#4	G4	F#4	E4	F#4	C4	Bd3/Bb#3	<table style="margin-left: auto; margin-right: auto;"> <tr> <td>G4</td> <td>F4</td> </tr> <tr> <td>E4</td> <td>F4</td> </tr> <tr> <td>C4</td> <td>Bd3/Bb#3</td> </tr> <tr> <td>A3</td> <td>Bd3/Bb#3</td> </tr> </table> <p style="text-align: center;">(m7-5 + m3-1 + M3-5 + m3-1)</p>	G4	F4	E4	F4	C4	Bd3/Bb#3	A3	Bd3/Bb#3
A4	Bd4/Bb#4																
G4	F#4																
E4	F#4																
C4	Bd3/Bb#3																
G4	F4																
E4	F4																
C4	Bd3/Bb#3																
A3	Bd3/Bb#3																

Located within the nearer Ab-B portion of the circle, the unstable sonorities of these cadences give the best 17-WT approximations of 14:18:21:24 and 12:14:18:21. More generally, as Secor remarked to me in an early letter, an equable cadence like this “has a very satisfying sound, every bit as effective” as a standard 14th-century European intensive or remissive formula.<sup>53</sup>

On C or degree 7, we have neutral cadences with a somewhat “omnitonal” affinity, at least to my ears, as in this three-voice formula using the same categories of resolutions as our remissive-like example on degree 5, neutral third to fifth (5°17-10°17) and neutral sixth to octave (12°17-17°17):

Bd4/Bb≠4	C5
F≠4	G4
D4	C4

(N6-8 + N3-5)

An exciting four-voice variation introduces the vertical interval of the neutral seventh contracting to a fifth (15°17-10°17), or a neutral second expanding to a fourth (2°17-7°17):

A4	G4	Bd4/Bb≠4	C5
F≠4	G4	A4	G4
D4	C4	F≠4	G4
Bd3/Bb≠3	C4	D4	C4

(N7-5 + N3-1 + N3-1 + N3-1)                      (N6-8 + N3-5 + N3-5 + N2-4)

These examples may suggest some of the rich harmonic possibilities of Zalzal’s scale, with a 17-WT rendition like this D-D transposition giving the Pythagorean intervals of the original JI version a “7-based” flavor and also bringing into play subtle gradations of the neutral intervals. In a “fusion” style including some elements of a 13th-century European approach, a piece might take any of the five stable centers as its primary octave species or “mode,” cadencing on various degrees of this mode as the music progresses, or oscillating between two centers of more or less equal prominence. A vertical outlook more along 14th-century or Ars Nova lines could focus especially on a contrast between degree 6 with its intensive-like equable cadences, and degree 5 with its remissive-like qualities, as primary centers.

These vertical resources, however, should not distract us from appreciating the sheer melodic beauty of the Zalzal modes, which I have explored by playing in a given mode above a simple drone. Much of the beauty of these modes is that

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<sup>53</sup> Personal correspondence, 26 September 2001, writing about the equable progression Ed3-G≠3-C≠4 to D3-A3-D4 (Pythagorean spelling D#3-Ab3-Db4 to D3-A3-D4) and comparing it to the usual 14th-century E3-G#4-C#4 to D3-A3-D4.

they are *not* bound by diatonic European conventions, but have their own musical integrity and logic. The G-G octave species or mode on degree 4 of our D-D transposition in 17-WT, for example, has an effect I find especially majestic which might recall the medieval European Dorian (diatonic D-D, or G-G with Bb), but is at the same time quite different with its neutral steps:

G	A	A#	C	D	E	Gb	G
G	A	Bd	C	D	E	F#	G
0°17	3°17	5°17	7°17	10°17	13°17	15°17	17°17
0	214.44	350.77	492.78	707.22	921.66	1055.14	1200
	3°17	2°17	2°17	3°17	3°17	2°17	2°17
	214.44	136.33	142.01	214.44	214.44	133.48	144.86

Vertically, a “mixed” cadence in this mode of A3-C4-F#4 to G3-D4-G4 with the small tritone or superfourth of between the upper voices (8°17 in 17-WT) is quite distinct from either the omnitonal manner (A3-C4-F4 to G3-D4-G4) or a mixed manner which seems rather common in 13th-century European music, with a Pythagorean tritone of 729:512 (~611.73 cents) between the upper voices, mapping to 9°17 in 17-WT (A3-C4-F#4 to G3-D4-G4).

Our Zalzal scale features yet other harmonic resources, for example 6:8:9 or 8:9:12 sonorities which may be treated in a Gothic fashion as relatively concordant but unstable, resolving to stable trines or fifths:

G4	A4	A4	Bd4/Bb#4
D4	E4	G4	F#4
C4	A3	D4	Bd3/Bb#3

The first example is a typical 13th-century European progression, while the second gives a similar formula a new color with its melodic neutral seconds and thirds (2°17, 5°17).

In more adventurous neo-medieval styles, such “quintal/quartal” sonorities might be treated as stable concords, along with the full 6:8:9:12 available in a tempered 17-WT version at D4-G4-A4-D5 or G4-C5-D5-G5 (and pure in Zalzal’s original scale). This is the sonority formed by all four hammers or strings by which Pythagorean is said to have discovered the principal ratios of music, including the 2:1 octave, 3:2 fifth, 4:3 fourth, and 9:8 whole-tone.

Similarly, while A3-C4-E4-G4 provides a fine unstable cadential sonority resolving equably to the fifth Bd3/Bb#4-F4, its 17-WT version, as Secor observes, can also serve in appropriate styles as a stable concord near 12:14:18:21, or its subset A3-C4-E4 as a conclusive 6:7:9.

The Zalzal scale, with its history of some 12 centuries, provides one avenue for musics old and new in the 21st century to which musicians coming from Near Eastern and diverse other traditions may contribute.

During the first weeks of our correspondence, George Secor and I also together came upon another kind of 17-WT scale with very deep Near Eastern roots — if not going back quite as far as Zalzal, then at least to the early 11th century and Ibn Sina, as we would discover in due course.

#### 4.2. A symmetrical tetrachord scale: Ibn Sina's soft diatonic

In his second letter to me (18 September 2001), Secor presented a heptatonic scale which he used as the basis for some very effective progressions in a tonal style corresponding to that of 18th-19th century Europe, as discussed in his article:

C	Dd	Eb		F		G	Ad		Bd	C
0°17	2°17	4°17		7°17		10°17	12°17		15°17	17°17
	2°17	2°17		3°17		3°17	2°17		3°17	2°17

At the keyboard, this modification occurred to me, with the seventh degree Bd shifted to Bb, so that the two tetrachords C-F and G-C are symmetrical, sharing the identical pattern of 2°17-2°17-3°17 steps:

C	Dd	Eb		F		G	Ad	Bb		C
0°17	2°17	4°17		7°17		10°17	12°17	14°17		17°17
	2°17	2°17		3°17		3°17	2°17	2°17		3°17

As I wrote (Letter, 29 September 2001), "Somehow the symmetry seems to draw me in, and also the availability of C-Eb-G-Bb as a 12:14:18:21, which might serve as a stable concord in a kind of modal jazz style or the like." On my 17-WT keyboard arrangement, this symmetry takes on a concrete aspect: all notes are conveniently available on the lower manual, with the two tetrachords forming a repeating visual pattern of accidentals (C-C#-Eb-F=G-G#-Bb-C).

In response (Letter, 4 October 2001), he noted that this scale could be defined in JI terms as a subset of a 13-limit tuning he had discussed in earlier letters, with values in cents and consecutive step sizes here added to his tuning ratios:

0	138.57	266.87	498.04	701.96	840.53	968.83	1200
1/1	13/12	7/6	4/3	3/2	13/8	7/4	2/1
	13:12	14:13	8:7	9:8	13:12	14:13	8:7
	138.57	128.30	231.17	203.91	138.57	128.30	231.17

This combines tones from two different harmonic series, with tetrachords of 12:13:14:16. I originally found this one by adding tones (ratios of 13) to the following (septimal) pentatonic scale:

0	266.87	498.04	701.96	968.83	1200
1/1	7/6	4/3	3/2	7/4	2/1
	7:6	8:7	9:8	7:6	8:7
	266.87	231.17	203.91	266.87	231.17



Although my first reaction to the symmetrical tetrachord scale was that it “draws me in,” I did not get fully “drawn in” until the end of the year, when Secor suggested to me the term “equable” for resolutions where each voice moves  $2^{\circ}17$  (Section 3.2). Enchanted by this concept, I eagerly canvassed some of my favorite tuning systems for divisions of common neo-medieval minor thirds such as 7:6 into 14:13:12, 13:11 into 13:12:11, and also the “ultraminor” 15:13 into 15:14:13 (approximated in 29-ET as  $0^{\circ}29$ - $3^{\circ}29$ - $6^{\circ}29$ ), finding a range of tempered variations.

From this exciting perspective I looked again at our symmetrical tetrachord scale in 17-WT, and came up with another JI version:

0	128.30	266.87	498.04	701.96	830.25	968.83	1200
1/1	14/13	7/6	4/3	3/2	21/13	7/4	2/1
	14:13	13:12	8:7	9:8	14:13	13:12	8:7
	128.30	138.57	231.17	203.91	128.30	138.57	231.17

Sharing my New Years’ enthusiasm with Secor (Letter, 4 January 2002), I reported my discovery through a search of Manuel Op de Coul’s *Scala* scale archive collection that this tuning was identical to a “soft diatonic” version of the Dorian mode (evidently the Classic Greek rather medieval European mode) given by the famed Persian scholar Ibn Sina (981–1037).

In his reply of 7 January, Secor made a comparison with his own JI version of this 17-WT symmetrical tetrachord scale given in the passage quoted above. The only difference was that while I had “reinvented” Ibn Sina’s millennium-old arithmetic division of 14:13:12, Secor’s division has a harmonic division of 12:13:14, as he notes in the quoted passage describing each tetrachord as a “harmonic series” of 12:13:14:16. In Ibn Sina’s tuning, we have tetrachords in the arithmetic series of 28:26:24:21.

Accordingly, I came to refer to these arithmetic and harmonic JI divisions respectively as the “Ibn Sina variation” and “Secor variation.” On another structural level, as Secor and I discussed, both versions include a harmonic division of the outer 3:4 fourth of the tetrachord into 6:7:8. Secor’s tuning thus has the property of harmonic divisions at both levels (6:7:8, 12:13:14), while Ibn Sina’s arranges the steps of a tetrachord in ascending order of size (14:13-13:12-8:7).

Moving around the 17-WT circle, we can find transpositions of this symmetrical tetrachord scale resembling more or less closely either the Ibn Sina or Secor variation as sizes of neutral seconds and other intervals shift. All of these 17-WT versions, however, differ from either JI variation in one important way.

In our JI versions, the fourth and seventh degrees at 4/3 and 7/4 form a narrow fourth at 21:16 (~470.78 cents), an Archytas’ comma narrower than 4:3, so that there is no 3:2 fifth available above the seventh degree. In 17-WT, however, these steps form tempered perfect fourths and fifths, making available the four “modes” of a seven-note JI version (on degrees 1, 2, 3, 4) plus an extra

mode on degree 7 — a mode with the fifth Bb-F in the C-C transposition we are about to explore.

Here is the C-C scale shown in more detail:

C	C#	Eb	F	G	G#	Bb	C
C	Dd	Eb	F	G	Ad	Bb	C
0°17	2°17	4°17	7°17	10°17	12°17	14°17	17°17
0	144.86	278.34	492.78	707.22	849.23	985.56	1200
	2°17	2°17	3°17	3°17	2°17	2°17	3°17
	144.86	133.48	214.44	214.44	142.01	136.33	214.44

Alternative or “hybrid” fractional spellings reflect my subjective impressions of certain modes and progressions: thus I tend to hear the equable cadence Eb4-G4-C5 to Dd/Db≠4-Ad/Ab≠4-Dd5/Db≠5 as quite “intensive,” and the neutral cadence Dd/Db≠4-F4-Bb4 to C4-G4-C5 as rather “remissive.” One would not necessarily predict these perceptions on the basis of the step sizes alone, and a range of factors could be involved (see also Sections 3.3, 3.5).

This 17-WT transposition features a neutral sixth at Dd4-Bb4 at about 840.703 cents, only about 0.175 cents wide of a pure 8:13 (~840.528 cents). Leaning toward Secor’s harmonic division of 12:13:14 (steps of ~128.30-138.57 cents), the first three degrees at ~0-144.86-133.48 cents happen very closely to approximate the complex harmonic division of 23:25:27 (steps of ~144.35-133.24 cents).<sup>54</sup>

Cadences on C, or degree 1, have at least to my ears a convincing “remissive” quality, as in this three-voice progression with resolutions from neutral third to fifth (5°17-10°17) and neutral sixth to octave (12°17-17°17):

Bb4	C5
F4	G4
Dd4/Db≠4	C4

Melodically, the C-C mode suggests to me the medieval European Phrygian mode (E-E) with its characteristic descending diatonic semitone to the final or note of repose (F-E); the hybrid spelling Db≠4-C4 may communicate a kindred impression. The degree of C can play an important role not only in pieces taking this as a very beautiful primary mode, but as a goal for remissive-like internal cadences in pieces concluding on some other center such as intensive-like Dd/Db≠ or the omnitonal-like Bb.

From a stylistic perspective along 14th-century European lines, the other “strong” center is Dd/Db≠, degree 2, where equable cadences have to my ears a very convincing “intensive” flavor, as in these four-voice progressions with

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<sup>54</sup>In Secor’s terms, this is an isoharmonic ratio with difference tones of 2 between the notes of 23:25 and 25:27, see Section 7.

unstable sonorities near 14:18:21:24 and 12:14:18:21 (the best 17-WT approximations):

C4	Dd4/Db $\neq$ 3	Bb4	Ad4/Ab $\neq$ 4
Bb3	Ad3/Ab $\neq$ 3	G4	Ad4/Ab $\neq$ 4
G3	Ad3/Ab $\neq$ 3	Eb4	Dd4/Db $\neq$ 4
Eb3	Dd3/Db $\neq$ 3	C4	Dd4/Db $\neq$ 4

Melodically, the Dd-Dd mode seems somewhat to resemble a medieval European Lydian (F-F), with the characteristic non-Gothic touch of the small tritone or superfourth Dd/Db $\neq$ -G between the first and fourth steps of this mode at about 562.36 cents, very close to 13:18. In styles following a 14th-century European outlook that intensive cadences are the most conclusive, degree 2 is thus the most compelling primary center of the scale, with degree 1 providing a most satisfying remissive-like contrast for other important cadences (see Section 3.2).<sup>55</sup>

In a style with a vertical approach more along 13th-century European lines, the other cadential centers with a more “gentle” or “omnitonal” quality can also serve very nicely as goals for final or internal cadences. The following cadences on Eb, degree 3, has a fifth preceeding a neutral sixth expanding to an octave:

C5	Dd5/Db $\neq$ 5	Eb5
Ad4/Ab $\neq$ 4		G4
F4		Eb4

This progression charmingly at once evokes and yet subtly differs from an early Gothic progression of minor third to fifth (4°17-10°17) and minor sixth to octave (11°17-17°17); these expanding intervals are each 1°17 larger, and the opening sonority with a fifth split into two neutral thirds (~0-356.45-707.22 cents) also quite distinct from known 13th-century European practice. Curiously, I tend to parse the melodic progression of the upper voice C-Dd-Eb as analogous to

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<sup>55</sup>In his first remarks to me (Letter, 4 October 2001) on this scale, Secor remarked, “I think that if you’re going to use this in a medieval style, you’ll probably want to change the 7th degree from 14° to 15° for cadences.” That is, in the kind of 14th-century or late medieval style we had been discussing in our correspondence, one might predict that more convincing cadences to degree 1 or C could be obtained by raising the 7th degree Bb to Bd — and likewise the 4th degree F to F $\neq$  — thus obtaining what we would come to call an equable progression such as Dd4-F $\neq$ 4-Bd4 to C4-G4-C5, with major third expanding to fifth (6°17-10°17) and major sixth to octave (13°17-17°17). In the unaltered scale, such cadences uniquely occur on degree 2. As it happens, although one would hardly predict this based on the interval categories, unaltered cadences on degree 1 have a satisfyingly remissive quality in such a style, e.g. Dd4-F4-Bb4 to C4-G4-C5, while the altered equable formula Dd4-F $\neq$ 4-Bd4 to C4-G4-C5 has also a “remissive-type” of flavor, so that these forms might seem like two “colorings” of the “same” basic progression.

something like E-F-G, with a “semitone” followed by a “whole-tone,” although C-Dd is actually a larger  $2^{\circ}17'$  step than Dd-Eb.

Melodically, the Eb-Eb mode or octave species suggests to me the Mixolydian of medieval Europe (G-G), one of my favorites to play above a drone.

On F, degree 4, we have available omnitonal cadences with thirds and sixths near 7-based ratios:

Eb4	F4	Bb4	C5
Bb3	C4	G4	F4
G3	F3	Eb4	F4
(m6-8 + m3-5)		(M3-1 + m3-5)	

This mode might have some affinity to a medieval European octave species of A-A, or D-D with Bb, evidently regarded in that era as a variation on Dorian and recognized in the 16th century as a distinct Aeolian mode. Here the sixth step above the final F, Dd, forms an interval of about 852.08 cents, almost identical to 18:11 (~852.59 cents), giving this mode its own distinct character vis-a-vis such Gothic or Renaissance scales.

Cadences on step 7, Bb, may sometimes also take a gentle omnitonal form, as in this progression with resolutions of major third to unison and minor third to fifth, with an unstable sonority of the near-6:7:9 type:

G4	F4
Eb4	F4
C4	Bb3

However, a more dramatically tense form is also available where a striking outer interval of a neutral seventh (Ad3-G4) contracts to a fifth ( $15^{\circ}17' - 10^{\circ}17'$ ), with the unstable sonority also including the altered fifth Ad3-Eb4 at  $9^{\circ}17'$ :

G4	F4
Eb4	F4
C4	Bb3
Ad3/Ab $\neq$ 3	Bb3

Melodically, the Bb-Bb mode might somewhat resemble the medieval European Dorian at D-D with a major sixth of D-B, or here Bb-G.

While this presentation has attempted to cover a few points of melody and harmony, a fuller study of this symmetrical tetrachord scale both in 17-WT and in other tuning systems might focus also on the dimension of discant or counterpoint with its patterns of interweaving melodic lines. Some notable suspension idioms are discussed later on (Section 8).

To illustrate the range of cadential expression offered by this scale, I might conclude with two variations on the three-voice remissive-like progression to C

given above, Dd4-F4-Bb4 to C4-G4-C5. The first is a four-voice cadence with the added element of a neutral second between the upper voices resolving to a fourth (2°17-7°17):

Bb4	C5
Ad4/Ab#4	G4
F4	G4
Dd4/Db#4	C4

(N6-8 + N3-5 + N3-1 + N2-4)

From a certain neo-medieval perspective, this type of progression adds another fine gradation to the already subtle concord/discord theory found in some 13th-14th century sources: the vertical 2°17 might be considered somewhat more tense than a whole-tone (3°17), but less tense than a diatonic semitone (1°17). In any event, I find this a very rich and effective cadence.

The second variation grows out of an early suggestion by Secor (Letter, 4 October 2001, see n. 55 above) that one might alter the seventh degree Bb to Bd when making a cadence on C. Likewise we can alter F to F#, for an equable progression of Dd4-F#4-Bd4 to C4-G4-C5 with major third and sixth before fifth and octave. On trying this, I find that the altered version seems to have the same general “remissive-like” affinity as the unaltered Dd4-F4-Bb4 to C4-G4-C5, a conclusion leading me to the experiment of combining the two alternatives, as it were:

Bb4	Bd4	C5
F4	F#4	G4
Dd4		C4

The upper voices open at the neutral third and sixth, and then move move up together by 1°17 to the major third and sixth above the stationary lower voice, then resolving to fifth and octave. The effect, at least to my ears, is one of “enharmonic drift” between two “colors” of the same basic progression with its remissive-like meaning. On this type of “sliding in thirddtones,” which I find a most expressive resource in 17-WT and similar systems, see Section 5.5.

#### 4.2. A Pelog-like pentatonic

To illustrate the many types of scale structures old and new supported within 17-WT, I give the example of an exquisite “pelog-like” pentatonic quite similar to a JI scale of Lou Harrison<sup>56</sup>:

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<sup>56</sup>Harrison’s scale is 1/1-28/27-4/3-3/2-14/9-2/1, ~0-62.96-498.04-701.96-764.92-1200 cents, and appears in Manuel Op de Coul’s *Scala* scale archive files.

E	F	G		B	C	E
0	63.90	278.34		707.22	771.12	1200
	63.90	214.44	428.88	63.90	428.88	

This version approximates a JI scale of 1/1-28/27-7/6-3/2-14/9-2/1, or about 0-62.96-266.87-701.96-764.92-1200 cents, and differs from Harrison's basic arrangement only in placing the third step at 7/6 instead of 4/3. In an improvisation or composition, it might be very interesting to oscillate between these two patterns, with Harrison's having this E-E realization in 17-WT:

E	F		A	B	C	E
0	63.90		492.78	707.22	771.12	1200
	63.90	428.88		214.44	63.90	428.88

Like either JI variation, the 17-WT versions resemble the pelog of Balinese or Javanese gamelan and also some Japanese pentatonics more in the contrast between semitone-like and major-third-like steps than in the intonational details. This contrast is accentuated by the use of 27:28 semitones and 7:9 major thirds, or their 17-WT equivalents at 1°17 and 6°17. The JI versions also include an 8:9 step (between the second and third steps in my version, or the third and fourth in Harrison's), here realized as 3°17.

The first or E-F-G-B-C-E version includes a conventional Gothic cadence on F in the intensive manner:

E4	F4
B3	C4
G3	F3

This scale also invites some beautiful progressions involving relatively concordant sonorities such as 8:9:12 or 4:6:9 of a kind found in Gothic Europe and in other traditions favoring fifths and fourths such as Japanese koto music:

		G4	B4	G4	B4
C4	E4	F4	E4	F4	E4
G3	B3	C4	E4	C4	B3
F3	E3	F3	E3	F3	E3

Melodically, the motion of each part by a large major third or compact semitone brings out the special qualities of this scale, while the descending semitones might suggest either pelog or a medieval European Phrygian.

Harrison's scale, in its just or 17-WT version, permits a Gothic-type remissive cadence to E with stepwise motion in all parts, or with the gesture of an ascending major third in the highest voice leading to a complete trine:

C4	B3	C4	E4
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A3	B3	A3	B3
F3	E3	F3	E3

A three-voice Gothic cadence to F involving an 8:9:12 sonority is also available, with related forms featuring sonorities such as 4:6:9 or 6:8:9:12, with each voice ascending by a semitone or descending by a major third:

E4	F4	B4	C5	E5	C4
B3	C4	E4	F4	B4	C4
A3	F3	A3	F3	A4	F4
				E4	F4

As Secor remarks in another connection (Letter, 4 October 2001), the opening sonorities of these progressions “are essentially fourth-chords” of a kind much favored in 20th-century European and related musics also, giving an overall impression of relative concord while in a Gothic or conventional neo-medieval style maintaining a considerable degree of tension or complexity by comparison with a 2:3:4 trine or fifth.

These scales also invite slow and sustained counterpoint of a kind heard in gamelan music, as well as the rapid figures and ornaments which enliven this tradition, or drone-based techniques, which might alternate with harmonic progressions such as the above in three or more voices.

As our brief survey of some “neo-medieval fusion” styles may have suggested, 17-WT is not a substitute for the diverse tuning systems of a host of world musics and cultures, but offers an intonational meeting ground for many of these currents. With Zalzal, or the symmetrical tetrachord scale given in JI versions by Ibn Sina (28:26:24:21) and Secor (12:13:14:16), 17-WT provides reasonably close and sometimes virtually just approximations, with intermediate or neutral intervals based on ratios of 11 or 13 often taking center stage, and cadences using these intervals as melodic or harmonic elements weaving together medieval Near Eastern and Gothic threads in a 21st-century tapestry.

With the pelog-like pentatonic scales in 7-based JI or 17-WT, the resemblance to Javanese or Balinese gamelan is more generic than intonationally specific, accentuating the contrast between large major third and small semitone steps, and inviting an imaginative fusion of traditional gamelan and Gothic elements.