Julien Jalâl Ed-Dine Weiss: A Novel Proposal for the Middle Eastern *Qānūn*

Stefan Pohlit

INTRODUCTION

The Arab zither *qānūn*, with its abundant supply of pitches, is the most complex instrument in contemporary musical practice of the Middle East. In the Arab world—where all lutes with fixed frets have disappeared from use in traditional music—the *qānūn* provides a principal basis for the location of pitches and scales. As on the pedal harp, the arrangement of strings on the *qānūn* resembles a heptatonic scale. The invention of movable bridges next to each course of strings in the first half of the 20th century enabled *qānūn* players to fine-tune their strings to produce reliable interval sizes during performance. In Turkey, these levers are called *mandal*-s, in the Arab world *orab*-s.

Most Arab *qānūn*-s now incorporate a fundamental scale tuning of 24 "quarter tones"[1] per octave, some of them containing an additional bridge for the larger semitone of *maqām ḥiĝāz*. Prior to the 1990s, there also existed an instrument with ten *mandal*-s, specifically built for the local tradition of Aleppo, Syria (Weiss 2009–11). The more complicated modern Turkish system divides each semitone into six different microtones and thus uses a 72-note scale that closely resembles the Byzantine tuning system after the reform of Chrysanthos[2].

Current models of the *qānūn* reduce the traditional pitch inventory of Middle Eastern music by employing Western equal temperament rather than the just ratios of the theoretical tradition. A fundamental scale based on 12-semitone equal temperament results in

[1] Throughout this paper, the term "quarter tone" is written in quotation marks when it relates to a pitch located roughly half way between two semitones, such as in the context of Arab performance practice.
[2] In his treatise, *Theoritikon Mega* (1881), Chrysanthos of Madytos simplified the modal system and the notation of Byzantine music. The octave was divided into a 72-step gamut (Giannelos 1996, 24) that is still being used for the theoretical description of the Byzantine modes (Karas 1989).

transformations of the intonation and structure of important *maqāmāt*[3]. Furthermore, it affects the *qānūn*'s resonance: as all strings on the *qānūn* remain constantly undamped, the vibrations produced during performance may cause beating across the instrument's whole range. The *qānūn*'s intonation may also differ to an audible extent from that of a justly tuned *tanbūr* (the Ottoman long-necked lute) or from that of fretless instruments, such as the *'ūd* (the Arab lute) and the *nāy* (the open reed flute).

The heptatonic framework may be tuned by ear to produce Pythagorean interval sizes. In this case—which Weiss (2004) defines as "unequal Pythagorean temperament"—performers tune the strings by means of just intonation whereas the tuning of the *mandal*-s remains based on equal temperament. The difference of roughly two cents (subsequently abbreviated by the ¢ symbol) between an equal tempered and a harmonic fifth, however, multiplies with every further step in this procedure. Musicians have responded to this defect by basing the tuning on different fundamentals (such as basing the scale of *'aĝam* either on C or on B-flat) and staying within the reach of only a few modulations. On the other hand, this method also replaces certain theoretical ratios by approximations.

In general performance practice, the *qānūn* often doubles melodic progressions in its lower octaves due to its usual range of three octaves and a fifth. Most Turkish *qānūn*-s, however, do not permit precise octave duplication for all microtonal pitches: different registers do not have the same number of *mandal*-s, and registers that only have eight instead of 12 *mandal*-s simply divide the equal-tempered semitone of 100¢ according to microtonal steps of different size. Few performers can afford customized instruments with a more specified tuning, and Turkish *qānūn* players have agreed on 72-note equal temperament as their standard system (Beşiroğlu 2011).

3 Plural of *maqām*.

JULIEN JALÂL ED-DINE WEISS

Julien Jalâl Ed-Dine Weiss (b. 1953, Paris, France) started his musical career as a classical guitar player in Paris. In the early 1980s, fascinated by the intellectual dimensions of the Arab theoretical tradition, he moved to the Middle East and became a disciple of famous masters in various countries. As an Occidental convert to the *maqām* tradition, he gained broad recognition as a qanun player, founding [or and founded] one of today's foremost exponents of maqam music on the international stage, the Al-Kindi Ensemble. Since his early studies, Weiss felt dissatisfied with the tuning practices that he encountered among his fellow Arab and Turkish musicians. Whereas performers used to tune their instruments by means of equal-tempered electronic devices, Weiss wished to recreate the intervallic ratios that he found described in ancient and modern treatises.

Like the French scholar of Hindustani music Alain Daniélou, Weiss has often regretted the hybridization of distinct traditions with their local customs and styles (Weiss 2009–11). Intonation in Middle Eastern music can vary substantially from one regional context to another. As a traveling artist, Weiss has been accustomed to performing with musicians from different backgrounds who would often disagree with the tuning preferences of other local traditions. In gradually extending the *qānūn*'s pitch inventory, Weiss finally constructed a *qānūn* that would both honor the characteristics of diverse local contexts and create a basis for transnational agreement among the members of the Al-Kindi ensemble.

Having completed the process of calculation and construction by 1990, Weiss commissioned the Izmir-based instrument maker Ejder Güleç to build the first of several prototypes. The eighth (Q8) and ninth (Q9) of Weiss's prototypes constitute the most advanced *qānūn* tuning systems that have ever been built and also extend the instrument's usual range by an additional octave in the low register. In 2005, Weiss moved to Istanbul and, since that time, has owned both a historic Mamlouk mansion in the city of Aleppo and an apartment in Galata. Considering his work in Aleppo as more or less complete, he conceived Q9 as a variation of the previous eight models that specifically addresses Ottoman-Turkish practice. He commissioned Kenan Özten of Istanbul to build Q9 in 2007.

THE *QĀNŪN*'S PITCH INVENTORY IN THEORY AND PRACTICE

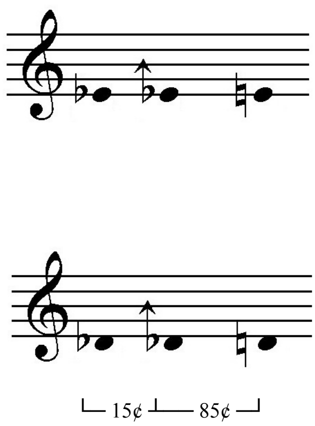
Discussion of traditional tuning in Middle Eastern music is extremely difficult due to considerable discrepancies between theory and practice. The great treatises of the 'Abbāsid era must have stood in firm conflict with the empirical methods of practical musicians (Wright 2005, 226; d'Erlanger 2001-V, 6; Chabrier 2001, 270). To judge from observations by d'Erlanger (2001-V, x) and Scott Marcus (1993, 40), it would seem evident that 20th-century performers have always been faced with the challenge of creating an applied theory of interval sizes in order to handle the conflicts between arithmetic calculation and oral transmission. Marcus defines this approach as a "meta-theory" because it shows how performers try to reconcile the postulations of written treatises with their practical experience.

The Tempered Semitone

The tempered semitone of 100¢, for example, is irrelevant to the context of Middle Eastern modes. The Pythagorean tradition on which these scales are founded prescribes a clear distinction between a minor semitone (*leimma*) and a major semitone (*apotome*). The size of the *leimma* corresponds, with 90.23¢, to the ratio 256/243—the difference between a Pythagorean major third (81/64) and a perfect fourth (4/3). The Pythagorean *apotome*, with 113.69¢, corresponds to the ratio 2187/2048, which is the difference between a major second 9/8 and a *leimma*. Medieval theorists, such as al-Farābī in his *Kitāb al-Kabīr* (d'Erlanger 2001-I), based the hepatonic framework of their gamuts on Pythagorean tuning (During 1985, 80). In addition, harmonic ratios were introduced to represent the "quarter tone" steps that referred to the influential early-'Abbāsid lutenist, Manṣūr Zalzal al-Ḍārib (d. 791) (Farmer 2001, 118). In this manner, theorists combined two methods: although in Pythagorean tuning they derived the ratios of all intervals from powers of two and three, they deduced the additional interval sizes from superparticular ratios corresponding to successive partials in the harmonic series.

In addition, the *apotome* may be deduced from a simpler, harmonic ratio, thus corresponding to the superparticular fraction of 16/15—the difference between a harmonic third 5/4 (386.31¢) and a perfect fourth 4/3 (498.05¢)—which equates to 111.73¢. As the second note in the *ḥiĝāz* genus should be pitched higher than in genre *kurdī*, some professional Arab *qānūn* models prior to the 1970s have included an additional lever to produce a supplementary, higher "flat" position. Consequently, they dispose of six interval sizes per string. While the distribution of *mandal*-s on such *qānūn*-s maintains the tempered semitone as a default value, the lower "flat" position is always located at the distance of 100¢ underneath the "natural" position. As shown in Figure 1, the roughly 15¢ between the lower and the raised "flat" positions produce an approximated *apotome* in equal tempered tuning, as the distance between, e.g., C-natural and this additional *mandal* position on D is, accordingly, 115¢.

Figure 1. Average tuning of the additional *mandal* on the extended arab *Qānūn*.



The heptatonic framework may be tuned according to Pythagorean ratios. Some Arab *qānūn* players continued to tune their instruments in this manner until the 1980s. More recently, the use of digital tuning devices has led to the disappearance of such customary tuning in favor of equal temperament (Weiss 2009–11). As the distance between the *mandal*-s remains fixed on all string courses, the interval sizes vary depending on which fundamental is chosen. This choice is taken in favor of the interval sizes that are required for the interpretation of a specific set of *maqāmāt*. Typically, the framework may be tuned to the scale of *maqām ʻaĝam* (which corresponds to the Western major scale) and either be based on C-natural or on B-flat (Weiss 2009–11). Figures 2 and 3 show the interval sizes of minor and major seconds and thirds relative to C-natural in *ʻaĝam* C and B-flat tuning. Within the first three string courses, the two alternatives only differ in regard to the thirds that they produce relative to C.

As described by Marcus, twelve semitone equal temperament often appears as a standard reference in contemporary contexts, even though it may sound confusing to state that "the" note E-flat "would be raised slightly" (Marcus 1993, 44). Both in theory and practice there exist, due to the Pythagorean, i.e. integer-ratio basis of even the earliest sources, two distinct E-flats—not only one, as suggested by a piano keyboard.

Neutral Seconds and Thirds

The Arab and Turkish traditions disagree about the intonation of the even more characteristic "neutral" scale degrees: *segāh*, *ʻawĝ*, and their octave equivalents. The discussion of these notes has remained unresolved since the Congress of Cairo in 1932 (d'Erlanger 2001-V, 12). Theory and practice in the Arab world define the third between the notes *rāst* and *segāh* as a "neutral" interval similar to a quarter tone. Since the Arel-Ezgi-Uzdilek (AEU) system was formulated in Turkey during the 1930s as an extension of the

Figure 2. Minor and major seconds and thirds on the extended Arab *Qānūn*, based on C.

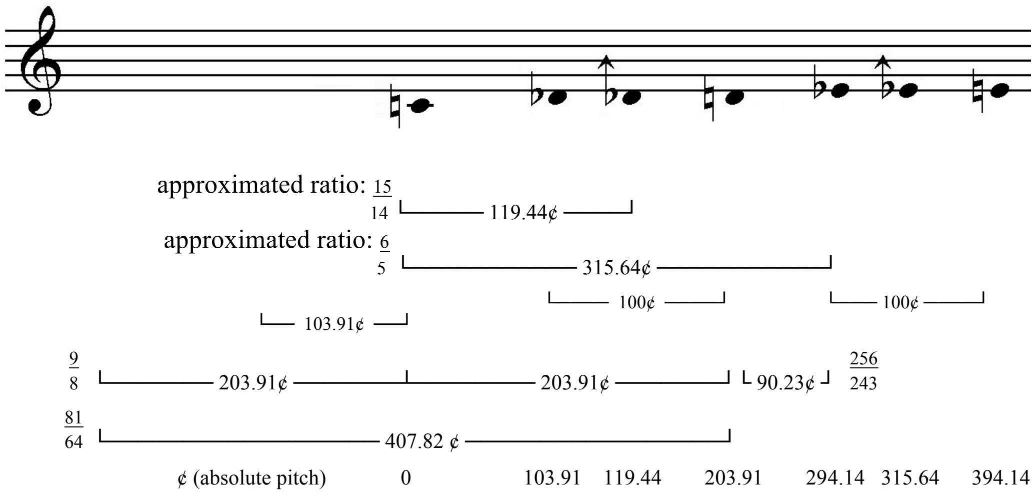
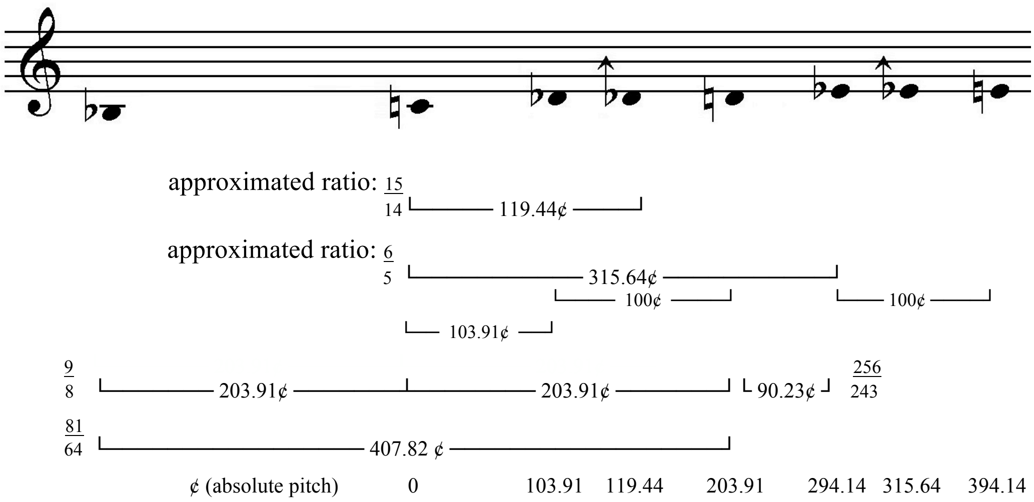


Figure 3. Minor and major seconds and thirds on the Extended Arab *Qānūn*, based on B-flat.



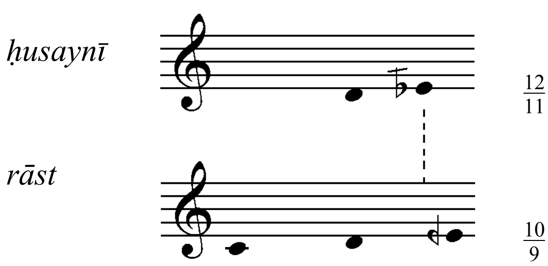
strictly Pythagorean system of Ṣafīyy al-Dīn (ṢD), Turkish standard theory defines this interval by means of the complex Pythagorean ratio 8192/6561 that, with 384.36¢, is almost identical with the interval of the harmonic third 5/4 (386.31¢)[4]. In this high intonation, the

[4] The first attempts at a revised theory that would reconcile the tradition with Westernizing tendencies was laid out by Raûf Yektâ in 1921 (Feldman 1996, 205; Ayangil 2008, 423), extending Ṣafīyy al-Dīn's 17-note scale to 24 pitches per octave and introducing a modified form of Western staff notation. Hüseyin Sadettin Arel was appointed head of the Conservatory for Turkish Music of Istanbul (then *Dar-ül el-Han*) in 1943 (Ak 2002, 162). Arel's theoretical efforts began during the 1920s (Arel 1964) and were concretized in collaboration with Suphi Ezgi during the 1930s while Ezgi directed the scientific committee of national culture (Ayangil 2008, 425).

note *segāh* differs by only one Pythagorean *comma* (i.e., (81/64) / (8192/6561) = 531441/524288 or 23.46¢) from the next higher note, *būselik*, which is traditionally conceived as a Pythagorean third (81/64 or 407.82¢) over *rāst*. D'Erlanger suggested that the main reason for this general disagreement originated in the collision of the *maqāmāt ḥusaynī* and *rāst*. The note *segāh* in *ḥusaynī* should be tuned by means of the harmonic quarter tone 12/11 (150.64¢) above the note *dugāh*. In *maqām rāst*, the third, although being labeled under the same name (*segāh*), should be tuned about 32¢ higher and thus correspond with the minor wholetone 10/9 (182.4¢), as shown in Figure 4.

In practice, on the other hand, Arabs tune the note *segāh* in all contexts as a "quarter tone" while Turks tune it as a minor semitone (either as Pythagorean, i.e. 65536/59049 or 180.45¢, or as superparticular ratio, i.e. 10/9 or 182.40¢). The same mismatch also occurs in the interpretation of the historical Ottoman repertoire that developed as a revivalist movement after the discovery of Bobowski's *maĝmū'ah* in the early 1970s (Ayangil 2011, Elçin 1976). Whereas Turkish musicians normally perform these compositions using Arel-Ezgi-Uzdilek's neo-Systematist scale (Arel 1993, Özkan 2006, Öztuna 1969), the Ottoman tuning system of the 17th century must have resembled contemporary Arab, not Turkish customs, and therefore must have included quarter tones (Feldman 1996, 206–07). This discrepancy already figures in the 17-note scale of Ṣāfīyy al-Dīn from the 13th century. Contrary to the (false) claim by Ṣāfīyy al-Dīn himself, the fretting of his lute did not permit the performance of the

Figure 4. *Segāh* in *Ḥusaynī* and *Rāst*.



characteristic “neutral” scale steps obtained from al-Farābī’s fundamental scale (d’Erlanger 2001-III, 116, Figure 73). Compared to each other, the lute systems of al-Farābi (10th century), Ibn Sīna (11th century), and Ṣāfīyy al-Dīn propose three different approaches to the intonation of “neutral” seconds and thirds, as seen in Table 1.

In his *Šarafīyyah*, Ṣāfīyy al-Dīn introduced two distinct divisions and names for the fret that he labeled as “W”: First, he described it as “*Zalzal*” (8192/6561), then as “Persian” (72/59) medius (d’Erlanger 2001-III, 115). Table 73 on the subsequent page of d’Erlanger’s edition (2001-III, 116) defines al-Farābī’s slightly higher ratio 27/22 (354.55¢) again as the *Zalzal* medius. This pair of thirds rose upwards in the course of Ṣāfīyy al-Dīn’s complicated formulation, while his nomenclature created an important confusion in regard to the older treatises: Ṣāfīyy al-Dīn’s Persian medius *wusṭā’ al-furs*, (*wf*) is practically identical with Ibn Sīna’s and almost identical with al-Farābī’s *Zalzal* medius *wusṭā’ Zalzal* (*wZ*). This noticeable

Table 1. Ṣāfīyy al-Dīn’s “neutral” scale steps in comparison with al-Farābī and Ibn Sīna.

FA		SD			IS	
(d’Erlanger 2001-I, 46)		(d’Erlanger 2001-III, 220–33)			(d’Erlanger 2001-II, 234)	
ratio	¢	ratio	¢		ratio	¢
		$\frac{16384}{14735}$	183.65		–	
$\frac{54}{49}$	168.21					
		$\frac{4609}{4235}$	146.51		–	
$\frac{162}{149}$	144.82					
		$\frac{64}{59}$	140.83		$\frac{13}{12}$	138.57
- - -	- - -	- - -	- - -	- - -	- - -	- - -
		$\frac{8192}{6561}$	384.36			
$\frac{27}{22}$	354.55					
		$\frac{72}{59}$	344.74	↔	$\frac{39}{32}$	342.48
$\frac{81}{68}$	302.87					
					$\frac{32}{27}$	294.14

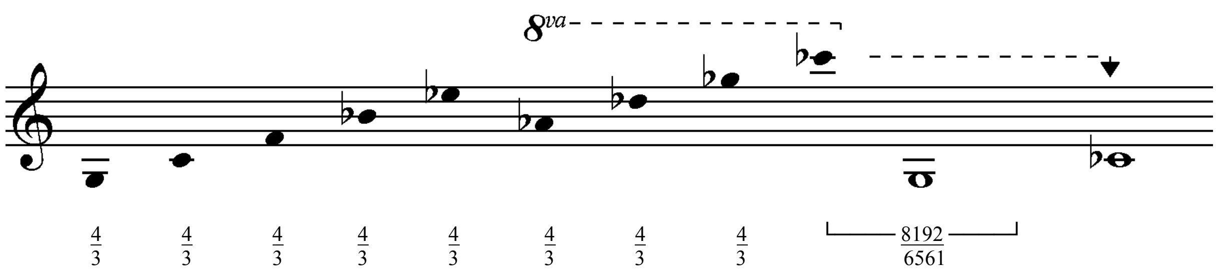
change in denomination involves a considerable rise of the characteristic thirds *wf* and *wZ*. Whether observed in practice or merely introduced as a theoretical artifice, this change emerged as the most significant controversy on tuning in the Middle Eastern tradition. For the first time in a written source, the note that today is known as *segāh* appeared only one Pythagorean *comma* below the Pythagorean major third (see Table 2).

Another question arises from the large integers in the fraction (8192/6561) that Ṣāfīyy al-Dīn's systematic approach postulates for *wZ*. If it has to be calculated, why should it not be formulated as the acoustically more convincing harmonic third (5/4 = 386.31¢) that would differ by only a *schisma* (1.95¢)? According to a strictly Pythagorean calculation, this interval should correctly be labeled as C-flat (relative to G) or F-flat (relative to C), as shown in Figure 5.

Table 2. Comparison of *wf* and *wZ* in FA, IS, and ṢD.

	FA		IS				ṢD	
					↗	**"*wZ*"**	$\frac{8192}{6561}$	384.36¢
wZ	$\frac{27}{22}$	354.55¢	$\frac{39}{32}$	342.48¢		**"*wf*"**	$\frac{72}{59}$	344.74¢
wf	$\frac{81}{68}$	302.86¢	$\frac{32}{27}$	294.13¢	↗			

Figure 5. Ṣāfīyy al-Dīn's Pythagorean calculation of *Segāh*, based on G.



The modern Turkish systems of Raûf Yektâ (d'Erlanger 2001-V, 27) and Arel-Ezgi-Uzdilek (Signell 2006, 41, 44–45; Özkan 2006, 38; 62), however, place it at the position of a third, as B minus a *comma* (relative to G) or E minus a *comma* (relative to C). Among the more widely discussed modern theorists, only Mustafa Ekrem Karadeniz (1985, 10–15) replaced this diminished fourth with the harmonic ratio 5/4.

THE 1932 CONGRESS OF CAIRO

To judge from Ottoman sources, the extension of the fundamental scale from 17 to 24 notes per octave must have been completed by the middle of the 19th century (Popescu-Judetz 2002, 169–71, Table I). The proposals that were presented at the Congress of Cairo in 1932 reflect the same disagreement observed among al-Farābī, Ibn Sīna, and Ṣāfīyy al-Dīn. Most theorists—including Maurice Collengettes, the Syrian *Mevlevī šeyẖ* ‘Alī al-Darwīš, the Lebanese Miẖā'īl 'Ibn Ĝurĝus Mušāqah, and the Egyptians Manṣūr 'Awaḍ, 'Āmīn al-Dīk Affendī, 'Idrīs Rāġib Bey, and Iskandar Šalfūn—proposed fundamental scales containing "neutral" seconds and thirds, each of them advocating a different method of calculation.

Collengettes based his calculations on recordings of empirical studies. He devised a scale containing the harmonic quarter tone 12/11 (150.64¢) but missing both the minor whole tone 10/9 (182.40¢) and the harmonic third (d'Erlanger 2001-V, 23, Figure 7).

Darwīš, who lived in Aleppo, offered an ultra-Pythagorean approach that seemed to attempt a bridge between Ottoman-Turkish and Arab intonation customs and in which he based all ratios on multiples of octaves and fifths. His system (d'Erlanger 2001-V, 29, Figure 9) results in impractically complex ratios: the "neutral" third (315657/256000 or 362.66¢)—considerably high compared to other Arab theories—was calculated by joining the major whole tone (9/8, 203.91¢) with the Pythagorean *apotome* (2187/2048, 113.68¢) and "half a *leimma*." For this purpose, Darwīš divided the *leimma* (256/243, 90.23¢) into two almost equal parts: 4000/3897 (45.16¢) and 3464/3375 (45.06¢). The first of these ratios is composed of the product of $(2^5) * (5^3) = 4000$ and that of $(3^2) * 433 = 3897$; the second is composed of the product of $(2^3) * 433 = 3464$ and that of $(5^3) * (3^3) = 3375$. In introducing prime numbers five and 433 into his system, Darwīš did not limit his interval ratios to multiples of two and three, and thus diverted from a principal standard of the Pythagorean tuning method. Furthermore, ratios of such complexity do not easily permit tuning on a monochord by means of geometrical construction and may involve cumulative errors. Weiss (2004) suggests that Darwīš could have omitted the complexity of these fractions by dividing the *leimma* into aliquot[5] parts: 512/499, i.e. 44.52¢ and 499/486, i.e. 45.70¢.[6]

Mušāqah obtained interval sizes that closely resemble those of Collengettes as well as those of the ultimate proposal of the Congress (d'Erlanger 2001, 34, Figure 10; 48–50) by dividing a string's length into 3,456 (= 27*128 = $(3^3)*(2^7)$) equal parts. He did not provide ratios of the interval sizes in his system. D'Erlanger (2001-V, 32–33) represented his "neutral" second only according to Mušāqah's own method, at the 3,177th node on an octave spanning over 1,728 divisions (which are half of 3,456). This interval, transformed into cents, amounts to 156.65¢, which is almost exactly six ¢ higher than the harmonic quarter-tone 11/10, i.e. 150.64¢. Weiss included an interval of approximately the same size (128/117, i.e. 155.56¢) in the tuning of his instrument Q9.

'Awaḍ's neutral third and sixth—40/33 (333.04¢) and 60/37 (836.92¢), respectively—are reminiscent of the aliquot division practices of Greek antiquity, but complicate the discussion by postulating intervals that diverge to an even greater extent from historical precedents and regional practices (d'Erlanger 2001-V, 37, Figure 11). His neutral second 40/37 (134.97¢)

[5] In order to be divided into aliquot parts, numerator and denominator of an interval ratio must be multiplied by the same number as that of the desired divider. If, for example, a fourth 4/3 shall be divided into three aliquot parts, its numerator and denominator are both multiplied by three: (4/3) = (12/9). The obtained set of intervals describes an excerpt from a sub-harmonic spectrum, and the denominator of each fraction equates to the numerator of the next one: (4/3) = ((12/11) * (11/10) * (10/9)).

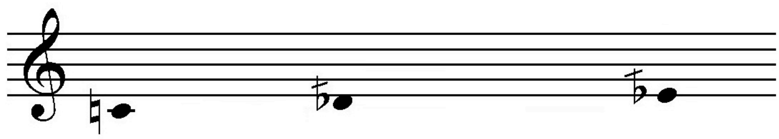
[6] (256/243) = (512/486) = ((512/499) / (499/486))

constitutes the lowest neutral second of all systems from the Congress and is almost identical with Ibn Sīna's simpler ratio 13/12 (138.57¢). The most problematic choice of 'Awaḍ's scale lies in his decision to lower the basic whole tone steps from the major (203.91¢) to the minor whole tone (182.4¢). For that reason his note *būselik* has the same ratio as Ṣāfīyy al-Dīn's and Raûf Yektâ's note *segāh*.

Rāġib and Šalfūn measured their intervals in ¢ values. Their intervals differ slightly from integer ratios, and probably reflect the practical context of their measurements quite well. Whereas Rāġib's "neutral" seconds and thirds seem to originate in the harmonic ratio 11/10 (165.0¢), Šalfūn departed from 12/11 (150.64¢) as a defining ratio for the three-quarter tone.

Collengettes' and 'Āmīn al-Dīk's systems (d'Erlanger 2001-V, 42, Figure 13) agree most closely with the general Arab scale from the conference, in using the harmonic quarter tone 12/11 (150.64¢) and al-Farābī's neutral third 27/22 (354.55¢). In lacking the minor whole tone and the harmonic third, they are, however, not relevant in modern Turkish practice. According to Weiss (2009–11), the Syrian school—represented by the legacy of 'Alī al-Darwīš—continues to define fundamental "neutral" interval sizes midway between the "quarter tone" intonation of the majority of Arab systems and the *comma-* and *leimma*-based Turkish theories. Furthermore, many "neutral" intervals tend to be tuned around 10¢ higher in Aleppo in comparison to the tradition of Damascus (Weiss 2009–11), as seen in Figure 6. Table 3 illustrates how Raûf Yektâ's (RY) note *dik pest hisâr* (65536/59049, i.e. 180.45¢) and 'Awaḍ's low tuned '*Ušayrān* (10/9, i.e. 182.40¢) meet at approximately the same pitch.

Figure 6. Approximate range of quarter-tone pitches in Damascus and Aleppo.



Damascus:	¢	0	155-65	355-65
Aleppo:	¢	0	165-75	365-75

Table 3. Substantial differences among three notes above *Yekgāh* in modern systems.

’Awad		Mušāqah		Collengettes, al-Dīk, Šalfūn		al-Darwīš		Rāġib Bey		RY	
ratio	¢	ratio	¢	ratio	¢	ratio	¢	ratio	¢	ratio	¢
40/37	134.97 ↗	(162)/(149)	144.82 ↗	12/11	150.64	35073/32000	158.75 ↗	54/49	168.21 ↗	65536/59049	180.45 (↗)
10/9	182.4 ↗	9/8	203.91	9/8	203.91	9/8	203.91	9/8	203.91	9/8	203.91
40/33	333.04 ↗	27/22	354.55	27/22	354.55 ↗	315657/256000	362.66 ↗	99/80	368.91 ↗	8192/6561	384.36

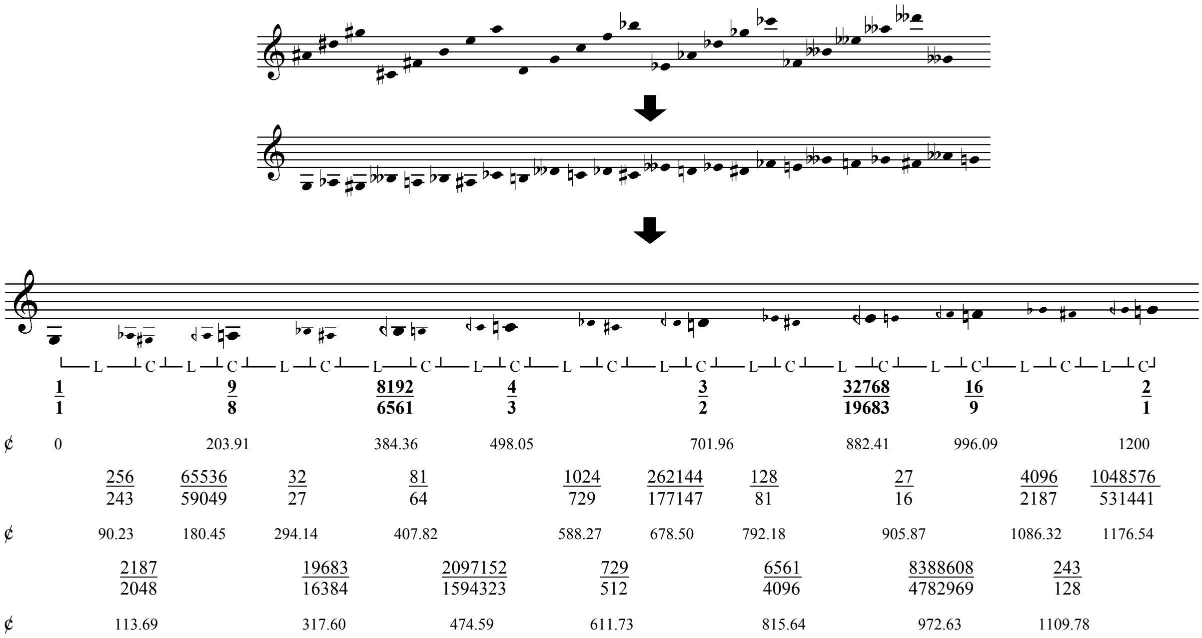
WESTERN STAFF NOTATION IN TURKEY

Raûf Yektâ (d’Erlanger 2001-V, 27, Figure 8) recreated the symmetry of Ṣāfīyy al-Dīn’s strictly Pythagorean approach in a tuning that is solely composed of *leimma*-s and *comma*-s. This system uses the same pitch inventory as the AEU system. Although theorists have normally described its intervals by means of Pythagorean ratios (Signell 2006, 41, 44–45; Özkan 2006, 38, 62; Ayangil 2008, 427), the octave division of its general scale resembles more truthfully that of 53 Holdrian *comma*-s ($\sqrt[53]{2}$, i.e. 22.64¢) which close the open spiral of perfect fourths or fifths to a circle, as Figure 7 demonstrates.

The AEU system, in revising Raûf Yektâ’s Western staff notation, adopts a similar approach in defining the note *‘irāq* by means of the Pythagorean ratio 8192/6561 ($2^{13}/3^{8}$, i.e. 384.36¢) from above *yekgāh*. It is written as a third although, in a strictly Pythagorean context, it should normally be regarded as a diminished fourth. Raûf Yektâ (1921, Ayangil 2008, 423) notated the note *segāh*—due to its status as a main note of the fundamental scale—without alteration signs. Arel-Ezgi-Uzdilek, in their closer adherence to Western staff notation, represented it with the reversed “*koma bemolü*” (Turkish) (Özkan 2006, 62), as shown in Figure 8.

In his approach, Weiss uses this symbol for indicating the syntonic *comma* (81/80, 21.51¢). He therefore defines his “Turkish *segāh*” explicitly as a harmonic third 5/4 that is wider than Raûf Yektâ's and Arel-Ezgi-Uzdilek's Pythagorean interval by the distance of the *schisma* (1.95¢), as seen in Figure 9.

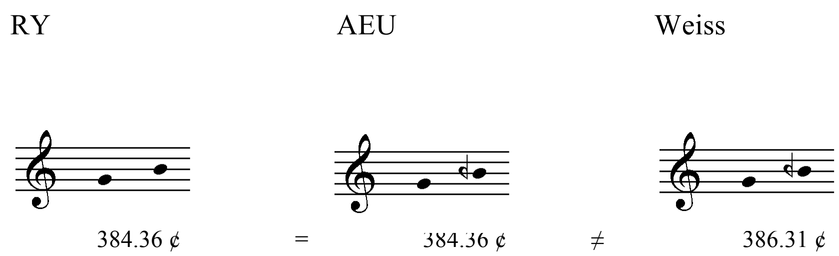
Figure 7. Derivation of Raûf Yektâ's 24-note System from powers of two and multiples of three.



L: *leimma* (≈ 4 *comma*-s)
C: *comma*
L + C = *apotome*

Figure 8. AEU notation: *Koma Bemolü*.

Figure 9. Comparison of *comma* notation in RY, AEU, and Weiss.



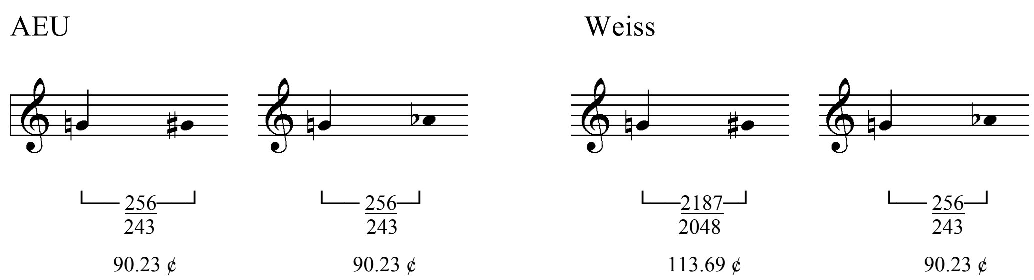
NOTATIONAL CONVENTIONS

The dilemma of Raûf Yektâ's and Arel-Ezgi-Uzdilek's diminished fourth that is notated as a third shows that their pitch inventory is limited even in comparison with the Western tuning system to which they refer. Yalçın Tura pointed out this problem by indicating the number of alteration signs required by a potentially endless spiral of fifths. For Western pitch notation, he counted 20 different pitches on a column of perfect fifths from C-natural to B double -sharp and 16 on a column of perfect fourths from C-natural to F-double-flat, which makes a total of 35 different pitches (Tura 1988b, 128). Tura emphasized that the modern Turkish system was constrained to a framework of twelve pitches on a fifths spine from C-natural to E-sharp and to 13 pitches within a fourth spine from C-natural to D-double-flat. This provides only the known 25 pitches (24 notes) per octave, although a Pythagorean tuning system would provide the potential for more.

AEU notation provides most pitches with two alternative ways of spelling: a note with a sharp sign is equal to the next diatonic step with a flat, apparently creating an analogy with Western enharmonic convention. This, however, conflicts with strictly Pythagorean calculation. Weiss's alteration signs, on the other hand, distinguish between pitches that in Western notation would be enharmonic equivalents.

In Pythagorean tuning, the difference between the G-sharp and the A-flat in Figure 10 would correspond to the Pythagorean *comma* that is correctly included in Weiss's *mandal*-s.

Figure 10. Minor and Major Semitone in Comparison: AEU vs. Weiss.

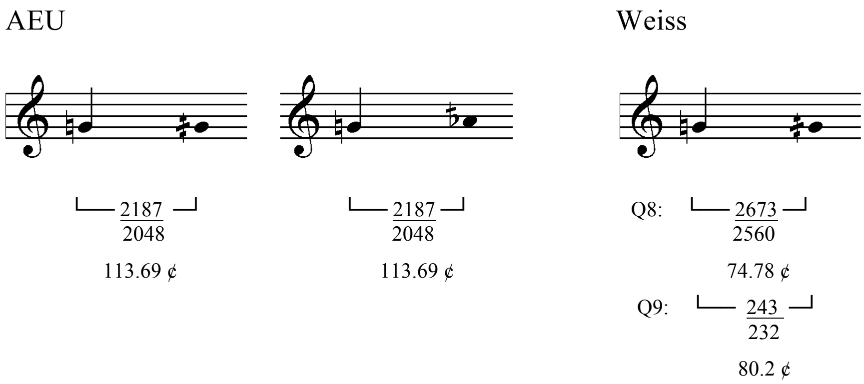


In the AEU system, the distances between G-natural and G-sharp and between G-natural and A-flat—chromatic and diatonic semitones—are the same.

This creates an analogy to the tempered piano in that it does not reflect the original meaning of the Western notational symbols. Since, in general, the modern Turkish system does not substantially differ from the Western pitch inventory, Tura emphatically denounced it as a "deficient copy of the Western system"[7] (1988a, 130). Arel-Ezgi-Uzdilek, on the other hand, introduced a new alteration sign for raising a note by an *apotome*, namely, the triple-sharp symbol (Figure 11). This would not have been necessary if Arel-Ezgi-Uzdilek had employed Western notation in its original Pythagorean framework rather than its tempered signification. In Weiss's *mandal* notation, the triple-sharp figures among the "quarter tone" accidentals and, thus, is employed for a different context.

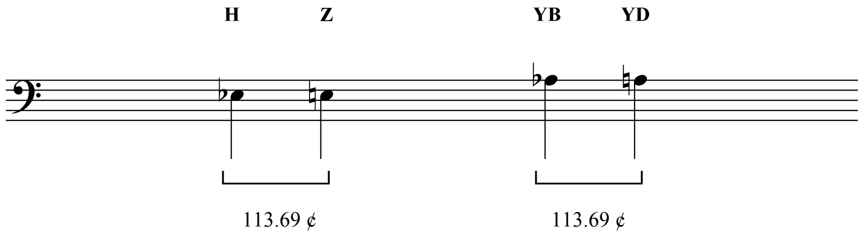
As Figure 12 illustrates, the Pythagorean *apotome* existed on Ṣāfīyy al-Dīn's monochord only as a secondary interval between the Pythagorean minor and major thirds. In a 24-note Systematist tuning such as that of Arel-Ezgi-Uzdilek, the *apotome* is employed as a major semitone relative to any pitch in the system. According to Signell's Stroboconn measurements of the basic interval steps of Turkish music, the *apotome* (*küçük mücenneb*) could vary within

Figure 11. The "triple-sharp" accidental in Arel-Ezgi-Uzdilek's and Weiss's notation.



[7] "eksik bir kopyası."

Figure 12. The Pythagorean *apotome* in ṢD relative to D and G, respectively.



a range from 111 to 117¢, with an average of 112¢ (Signell 2006, 145), which is very close to the size of the harmonic major semitone 16/15 (111.73¢). In Weiss's *mandal* notation there are two distinct kinds of *apotome*-s: the harmonic interval 16/15, produced as a minor second between two adjacent courses of strings, and the Pythagorean *apotome* (2187/2048) that—in contrast to Arel-Ezgi-Uzdilek—Weiss treats in accordance with its mathematical derivation as an augmented prime, produced on one single course of strings at a time.

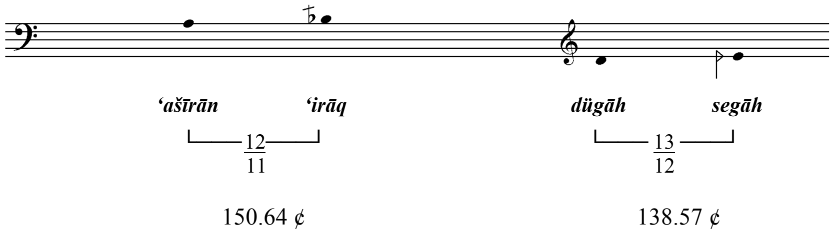
HISTORICAL PERFORMANCE PRACTICE IN TURKEY

Since the 1970s, Turkish musicians have also used Arel-Ezgi-Uzdilek's fundamental scale for interpreting the older Ottoman repertoire. The majority of Turkish theorists in the 20th century—Tura being the main exception—transcribed Prince Dimitrie Cantemir's 17th-century collection (Tura 2001) from later sources and in accordance with the pitch system of Arel-Ezgi-Uzdilek (Feldman 1996, 217–18). According to Eugenia Popescu-Judetz (1999, 66–67), a parallel tradition of Cantemir's compositions developed through oral transmission of pieces that often had not been included in the original compilation. Many of these works are constructed as four-part *pešrew*-s (transliteration from Ottoman Turkish), whereas composers of Cantemir's era still employed the older, tripartite form with one repeated ritornello (1999, 70), the *mülāzime*. Contemporary collections of Turkish music represent these compositions in AEU notation (Popescu-Judetz 1999, Wright 1992).

According to Feldman (1996, 206–213), "neutral" fundamental main notes, such as the note *Segāh*, were not realized at the ratio to which they would be assigned in AEU. Whereas Dimitrie Cantemir, on his 17th century *ṭanbūr*, defined a single fret and a single name for this neutral third (Feldman 1996, 207), contemporary theories usually distinguish three notes in that area. Feldman observed that, in its number (17) and tuning of frets, the 17th century's Ottoman *tanbūr* closely resembled the contemporary Iranian *setar*. He relied on During's recordings of Iranian *dastgāh*s where the modes *šūr* and *homāyūn* have approximately the same pitch in practice and sometimes are even tuned identically (Feldman 1996, 209–10, During 1985, 110–18). Between the notes *būselik* and *kürdī*, Cantemir specified only one fret and one note name—"*segāh*"—for an area that, on the contemporary Turkish *tanbūr*, has four distinct pitches. A modern Turkish *ṭanbūr*, according to the frets on Necdet Yaşar's instrument (Signell 2006, 144–48), also disposes of a different pitch for the note *'uššāq*—which lowers from the adjacent unaltered note by approximately 2.5 *comma*-s.

In accordance with the previous discussion and Feldman's conclusions, Weiss's interpretation of a selection of compositions from Cantemir's *Kitāb-u 'ilm-i l-Musīqī* on the CD "Parfums Ottomans" sounds remarkably "Arab." For that reason, it received mixed reactions among Weiss's colleagues in Turkey (Weiss 2009–11, Ayangil 2011). Weiss tuned the "neutral" intervals by means of ratios handed down in the Arab tradition; in his *maqām bayātī* the distance between the notes *'ašīrān* and *'irāq* amounts to the ratio 12/11 (150.64¢), and the interval *dügāh-segāh* corresponds to the ratio 13/12 (138.57¢)—Ibn Sīna's low tuning of the "neutral" second (Weiss 2006, 14). At a time when Q9 was not yet constructed, Q8 already offered a distinct *mandal* for each of these ratios. Admittedly, this approach exceeds the possibilities of a 17th century's lute on which these pitches would have been played on the same fret, as shown in Figure 13.

Figure 13. Ottoman "*wZ*" notes on Q8.



NECDET YAŞAR'S *ṬANBŪR*

The extended—and most probably, justly tuned—supply of pitches on Necdet Yaşar's *ṭanbūr* marks a decisive step towards Weiss's first instrument, Q1. Yaşar was born in 1930 in the town of Nizip in the district of Gaziantep (southeast Turkey), very close to Syria. Weiss believes that Yaşar's background also let him discover traits of the local tradition of Northern Syria and the city of Aleppo; however, Yaşar was most notably influenced by the legacy of Tanburî Cemil Bey in Istanbul, and it was Cemil's son, Mesut Cemil, who inspired him to learn the *ṭanbūr* at the age of 20. Weiss experimentally recreated the division of the fourth in Yaşar's fretting and adjusted it according to his own "hypothesis of acoustic coherence" (Weiss 2004). This "ultra-Pythagorean" fourth (Weiss ibid.) contains 14 pitches and, thus, constitutes the most sophisticated system developed so far for a fretted lute in the Middle East. It already resembles the respective *mandal*-s on Q1–8, and, for that reason, Weiss's alteration signs represent its interval sizes without major discrepancies. According to Weiss's experimental reconstruction, this scale contains Ibn Sīna's neutral second (note four) next to the note "*uşşâk*" (note five). The distance between the A-flat and the A-natural as well as between the A-natural and the A-sharp on an imaginary *qānūn* would result in the Pythagorean *apotome* (2187/2048), in the same manner as on Q1–8 and Q9, as shown in Figure 14. As such a *qānūn* would need six different positions between A-flat and A-natural, it would include eleven *mandal*-s per string (see Figure 15).

Figure 14. Division of the fourth on Necdet Yaşar's *Tanbūr* (Weiss 2004).

1 2 3 4 5 6 7 8 9 10 11 12 13 14

ratios	256/243	16/15	13/12	128/117	10/9	9/8	32/27	6/5	39/32	16/13	5/4	81/64	4/3
¢	90.23	111.73	138.57	155.56	182.4	203.91	294.13	315.64	342.48	359.47	386.31	407.82	498.04

Figure 15. *Mandal*-s per string on a hypothetical *Qānūn* according to the frets on Necdet Yaşar's *Tanbūr* (Weiss 2004).

0 1 2 3 4 5 6 7 8 9 10 11

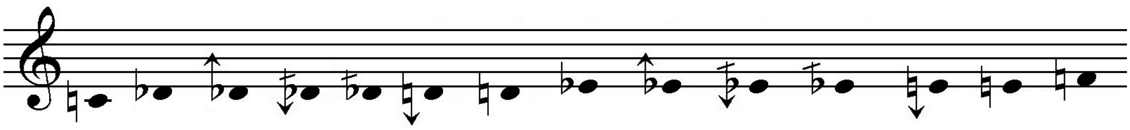
THE *QĀNŪN* OF ALEPPO

Yaşar's *ṭanbūr* scale could be compared to the division of the fourth obtained from the *qānūn* that was specifically built for the tuning practice of Aleppo. This instrument is closely related to the Aleppian *qānūn* player Šukrī Antaqlī, a contemporary of 'Alī al-Darwīš's son, Nadī al-Darwīš, who frequently performed with Sheyḫ Bakrī al-Kurdī during the 1950s (Weiss 2009–11). Antaqlī's *qānūn* was adopted and refined by other instrument-makers (such as 'Alī Wa'ez and Ṣāfīyy Zaynab) and eventually vanished in the 1980s (Weiss 2009–11). It provided eleven pitches on every course of strings. They were arrayed within the distance of two equal tempered semitones. The inner *mandal* positions were tuned by ear according to specific interval sizes. Weiss (2004, 2009–11) explains that this instrument, due to its tuning by means of "unequal Pythagorean temperament," marks the most rational of all *mandal* systems current at the time because it was based on a systematic division of the semitone. The first string of a theoretical lute with frets arranged according to the same tuning would result in the approximate division of the fourth represented in Figures 16 and 17 (Weiss 2004). As on the tempered Arab *qānūn*, the division of the fourth would vary depending on whether performers tuned the instrument in relation to C or B-flat.

STRUCTURE AND INVENTORY OF PITCHES ON WEISS'S *QĀNŪN* MODELS

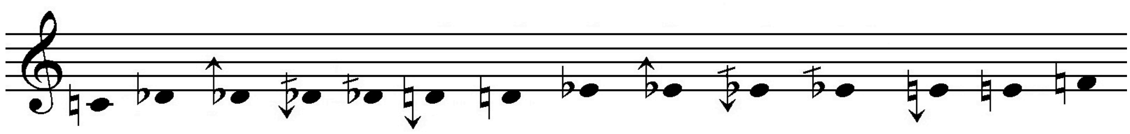
Together with Q1–8, Weiss invented a specific notation system, influenced by a set of Arab, Turkish, and Iranian alteration signs, as seen in Figure 18. Each course of strings spans over twice the Pythagorean *apotome* (2187/2048, 113.69¢).

Figure 16. Frets derived from the *Qānūn* of Aleppo, based on *'aĝam* in C.



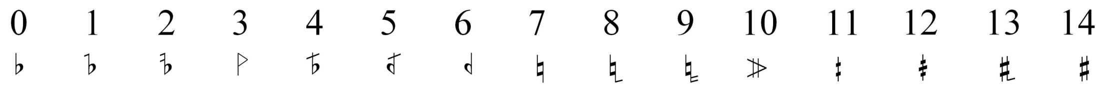
ratios relative to C	$\frac{18}{17}$	**$\frac{15}{14}$**	$\frac{88}{81}$	$\frac{128}{117}$	$\frac{512}{459}$	$\frac{9}{8}$	**$\frac{81}{68}$**	**$\frac{135}{112}$**	**$\frac{11}{9}$**	**$\frac{16}{13}$**	**$\frac{64}{51}$**	**$\frac{81}{64}$**	$\frac{4}{3}$
¢	98.95	**119.44**	143.5	155.56	189.18	203.91	**302.86**	**323.35**	**347.41**	**359.47**	**393.09**	**407.82**	498.05

Figure 17. Frets derived from the *Qānūn* of Aleppo, based on *'aĝam* in B-Flat.



ratios relative to C	$\frac{18}{17}$	**$\frac{16}{15}$**	$\frac{88}{81}$	$\frac{128}{117}$	$\frac{512}{459}$	$\frac{9}{8}$	**$\frac{32}{27}$**	**$\frac{6}{5}$**	**$\frac{39}{32}$**	**$\frac{27}{22}$**	**$\frac{5}{4}$**	**$\frac{64}{51}$**	$\frac{4}{3}$
¢	98.95	**111.73**	143.5	155.56	189.18	203.91	**294.14**	**315.64**	**342.48**	**354.55**	**386.31**	**393.09**	498.05

Figure 18. Weiss's alteration signs and *Mandal* positions.



Each flank comprises the same symmetrical set of micro-intervals. For that reason, Weiss named this prototype "modèle super-symétrique" (2009–11). While retaining the accidentals of Western notation at the extremities of each set of *mandal-s*, Weiss distinguishes three central "quarter tones" within each *apotome*. On Q1–8, the lower one of these intervals is assigned to Ibn Sīna's neutral second 13/12 (138.57¢) and signified by the Persian *koron* accidental (Figure 19) on the *apotome* between "flat" and "natural" and, respectively, by the Persian *sori* (Figure 20) between "natural" and "sharp." These accidentals, in Iran, originally signified an alteration by a low "quarter tone" of varying size (During 1985, 81–82; Wright 2000b, 18, 2005, 225–26).

On Q8, the next higher "quarter tones" refer to the harmonic ratio 12/11 (150.64¢) and are represented by the struck out flat accidental (Figure 21) that is normally used in Arab contexts for the same interval size (Shiloah 1981, Touma 2003). Between "natural" and "sharp," Weiss

Figure 19. *Koron*

Figure 20. *Sori*

Figure 21. "Struck out" flat accidental.

Figure 22. "Half" sharp accidental.

Figure 23. Raised "Arab" quarter-tone.

Figure 24. "Half" sharp with three lines.

Figure 25. Reversed flat accidental.

uses a "half" sharp sign (Figure 22), as it appears in Western quarter tone music. On Q1–8, the next higher "quarter tone" is related to the ratio 11/10 (165.00¢) and notated with a reversed struck out flat symbol on the *apotome* between "flat" and "natural" (Figure 23). On the second *apotome*, Weiss uses a half-triple-sharp, as it is known in AEU notation, yet with a different meaning (Figure 24). The *mandal-s* next to the extremities of each set are assigned to the alteration by a syntonic *comma* (81/80, 21.51c). Weiss's reversed flat accidental, shown in Figure 25, bears practically the same signification as it obtains in AEU notation (Özkan 2006, 62).

Weiss compiled the other accidentals of this group from modern Arab approaches, most notably from the notation practice of Tawfīq al-Sabbāġ (1950, as referenced in Racy 2003, 107). The *bemol wa-rub'* ("flat and a quarter") of this Syrian theorist, shown in Figure 26, is denoted by the lowering of a note by "three quarters" of a flat (= three-eighths of a tone). In Weiss's system, the added stem denotes the distance of a syntonic *comma* (21.51¢), and he

Figure 26. *Bemol wa-Rub'.*

Figure 27. Natural position plus syntonic *comma*.

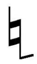


Figure 28. Sharp position minus syntonic *comma*.

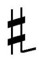


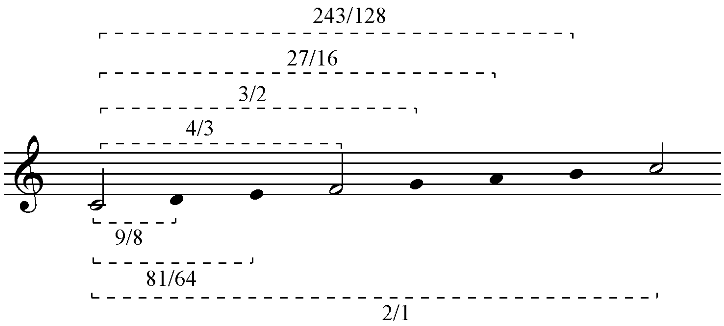
Figure 29. Symbols following "*comma* accidentals."

extended the same concept to other common alteration signs, shown in Figures 27 and 28. For the remaining two positions, Weiss devised symbols with yet another stem that follows those with one stem, as shown in Figure 29.

Q8 and Q9 both include an additional octave in the bass register and, thus, contain 33 courses of strings. Thus, the total amount of 99 strings (instead of the 78 on 26 courses of Turkish *qānūn*-s) encompasses four octaves and a fifth, spanning from C2 to G6. Even if the lowest octave may not be used very often, as on the pedal harp, it provides the lower registers with supplementary overtones and, thus, more resonance.

As on common Turkish instruments, Weiss tunes A4—which equals the note *Nawā*/*Nevâ* in Middle Eastern notation—to 440 Hertz. As all courses on Q1–9 are tuned in just intonation according to A, C is tuned by six ¢ lower than in absolute Western pitch, at the distance of 27/16, i.e. 905.87c to A, as seen in Figure 30.

Figure 30. Pythagorean heptatonic scale on Q1–9.



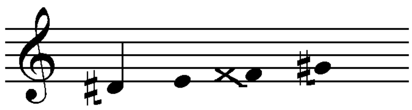
Both Q1–8 and Q9 have 14 *mandal*-s for every course of strings. This results in 15 different pitches per course of strings. For practical reasons, though, a portion of *mandal*-s on some courses remains fixed in every octave. Thus, as seen in Figure 31, Weiss omitted positions 8 to 10 for courses D, E, G, A, and B because he considered them dispensable in order to gain more flexibility during quick modulations.

Weiss reduced the distribution of *mandal*-s further in the upper octave and left out the ratios represented by accidentals with two additional stems. However, he tuned all remaining positions in exactly the same fashion as in the lower octaves. The two highest string-courses in the upper octave (F6 & G6) only span one *apotome*. They can be tuned depending upon context so that they either produce pitches between "flat" and "natural" or between "natural" and sharp." The highest course of strings (G6) only has four *mandal*-s. Weiss conceived this distribution by systematically ruling out the least common transpositions of Middle Eastern performance practice. Additionally, as shown in Figure 32, the courses of F4 and F5 contain a

Figure 31. *Mandal* distribution on the seven courses of strings per octave.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
√	√	√	√	√	√	√	√	—	fixed	—	√	√	√	√

Figure 32. *Ḥiĝāz* on D-sharp.

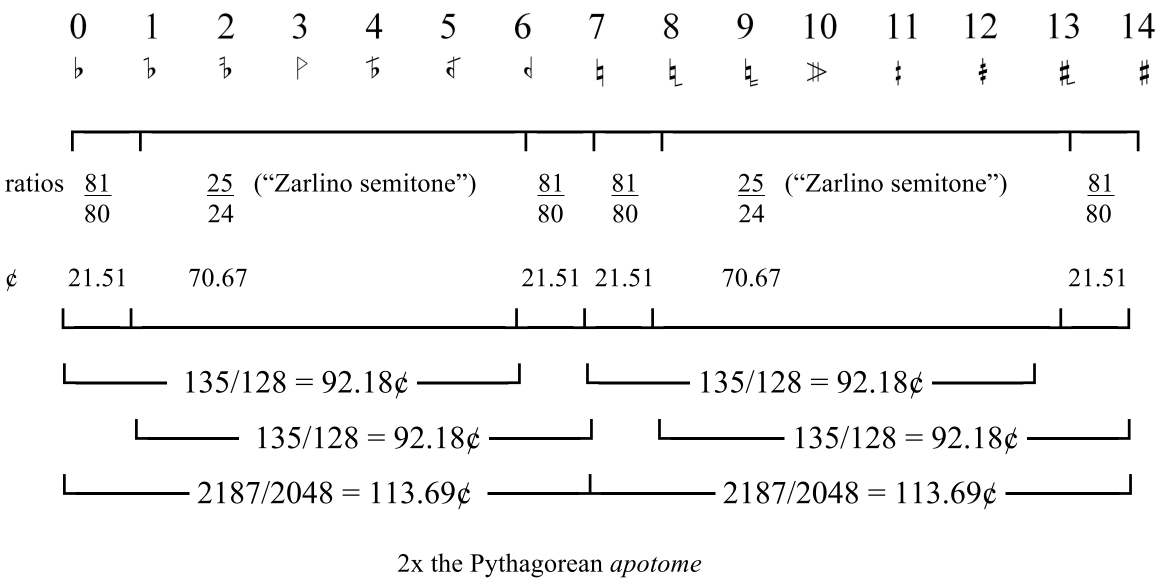


double-sharp pitch that proves to be useful in a number of transpositions, as in a rare genre *ḥiĝāz* on D-sharp.

Both on Q8 and Q9, each Pythagorean *apotome* (2187/2048 = 113.69¢) is divided into two framing syntonic *comma*-s 81/80 (21.51¢) with the "Zarlino semitone" 25/24 (70.67¢) at their center. In this manner, 113.69¢ are divided into 21.51¢ + 70.67¢ + 21.51¢. The ratio 135/128 (92.18¢) is beautifully embedded in symmetrical interconnection, as illustrated in Figure 33.

The only differences between Q8 and Q9 involve the interior *mandal*-s that are encompassed by the "Zarlino semitones." Q9 was not intended to be an improvement, but a

Figure 33. Q8 and Q9: basic division of the Pythagorean *apotome*.



variant of Q8, more suitable for the performance of specifically Turkish-Ottoman music, whereas Weiss has used Q8 preferably in Arabian contexts. On Q8, each *apotome* is divided into seven micro steps of 21.51, 14.2, 12.65, 12.06, 14.37, 17.4, and 21.51¢, as shown in Table 4.

A clearer understanding of Weiss's decisions is obtained by an observation of these divisions among the ratios that result on the D strings relative to C-natural. On Q8 and Q9, D-flat is related to C-natural by the Pythagorean *leimma* 256/243 = 90.23¢. E, G, A, and B-flat are related in the same way with regard to D, F, G, and A-natural, and F and C-natural in regard to E and B-natural. On Q1–8, the repertory of seconds between D-flat and D-natural describes an almost perfect series of harmonic ratios from 16/15 (*mandal* 1) to 9/8 (*mandal* 7) in which only the ratios 15/14 and 14/13 are missing (see Table 5).

On Q9, Weiss divided each *apotome* into seven micro steps of 21.51, 16.57, 15.20, 12.06, 12.35, 14.49, and 21.51¢ (see Table 6). The inner *mandal* positions appear, therefore, in

Table 4. Distribution of micro steps per string on Q1-8 from one position to another.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	♭							♮							♯
ratios	81/80	245/243	3159/3136	144/143	121/120	100/99	81/80	81/80	245/243	3159/3136	144/143	121/120	100/99	81/80	
¢	21.51	14.19	12.65	12.06	14.37	17.40	21.51	21.51	14.19	12.65	12.06	14.37	17.40	21.51	

Table 5. Ratios on the D string relative to C-natural on Q1-8.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	♭							♮							♯
¢	↔ 21.51↔	14.19↔	12.65 ↔	12.06 ↔	14.37 ↔	17.40 ↔	21.51 ↔	21.51 ↔	14.19↔	12.65↔	12.06 ↔	14.37 ↔	17.40 ↔	21.51↔	
ratios	256/243	16/15	784/729	13/12	12/11	11/10	10/9	9/8	729/640	147/128	9477/8192	6561/5632	24057/20480	1215/1024	19683/16384
¢	90.23	111.73	125.92	138.57	150.64	165.00	182.40	203.91	225.42	239.61	252.26	264.32	278.69	296.09	317.60

Table 6. Distribution of micro steps per string on Q9 from one position to another.

	0–1	1–2	2–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	10–11	11–12	12–13	13–14
ratios	81/80	105/104	572/567	144/143	1547/1536	120/119	81/80	81/80	105/104	572/567	144/143	1547/1536	120/119	81/80
¢	21.51	16.57	15.20	12.06	12.35	14.49	21.51	21.51	16.57	15.20	12.06	12.35	14.49	21.51

Table 7. Ratios on the D string in regard to C-natural on Q9.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ratios	256/243	16/15	14/13	88/81	128/117	119/108	10/9	9/8	729/640	23/20	297/256	243/208	273/232	1215/1024	19683/16384
¢	90.23	111.73	128.30	143.50	155.56	167.92	182.4	203.91	225.41	241.96	257.18	269.25	275.38	296.09	317.60

¢ (steps): ↔21.51↔16.57↔15.20↔12.06 ↔12.35 ↔14.49 ↔21.51 ↔21.51 ↔16.57 ↔15.20↔12.06 ↔12.35 ↔ 14.49 ↔ 21.51 ↔

slightly higher tuning (Table 7). The analysis of interval sizes on Q1–8 and Q9 in descending manner, as shown in Figure 34, reveals that the order of ratios observed on Q8 in ascending manner reappears, simply in reversed direction, on Q9.

The tuning frame of a Pythagorean diatonic scale applies to all *mandal* positions on Q1–9. The distance between a flat position in the first *apotome* and its sharpened counterpart in the second *apotome* (for example, position one in regard to eight, four in regard to 11) is uniformly 113.69¢. For that reason, Q8 and Q9 are not suitable to perform together with tempered instruments. Weiss tuned the highest *mandal* on every course to a pitch higher than the lowest *mandal* of the next higher string. Between the major seconds (C-D, D-E, F-G, G-A, A-B), this difference amounts to 23.46¢—the Pythagorean *comma*.

Weiss is able to realize exactly the distance of the *schisma* (32,805/32,768, i.e. 1.95¢). On string courses D, E, G, A, and B, position zero is by a *schisma* lower than position 13 of the

Figure 34. Descending seconds between F and E-flat on Q8 and Q9.

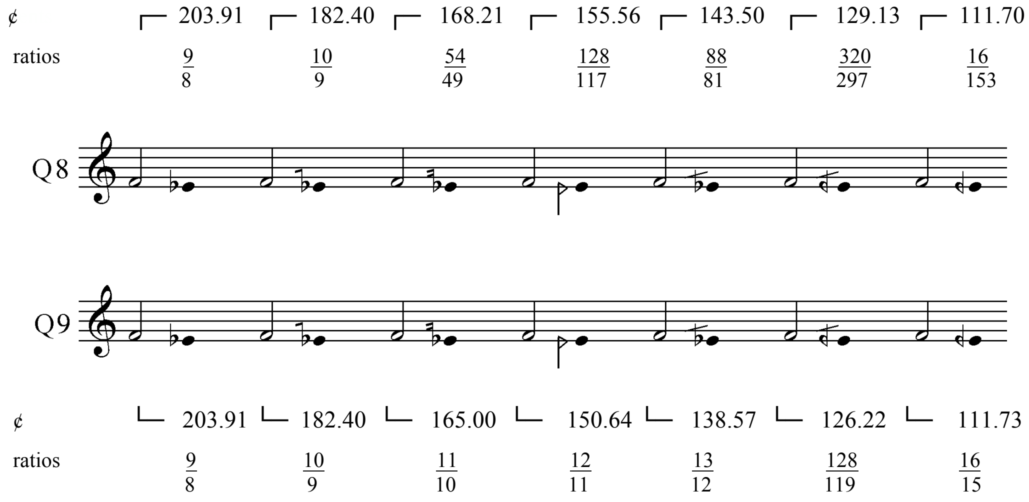
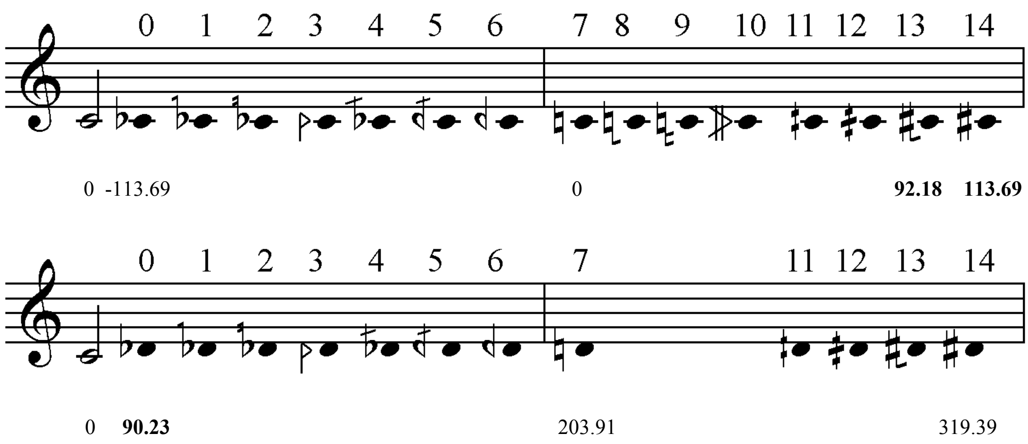


Figure 35. *Schisma* on Q1-8 and Q9 (C-13 and D-0) in cents.



next lower course of strings (Figure 35). On courses C and F, position seven must be chosen to provide the same interval relative to the next lower course.

As shown in Figure 36, Weiss is able to play perfect fifths of different sizes: either a very close approximation to the tempered perfect fifth, namely, 700.0013¢, a just (3/2, 701.96¢), and a slightly widened fifth (703.91¢) by using various combinations of *mandal*-s. In return, the lowest positions on F and C are also 23.46¢ lower than the sevenths positions on course E or, respectively, B. F-flat and F-natural—at 384.36 and 498.05¢—are lower than E-natural and E-sharp, and thus in accordance with exact Pythagorean deduction (see Figure 37).

Figure 36. Three different perfect fifths.

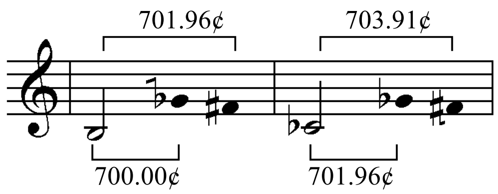
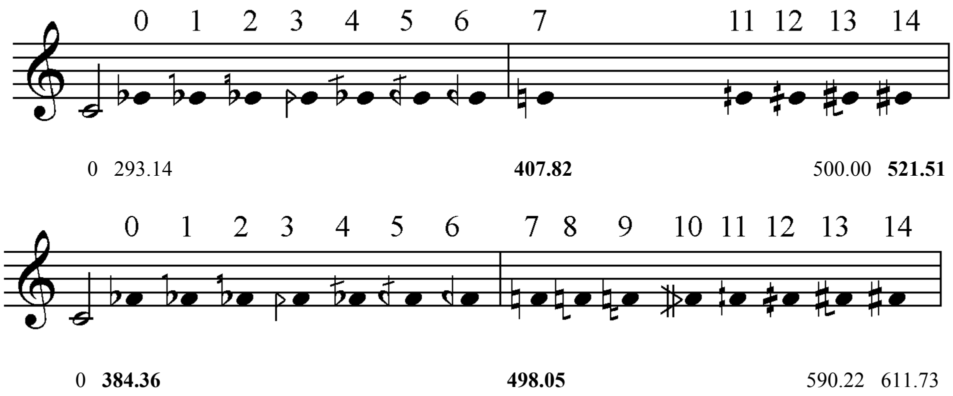


Figure 37. Flats and sharps on E and F strings in cents.



Tables 8 and 9 offer a complete view of the ratios relative to C-natural on both instruments. The abundance of choices for seconds and thirds reveals in how many different tuning contexts Weiss is able to perform while maintaining intervals at exactly defined ratios. This system permits Weiss to select from all principal interval ratios that appear in the theoretical tradition as well as in different local contexts. Furthermore, he is able to maintain the same ratios in all major transpositions and in a wide range of modulations. In this manner, his instruments have accomplished the challenging task of allowing complex modulations without undesired pitch shifts, while keeping just ratios.

Figure 38 offers a full view of Weiss's ninth prototype (Q9). Figure 39 displays the distribution of *mandal*-s in the middle register from close distance.

Table 8. Q1–8: available pitch content per octave in relationship to C-natural.

DO	$\frac{2048}{2187}$ 113.69¢	$\frac{128}{135}$ 92.18¢	$\frac{2560}{2673}$ 74.78¢	$\frac{704}{729}$ 60.41¢	$\frac{1053}{1024}$ 48.35¢	$\frac{48}{49}$ 35.70¢	$\frac{80}{81}$ 21.51¢	$\frac{1}{1}$ 0	$\frac{81}{80}$ 21.51¢	$\frac{49}{48}$ 35.70¢	$\frac{1053}{1024}$ 48.35¢	$\frac{729}{704}$ 60.41¢	$\frac{2673}{2560}$ 74.78¢	$\frac{135}{128}$ 92.18¢	$\frac{2187}{2048}$ 113.69¢
RE	$\frac{256}{243}$ 90.22¢	$\frac{16}{15}$ 111.73¢	$\frac{784}{729}$ 125.92¢	$\frac{13}{12}$ 138.57¢	$\frac{12}{11}$ 150.63¢	$\frac{11}{10}$ 165.00¢	$\frac{10}{9}$ 182.40¢	$\frac{9}{8}$ 203.91¢	$\frac{729}{640}$ 225.41¢	$\frac{147}{128}$ 239.60¢	$\frac{9477}{8192}$ 252.26¢	$\frac{6561}{5632}$ 264.32¢	$\frac{24057}{20480}$ 278.68¢	$\frac{1215}{1024}$ 296.09¢	$\frac{19683}{16367}$ 319.39¢
MI	$\frac{32}{27}$ 294.14¢	$\frac{6}{5}$ 315.64¢	$\frac{98}{81}$ 329.83¢	$\frac{39}{32}$ 342.48¢	$\frac{27}{22}$ 354.55¢	$\frac{99}{80}$ 368.91¢	$\frac{5}{4}$ 386.31¢	$\frac{81}{64}$ 407.82¢	$\frac{6561}{5120}$ 429.32¢	$\frac{1323}{1024}$ 443.52¢	$\frac{85293}{65536}$ 456.17¢	$\frac{59049}{45056}$ 468.23¢	$\frac{216513}{163840}$ 482.59¢	$\frac{10935}{8192}$ 500.00¢	$\frac{177147}{131072}$ 521.51¢
FA	$\frac{8192}{6561}$ 384.36¢	$\frac{512}{405}$ 405.87¢	$\frac{25088}{19683}$ 420.06¢	$\frac{104}{81}$ 432.71¢	$\frac{128}{99}$ 444.77¢	$\frac{176}{135}$ 459.13¢	$\frac{320}{243}$ 476.54¢	$\frac{4}{3}$ 498.05¢	$\frac{27}{20}$ 519.55¢	$\frac{49}{36}$ 533.74¢	$\frac{351}{256}$ 546.39¢	$\frac{243}{176}$ 558.46¢	$\frac{891}{640}$ 572.82¢	$\frac{45}{32}$ 590.22¢	$\frac{729}{512}$ 611.73¢
SOL	$\frac{1024}{729}$ 588.27¢	$\frac{64}{45}$ 609.78¢	$\frac{3136}{2187}$ 623.97¢	$\frac{13}{9}$ 636.62¢	$\frac{48}{36}$ 648.69¢	$\frac{22}{15}$ 663.05¢	$\frac{40}{27}$ 680.45¢	$\frac{3}{2}$ 701.96¢	$\frac{243}{160}$ 723.46¢	$\frac{147}{96}$ 737.65¢	$\frac{3159}{2048}$ 750.30¢	$\frac{2187}{1408}$ 762.37¢	$\frac{8019}{5120}$ 776.73¢	$\frac{405}{256}$ 794.13¢	$\frac{6561}{4096}$ 815.64¢
LA	$\frac{128}{81}$ 792.18¢	$\frac{8}{5}$ 813.69¢	$\frac{392}{243}$ 827.88¢	$\frac{13}{8}$ 840.52¢	$\frac{18}{11}$ 852.59¢	$\frac{33}{20}$ 866.96¢	$\frac{5}{3}$ 884.36¢	$\frac{27}{16}$ 905.87¢	$\frac{2187}{1280}$ 927.37¢	$\frac{441}{256}$ 941.56¢	$\frac{28431}{16384}$ 954.21¢	$\frac{19683}{11284}$ 963.21¢	$\frac{72171}{40960}$ 980.64¢	$\frac{3645}{2048}$ 998.04¢	$\frac{59049}{32768}$ 1019.55¢
SI	$\frac{16}{9}$ 996.09¢	$\frac{9}{5}$ 1017.6¢	$\frac{49}{27}$ 1031.79¢	$\frac{117}{64}$ 1044.44¢	$\frac{81}{44}$ 1056.5¢	$\frac{297}{160}$ 1070.87¢	$\frac{15}{8}$ 1088.27¢	$\frac{243}{128}$ 1109.78¢	$\frac{19683}{10240}$ 1131.28¢	$\frac{3969}{2048}$ 1145.47¢	$\frac{255879}{131079}$ 1158.03¢	$\frac{177147}{90112}$ 1170.19¢	$\frac{649539}{327680}$ 1184.55¢	$\frac{32805}{16384}$ 1201.95¢	$\frac{531441}{262144}$ 1223.46¢
DO	$\frac{4096}{2187}$ 1086.31¢	$\frac{256}{135}$ 1107.82¢	$\frac{5120}{2673}$ 1122.01¢	$\frac{52}{27}$ 1134.66¢	$\frac{64}{33}$ 1146.73¢	$\frac{88}{45}$ 1161.09¢	$\frac{160}{81}$ 1178.49¢	$\frac{2}{1}$ 1200.00¢	$\frac{81}{40}$ 1221.51¢	$\frac{49}{24}$ 1235.70¢	$\frac{1053}{512}$ 1248.35¢	$\frac{729}{352}$ 1260.41¢	$\frac{2673}{1280}$ 1274.78¢	$\frac{135}{64}$ 1292.18¢	$\frac{2187}{1024}$ 1313.69¢

Table 9. Q9: available pitch content per octave in relationship to C-natural.

DO	$\frac{2048}{2187}$ 113.69¢	$\frac{128}{135}$ 92.18¢	$\frac{232}{243}$ 80.20¢	$\frac{26}{27}$ 65.34¢	$\frac{32}{33}$ 53.27¢	$\frac{1664}{1701}$ 38.07¢	$\frac{80}{81}$ 21.51¢	$\frac{1}{1}$ 0	$\frac{81}{80}$ 21.51¢	$\frac{1701}{1664}$ 38.07¢	$\frac{33}{32}$ 53.27¢	$\frac{27}{26}$ 65.34¢	$\frac{243}{232}$ 80.20¢	$\frac{135}{128}$ 92.18¢	$\frac{2187}{2048}$ 113.69¢
RE	$\frac{256}{243}$ 90.22¢	$\frac{16}{15}$ 111.73¢	$\frac{14}{13}$ 128.29¢	$\frac{88}{81}$ 143.49¢	$\frac{128}{117}$ 155.56¢	$\frac{119}{108}$ 167.92¢	$\frac{10}{9}$ 182.40¢	$\frac{9}{8}$ 203.91¢	$\frac{729}{640}$ 225.41¢	$\frac{15309}{13312}$ 241.98¢	$\frac{297}{256}$ 257.18¢	$\frac{243}{208}$ 269.25¢	$\frac{9639}{8192}$ 281.60¢	$\frac{1215}{1024}$ 296.09¢	$\frac{19683}{16367}$ 319.39¢
MI	$\frac{32}{27}$ 294.14¢	$\frac{6}{5}$ 315.64¢	$\frac{63}{52}$ 332.21¢	$\frac{11}{9}$ 347.41¢	$\frac{16}{13}$ 359.47¢	$\frac{119}{96}$ 371.83¢	$\frac{5}{4}$ 386.31¢	$\frac{81}{64}$ 407.82¢	$\frac{6561}{5120}$ 429.32¢	$\frac{137781}{106496}$ 445.89¢	$\frac{2673}{2048}$ 461.09¢	$\frac{2187}{1664}$ 473.16¢	$\frac{86751}{65536}$ 485.51¢	$\frac{10935}{8192}$ 500.00¢	$\frac{177147}{131072}$ 521.51¢
FA	$\frac{8192}{6561}$ 384.36¢	$\frac{512}{405}$ 405.87¢	$\frac{448}{351}$ 422.43¢	$\frac{2816}{2187}$ 437.63¢	$\frac{4096}{3159}$ 449.7¢	$\frac{952}{729}$ 462.05¢	$\frac{320}{243}$ 476.54¢	$\frac{4}{3}$ 498.05¢	$\frac{27}{20}$ 519.55¢	$\frac{567}{416}$ 536.12¢	$\frac{11}{8}$ 551.32¢	$\frac{18}{13}$ 563.38¢	$\frac{357}{256}$ 575.74¢	$\frac{45}{32}$ 590.22¢	$\frac{729}{512}$ 611.73¢
SOL	$\frac{1024}{729}$ 588.27¢	$\frac{64}{45}$ 609.78¢	$\frac{56}{39}$ 626.34¢	$\frac{352}{243}$ 641.54¢	$\frac{512}{351}$ 653.61¢	$\frac{119}{81}$ 665.96¢	$\frac{40}{27}$ 680.45¢	$\frac{3}{2}$ 701.96¢	$\frac{243}{160}$ 723.46¢	$\frac{5103}{3328}$ 740.03¢	$\frac{99}{64}$ 755.23¢	$\frac{2187}{1404}$ 767.29¢	$\frac{3213}{2048}$ 779.65¢	$\frac{405}{256}$ 794.13¢	$\frac{6561}{4096}$ 815.64¢
LA	$\frac{128}{81}$ 792.18¢	$\frac{8}{5}$ 813.69¢	$\frac{21}{13}$ 830.25¢	$\frac{44}{27}$ 845.45¢	$\frac{64}{39}$ 857.52¢	$\frac{119}{72}$ 869.87¢	$\frac{5}{3}$ 884.36¢	$\frac{27}{16}$ 905.87¢	$\frac{2187}{1280}$ 927.37¢	$\frac{45927}{26624}$ 943.94¢	$\frac{891}{512}$ 959.14¢	$\frac{19683}{11232}$ 971.20¢	$\frac{28917}{16384}$ 983.56¢	$\frac{3645}{2048}$ 998.04¢	$\frac{59049}{32768}$ 1019.55¢
SI	$\frac{16}{9}$ 996.09¢	$\frac{9}{5}$ 1017.6¢	$\frac{189}{104}$ 1034.16¢	$\frac{11}{6}$ 1049.36¢	$\frac{24}{13}$ 106143¢	$\frac{119}{64}$ 1073.78¢	$\frac{15}{8}$ 1088.27¢	$\frac{243}{128}$ 1109.78¢	$\frac{19683}{10240}$ 1131.28¢	$\frac{413343}{212992}$ 1147.85¢	$\frac{8019}{4096}$ 1163.05¢	$\frac{6561}{3328}$ 1175.11¢	$\frac{260253}{131072}$ 1187.46¢	$\frac{32805}{16384}$ 1201.95¢	$\frac{531441}{262144}$ 1223.46¢
DO	$\frac{4096}{2187}$ 1086.31¢	$\frac{256}{135}$ 1107.82¢	$\frac{672}{351}$ 1124.39¢	$\frac{4224}{2187}$ 1139.59¢	$\frac{12288}{6318}$ 1151.65¢	$\frac{476}{243}$ 1164.01¢	$\frac{160}{81}$ 1178.49¢	$\frac{2}{1}$ 1200.00¢	$\frac{81}{40}$ 1221.51¢	$\frac{1701}{832}$ 1238.07¢	$\frac{33}{16}$ 1253.27¢	$\frac{27}{13}$ 1265.34¢	$\frac{243}{116}$ 1280.20¢	$\frac{135}{64}$ 1292.18¢	$\frac{2187}{1024}$ 1313.69¢

Figure 38. Weiss's prototype Q9, full view.

The abundance of justly tuned intervals observed in Tables 8 and 9 allows one to assume that Weiss may also develop his collaboration with contemporary Western composers on a more regular basis. So far, he has been involved in the creation of two Western scores: Klaus Huber's "Die Erde dreht sich auf den Hörnern eines Ochsen" (1996), premiered in 1994 at *Wittener Tage für neue Kammermusik* (Nyfeller 2003), and Christopher Trapani's "Disorientation" for the *cursus* in electroacoustic composition at IRCAM (Trapani 2010).

Figure 39. Weiss's prototype Q9, detail.

Weiss keeps experimenting with further prototypes that distribute micro-intervals through aliquot division and in elegant symmetry. None of these models has yet been built, but Weiss has already completed their theoretical construction with the explicit aim to simplify the building process. One can imagine that one day these prototypes will find their way into industrial production.

CONCLUSIONS

As a traveling foreigner performing throughout the Middle East, Weiss has provided a unique and multifold perspective on the entire tradition of *maqāmāt*. By creating a unified tuning system that incorporates diverse aspects of the *maqām* tradition, he is the first one to fully approach this art as a transnational phenomenon.

Like Cantemir's *tanbūr* scale in the 17th century (Feldman 1996, 206–07), Weiss's instruments Q8 and Q9 respond to the Middle Eastern tuning customs, modal genres, and pitch inventories of their time through the experience of one specialized individual of European descent. The abundance of justly tuned intervals available in Weiss's extended *mandal* system satisfies theoretical, acoustical, and practical demands. In their application to a diversity of local and historic contexts, Weiss's *qānūn*s are consistent with an opinion on which performers and theorists have agreed since the Congress of Cairo (d'Erlanger 2001-V, 12): As a mature tradition, the Middle Eastern *maqām* system can no more rely on simplistic attempts to formulate a single fundamental scale. As in Western polyphonic music, where the intonation of individual tones changes in different harmonic contexts, the Middle Eastern system comprises many modal dimensions that cannot be mapped onto one single set of 24 notes per octave. Except for the fixed intonation of the *qānūn*, actual practice does not necessitate the construction of one compulsory tuning system. As conveyed by alteration signs that closely adapt principal Western and Middle Eastern notational conventions in correct adaptation, Weiss's *qānūn* system has removed the obstacles of temperament and imprecise tuning. In this manner, Weiss's current solutions to problems posed by this immensely important instrument can be understood as the most precise and comprehensive Middle Eastern tuning system of the 21st century.

On the one hand, a foreign specialist may understand a musical tradition so well that he may be accorded lasting authority with regard to the general theory and interpretation of its repertoire. On the other hand, scholars should remain careful not to overlook the fact that Weiss's tuning system is the product of a single person. By no means could common local customs, as they are represented by Middle Eastern *qānūn* players (such as Ruhi Ayangil or Göksel Baktagir) or Ozan Yarman's ambitious 79-note temperament (Yarman & Beşiroğlu 2008) simply be labeled as "inauthentic" due to a combination of acousticist and historical criteria, for they still dominate today's performance culture. Since no one else has yet adopted Weiss's proposal, one can only speculate about whether or not it may stand the test of time.

BIBLIOGRAPHY

Ak, Ahmet Şahin. 2002. *Türk Musikisi Tarihi*. Ankara: Akçağ Yayınları.

Ensemble Al-Kindî. 2006. *Parfums Ottomans—Musique de Cour Arabo-Turque [Ottoman*

Perfumes—Music of the Arabo-Turkish Court]. 2CD + booklet. *Le Chant du Monde* CMT 5741414.15. Distributed by *Harmonia Mundi*.

Arel, Hüseyin Sadettin. 1964 (1927). *Türk musikisi üzerine iki konferans*, edited by M. Kemal Özergin. Ankara, Turkey: Hüsnütabiat Matbaası.
———. 1993 (ca. 1930). *Türk musıkîsi nazariyatı dersleri*, edited by Onur Akdoğu. Ankara, Turkey: Kültür Bakanlığı Yayınları.

Ayangil, Ruhi. 2008. "Western Notation in Turkish Music." In *Journal of the Royal Asiatic Society of Great Britain and Ireland* (Third Series), Vol. 18(4), 401–47.

———. 2011. Oral Communication, June 2011, Burgazadası, Turkey.

Beşiroğlu, Şefika Şehvar. 2011. Oral Communication, Apr. 2011, Istanbul, Turkey.

Chabrier, Jean-Claude. 2001 (1996). "Musical Science." In *Encyclopedia of the History of Arab Science*, Vol. 2: *Mathematics and the Physical Sciences*, edited by Rāshid, R. & R. Morélon. London, UK: Routledge, 242–273.

Chalmers, John. 1993. *Divisions of the Tetrachord*. Hanover, NH: Frog Peak Music.

Daniélou, Alain. 1971 (1967). "Plurality of Cultures or Synthesis." In *Asian Music*, Vol. 2(2), 2–6.

D'Erlanger, Rodolphe. 2001 (1935 & 1938). *La musique arabe*, Vol. I-VI. Paris, France: Geuthner.

During, Jean. 1985. "Théories et pratiques de la gamme iranienne." In *Revue de Musicologie*, vol. 71(1–2), 79–118.

Elçin, Şükrü (ed.). 1976. *Ali Ufki. Mecmua-i saz ü söz*. Istanbul, Turkey: Kültür Bakanlığı Yayınevi.

Farmer, Henry George. 2001 (1929). *A History of Arabian Music*. New Delhi, India: Goodword Books.

———. 1929. "The Influence of Music: From Arabic Sources." In: *Proceedings of the Musical Association*, 52nd Sess., 89–124. London, UK: Taylor & Francis.

Feldman, Walter. 1996. *Music of the Ottoman Court—Makam, Composition and the Early Ottoman Instrumental Ensemble*. Berlin, Germany: Verlag für Wissenschaft und Bildung.

Giannelos, Dimitri. 1996. *La musique byzantine. Le chant ecclésiaque grec, sa notation et sa pratique actuelle*. Paris, France: L'Harmattan.

Helmholtz, Hermann von. 1954 (1885). *On the Sensations of Tone*, translated by Ellis, A. J. Mineola, NY: Dover.

Karadeniz, Mustafa Ekrem. 1985. *Türk musıkîsinin nazariye ve esâsları*. Ankara: Türkiye İş Bankası Kültür Yayınları.

Karas, Simon. 1989. *Harmoniká. Des consonances (syn-phonies) par moyennes harmoniques: les intervalles musicaux*. Athens, Greece: Manoutios.

Manik, Liberty. 1969. *Das arabische Tonsystem im Mittelalter*. Leiden, the Netherlands: Brill.

Marcus, Scott. 1993. "The Interface between Theory and Practice: Intonation in Arab Music." In *Asian Music*, Vol. 24(2), 39–58.

Nyffeler, Max. 2003. "Avicenna und der Golfkrieg. Anmerkung zum jüngsten Schaffen von Klaus Huber." In *Neue Zeitschrift für Musik* Vol. 2/2003, 18–27.

Özkan, İsmail. Hakkı. 2006 (1982). *Türk Mûsıkîsi Nazariyatı ve Usûlleri*. Istanbul, Turkey: Ötüken.

Öztuna, Yılmaz. 1998 (1969). *Türk Musikisi Ansiklopedisi*. Istanbul, Turkey: Türkiye Cumhuriyeti Milli Eğitim Basımevi.

Popescu-Judetz, Eugenia. 1999 (1973). *Prince Dimitrie Cantemir. Theorist & Composer of Turkish Music*. Istanbul, Turkey: Pan.

———. 2002. *Tanburi Küçük Artin. A Musical Treatise of the Eighteenth Century*. Istanbul, Turkey: Pan.

Racy, Ali Jihad. 2003. *Making Music in the Arab World: The Culture and Artistry of Tarab*. Cambridge, UK: Cambridge University Press.

Shiloah, Amnon. 1981. "The Arabic Concept of Mode." In: *Journal of the American Musicological Society*. Vol. 34(1), 19–42.

Signell, Karl Lloyd. 2008 (1977). *Makam: Modal Practice in Turkish Art Music*. Sarasota, FL: Usul Editions.

Touma, Habib Hassan. 2003. *The Music of the Arabs*, translated by Schwartz, Laurie. Portland, OR: Amadeus Press.

Trapani, Christopher. 2010. *Cognitive Consonance*. Unpublished score, retrieved from composer in pdf format.

Tura, Yalçın. 1988 (1981): *Türk mûsikîsinin mes'eleleri*. Istanbul, Turkey: Pan

———. (trans.) 2001. Dimitri Kantemiroğlu (Cantemir): *Kitābu 'İlmi'l-Mūsīkī 'alā vechi'l-Hurūfāt (Mûsikîyi Harflerle Tesbît ve İcrâ İlminin Kitabı)*. Istanbul, Turkey:Yapı Kredi Yayınları.

Weiss, Julien Jalâl Ed-Dine. 2004. "Safiyuddin et la musique arabe moderne." Unpublished lecture, retrieved from author in digital format.

———. 2005. "Les genres arabes et turcs." Unpublished work sheet, retrieved from author in digital format.

———. 2006. "L'héritage occulté de la musique et des musiciens de cour arabes dans la musique ottomane." In *Parfums ottomans—musique de cour arabo-turque*, CD booklet. Le Chant du Monde, Harmonia Mundi CMT 5741414.15, 10–15.

———. 2009–11. Oral communication, Istanbul, Turkey.

Wright, Owen. 1995. "A Preliminary Version of the 'Kitāb al-Adwār'." In *Bulletin of the School of Oriental and African Studies*, Vol. 58(3): 455–478.

———. 2000 (1992). *Demetrius Cantemir. The Collection of Notations*, Vol. I, II. London, UK: SOAS Musicology Series.

———. 2005. "Die melodischen Modi bei Ibn Sīnā und die Entwicklung der Modalpraxis von Ibn al-Munağğim zu Ṣāfī al-Dīn al-Urmawī." In *Zeitschrift für die Geschichte der Arabisch-Islamischen Wissenschaften*, Sonderdruck, Vol. 16, 224–308.

Yarman, Ozan & Ş. Şehvar Beşiroğlu. 2008. "Türk Makam Müziği'nde Nazariyat-İcra Örtüş Mezliğine bir Çözüm: 79-Sesli Düzen." In: *İstanbul Teknik Üniversitesi Dergisi B*, Vol. 5 (2), 23–34. Istanbul, Turkey: Istanbul Technical University.

Yektâ, Raûf. 1921 (1913). "La musique turque." In *Encyclopédie de la Musique et Dictionnaire du Conservatoire*, Vol. 1(5), 2945–3064.