A MICROTONAL ANALYSIS OF

IGOR STRAVINSKY'S CONCEPT OF PITCH

AND ITS RESULTING SCALE

by Johnny Reinhard

Bassoonists Johnny Reinhard and Rezeda Gabdrakhmanova play Igor Stravinsky's "Lied Ohne Nahme" in higher harmonics at Rimsky-Korsakov Home Museum, St. Petersburg, Russia

IGOR STRAVINSKY'S SCALE IN HIGHER HARMONICS

[25 TOTAL NOTATED PITCHES USED IN HIS SCORES]

Deduced by Johnny Reinhard through
8th octave of the overtone series (128) tuning

Notated Pitch			Cents Value	Harmonic	Interval	Tempered to ET
A	(ET)	=	0	1	unison	identical
Bbb		=	13	129	sixteenthtone	+ 13
A#		=	92	135	small semitone	+ 8
Bb	(ET)	=	105	17	semitone	- 5
Cb		=	192	143	minor whole tone	+ 8
B (H)	(ET)	=	204	9	major 2nd	- 4
B#		=	286	151	small minor third	+14
C	(ET)	=	298	19	minor 3rd	+ 2
C#	(ET)	=	397	161	major 3rd	+3
Db		=	408	81	Pythagorean ditone	- 8
Cx		=	491	85	major "fourth"	+ 9
D	(ET)	=	501	171	"perfect" 4th	- 1
D#		=	590	45	D# tritone	+ 10
Eb	(ET)	=	600	181	Eb tritone	less than a cent off
Fb		=	693	191	1/6th comma meantone 5th	+ 7
E	(ET)	=	702	3	perfect 5th	+ 2
E#		=	790	101	small minor sixth	+10
F	(ET)	=	798	203	minor sixth	+ 2
F#	(ET)	=	898	215	major sixth	+ 2
Gb		=	906	27	Gb	- 6
Fx		=	992	227	small minor seventh	+ 8
G	(ET)	=	1001	57	minor 7th	- 1
G#	(ET)	=	1103	121	major 7th	- 3
Ab		=	1110	243	big major 7th	- 10
Gx		=	1193	255	pre-octave	+ 7

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Beginning the bassoon as a teenager, it wasn't long before I made the acquaintance of the greatest composer of the 20th Century through his music. The "Rite of Spring" with its famous opening bassoon solo was among my earliest classical music icons. The "Firebird" *Berceuse* solo is another bassoon solo worthy of mention. Igor Stravinsky seemed to know how to write for bassoon brilliantly.

When I have performed Stravinsky in my professional life, I never felt especially restricted to a "tuning system." The notes hollered and roared; they were not well behaved and contrite. I played the parts very much by ear to my section and to the winds generally, as opposed to responding to an intellectual decision determining which way to pitch sharps as opposed to their respective flats (e.g., C# vs. Db).

But along the way I found other 20th Century composers who vied for my attention, individual musicians plucked out of time, to include as Harry Partch, Charles Ives, and Johann Sebastian Bach. Something each composer had in common, I came to discover, was an inner hierarchical ordering of a constellation of tonal relationships. Yet, each of these composers had a completely different model of idealized intonation constituted in their respective minds.

Any organ tuning Johann Sebastian Bach (1685-1750) was likely to use for his music was tuned to a well tempered arrangement. My book, "Bach and Tuning" examines tuning practices at the time of Bach and the great likelihood that he was consistent with the same tuning on organs, which today is called "Werckmeister III tuning" (although at the time it had no specific qualified name other than well temperament). The "III" in its name is its actual position as third in an order of six tunings etched into a copperplate that was given with a purchase of the 1691 publication of Andreas Werckmeister's "Musicalische

Temperatur." In this temperament, Bach would have different sentiments available in different keys. There would be 29 different intervals in this well temperament, no doubt invented for keyboard improvisers to circumnavigate the 24 major and minor keys (See Bach and Tuning by Johnny Reinhard.)

Charles Ives's story is scandalous, with then teenage Elliott Carter reporting 40 years after the fact that he saw with his own eyes how Ives changed his dates, as well as switching his chromatics. Carter reported this to Beethoven biographer Maynard Solomon, who spread the gossip to The New York Times Donal Henahan, that Ives "was a cheat" who nefariously wanted to appear more dissonant in his scores, to appear as if he foreshadowed Europe in the new language of dissonance. (see Donal Henahan, The New York Times, "Did Ives Fiddle with the Truth").

Turns out the flats for Ives are intended to be lower than the sharps for the Pythagorean plan of intonation he had in mind, such that reading the revised notation properly demonstrated a chromaticism of 24 notes or more through the spiraling of pure fifths. New notes could be gained by spiraling additional fifths. Ives could imagine a personal model of idealized intonation in his mind which is called extended Pythagorean tuning, and which has available to it a microtonal dimension of intervallic relationships. (See The Ives 'Universe' by Johnny Reinhard.) This intonation for the majority of Ives's music is in addition to notated quartertones, or even eighthtones.

Igor Stravinsky would seem at first brush to be a twelve-tone equal temperament composer since he never said otherwise, and he favored the piano since an early age. The piano is the stereotypical 12-tone equal temperament instrument, what with its metal string inharmonicities, its blank nodes where the felted hammer hits, the duplication and tripling of strings meant to be identical, its countless calculated countings of acoustical beats by the rushed piano tuner.

However, a closer look reveals that Igor Stravinsky had a completely different model of idealized intonation in his mind. It was possible to deduce what his idealized tuning would be for future performances of his music, yes even the Rite of Spring. And of course, Stravinsky might even suggest his method to others for the future, but surely after he had left the scene.

Stravinsky was clearly not talking about 12 equal divisions of the octave. And like with Charles Ives, eight years his senior, a microtonal dimension of musical intervals appears. Stravinsky indicated a difference in meaning between a notated Db and a notated C# found in close proximity. They are not treated as identical by any means, as seen in his voice leading, and in player interpretations. For Ives, the Db is lower in pitch than any neighboring C#, quite

the opposite view than that of Stravinsky. How is this known? Through the study of tuning, it is known that the use of the overtone series as a source of knowledge of interval relationships mathematically measures the C# lower than Db by a distinct difference, every time.

Igor Freidorovich Stravinsky (1882-1971), by his own admission to his protégé Robert Lawson Craft (1923-2015) as heard in a televised interview of 1957, composed mainly at the piano. To hear Igor Stravinsky say it, "It was always about the piano," and his first career was as a pianist. Stravinsky went on to discuss his need to feel the vibrations of the music as his primary reason for playing the piano. My emphasis on Stravinsky's active relationship to the vibrating piano is because it is not in any way associated with any concept of "equalness." Stravinsky simply admonished those learning through his advice, "You have to touch the music, not only to hear it!" Stravinsky followed that up with a theatrical demonstration, placing a pencil in his mouth, only to lightly touch the tip of his pencil to the music stand of the piano, while playing. Stravinsky continued by speaking of conducting as being critical for him to be fully connected to the vibration of music.

Stravinsky's early study of scales was with a student of Rimsky-Korsakov, which he repeatedly described in the Interview with Craft as "very dull!" Stravinsky's disdain for harmony was reason enough for Nikolai Rimsky-Korsakov (1844-1908) to recommend that Igor Stravinsky not go on to the conservatory. In contrast, Stravinsky was rather in love with counterpoint. Even in his serialism, Stravinsky felt the tonal pull of his notes in his mind, if not in what his ears heard back.

> ROBERT CRAFT: Do you think of the intervals in your series as tonal intervals; that is, do your intervals always exert tonal pull?
>
> IGOR STRAVINSKY: The intervals of my series are attracted by tonality; I compose vertically and that is, in one sense at least, to compose tonally.

When Craft specifically asked for the Maestro's definition of music, Igor Stravinsky was fully prepared to be precise and crisp conceptually. He replied, right on cue:

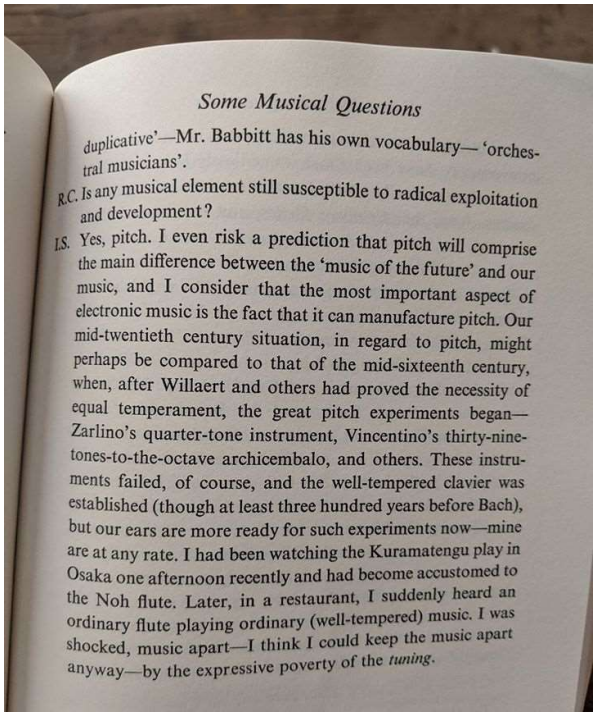
> Music is an organization of tones, an act of human mind (Stravinsky).

Stravinsky then pointed readily to a quote by philosopher Arthur Schopenhauer (1788-1860), who he claimed was speaking about music when Schopenhauer wrote about that consciousness.

And the musical tones inhabit, and form a universe of their own, and with the human mind has created the materials, introduced them to order (Shopenhauer).

Neither Ives nor Stravinsky could get past the imagination phase, to transcend as Ives intimated. Harry Partch was able to do so, and wrote a book, Genesis of a Music, on the mechanics of how he was able to accommodate the tuning challenges of his original compositions. Partch's system of "monophonic fabric" was reduced to a 43-note scale. It was clearly a completely different model of idealized intonation as he constituted in his mind, a model based on the 11th harmonic limit and its relative undertone series in what is usually described as "11 limit just intonation." With Partch there is finally the ability for a composer to hear original works performed successfully (most of the time) in their intended idealized intonation.

In publishing a book chapter entitled "Some Musical Questions" from Memories and Commentaries," Robert Craft once again prepared questions for the Maestro to answer, for publication. This time, Stravinsky advanced his ideas about pitch in a rare and unique manner.



Some Musical Questions

duplicative'—Mr. Babbitt has his own vocabulary— 'orchestral musicians'.

R.C. Is any musical element still susceptible to radical exploitation and development?

I.S. Yes, pitch. I even risk a prediction that pitch will comprise the main difference between the 'music of the future' and our music, and I consider that the most important aspect of electronic music is the fact that it can manufacture pitch. Our mid-twentieth century situation, in regard to pitch, might perhaps be compared to that of the mid-sixteenth century, when, after Willaert and others had proved the necessity of equal temperament, the great pitch experiments began—Zarlino's quarter-tone instrument, Vincentino's thirty-nine-tones-to-the-octave archicembalo, and others. These instruments failed, of course, and the well-tempered clavier was established (though at least three hundred years before Bach), but our ears are more ready for such experiments now—mine are at any rate. I had been watching the Kuramatengu play in Osaka one afternoon recently and had become accustomed to the Noh flute. Later, in a restaurant, I suddenly heard an ordinary flute playing ordinary (well-tempered) music. I was shocked, music apart—I think I could keep the music apart anyway—by the expressive poverty of the *tuning*.

Interview question put to Igor Stravinsky by Robert Craft

ROBERT CRAFT: Is any musical element still susceptible to radical exploitation and development ?

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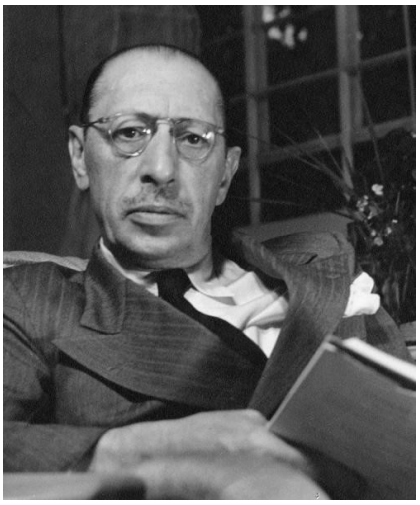

Igor Stravinsky

Stravinsky's prediction of future radical advances in pitch was tongue in cheek, for he was well aware of the contemporary microtonal achievements by such 20th century pioneers as Harry Partch, Ivan Wyschnegradsky, Juliàn Carrillo, and Alois Hába. But rather than acknowledge any success to them, he preferred an answer meant to supersede them. Admittedly, no one previously had conceptualized straight up harmonics in a public way in his lifetime, who might have caught his attention. Harry Partch was disqualified because he used an undertone series to profoundly affect the results. And Stravinsky did not himself utilize electronics to hear back the higher relationships of the overtone series. He could only imagine them, perhaps with Lithuanian folk music influence.

That Stravinsky chose "pitch," exclusively, as the musical element to watch for the future for music matches well my own musical investigations. Music has indeed moved enormously through new tuning systems and approaches. By not mentioning his specific preferences, as both Bach and Ives did not, Stravinsky kept close to the vest his personal side of music making. Personal, yet primary, based on his microtonal response to Robert Craft's open-ended question. No doubt hedging his bets, Stravinsky's prediction was already becoming a reality in his lifetime.

Stravinsky sought to give a historical perspective to his predictions about pitch.

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Adrian Willaert (1490-1562) was the prominent Flemish composer who was part of a dynasty of Dutch speakers in the Mediterranean, and who was preceded by Dunstable, Binchois, Dufay, and Tinctoris. Their revolution in tuning was through meantone tuning, which followed the Pythagorean tuning of spiraled fifths from the Middle Ages. The obvious exception was for fretted and strummed instruments such as the lute. Willaert is credited with a single composition that is said to have been designed for equal temperament.

> Adrian Willaert confounded supporters of Pythagorean and Just intonations with his four voice piece 'Quid non ebrietas,' written in 1519. Willaert intentionally wrote it so that performers would constantly run into musical commas, each setting the singers slightly off course. When sung in Pythagorean tuning, the melody concludes with a disastrous leap, slightly larger than a pure octave. Just Intonation produces a final octave leap too narrow. He designed the music to fail with either system; rather, he espoused a radical new tuning – what we today call equal temperament.

The second historical name that Stravinsky drops in regard to pitch is Gioseffo Zarlino (1570-1590), Nicola Vicentino's teacher. Zarlino was an ethnic Italian, the catalyst for the beginning of the first non-Flemish dynasty of Renaissance composers. Zarlino was known to favor 2/7ths comma meantone, as compared with the garden variety quarter-comma meantone of the Flemish composers. Most importantly, Zarlino acknowledged his support for the use of equal temperament for fretted instruments. I had been unfamiliar with any specific quartertone instruments devised by Zarlino. However, a simple Google search will bring up "Zarlino's quartertone instrument."
DENZIL WRAIGHT - Zarlino's 24-note harpsichord

Nicola Vicentino (1511-1575) was infamous in his lifetime as a microtonal musician, someone who added smaller relationships to the cultural pitch palette, including his building multiple multi-keyed keyboards. Vicentino positioned a dot above a note to indicate a slight sharpening of pitch, measured at less than a quartertone, although thought of generically throughout history as a quartertone simply for its diminutive size. Stravinsky was incorrect with his statement that Vicentino designed a archicembalo with "39 tones to the octave" as the instrument actually only had 36 keys total, as did a second instrument built by Vicentino. Although, most moderns scholar musicians interpret Vicentino's music through a 31-tone equal temperament lens, a tuning invented by Christian Huygens in the Baroque period to serve as a circular quarter comma meantone, Nicola Vicentino's aim was to rediscover the microtonal intonation of the ancient Greeks.

> The scales of the two instruments are identical, comprising thirty-six physical keys that are organized into two keyboards, each with three rows of keys. The Venetian organ builder Vincenzo Colombo built these instruments on Vicentino's commission. No historic specimen survives, but thanks in part to diagrams and descriptions that Vicentino published in *L'antica musica* and in another document, *Descrizione dell' Arciorgano* (1561), modern reconstructions have been possible.
> Microtonal Keyboard Instruments in Early Modern Europe | Sound & Science: Digital Histories (soundandscience.de)

Stravinsky was correct that these extra-keyed instruments were one-offs, and might be seen today only in museums, or through recent reconstructions. Knowledge of the well temperament of Bach was understandably substituted with modern equal temperament, even in Germany. Well temperament offers different sentiments in different keys, 39 different intervals per octave in Werckmeister III, while equal temperament has identical keys and is as such, redundant.

Stravinsky's rude comment about electronics is telling. By stressing that "the most important aspect of electronic music is the fact that it can manufacture pitch," one is both immediately drawn into the wonder with which modern electronics and computers have revolutionized music, along with its intrinsic microtonal potentiality, but also Stravinsky's paucity of electronic works, as somewhat anathema to his acoustic based aesthetic.

Most exciting is Stravinsky's rejoinder to present day circumstances regarding new adventures with pitch. "[B]ut our ears are more ready for such experiments now – mine are at any rate." My life has certainly improved my ear to the point that I work in a tuning named 128 tuning. It is based on a scale of the 128 notes found in the eighth octave of the overtone series above a single fundamental pitch, usually "A" for its commonality for tuning instruments and for the ease of naming by letters. After 15 years of work in making 128 music, there are several albums exclusively in 128 tuning, as well as new works by prominent contemporary composers, internationally.

Stravinsky's signals that he "is ready" for pitch experimentation. Since his passing, microtonal music has been in ascendency, and it is possible now for anyone to purchase the appropriate reasonably affordable synthesizer to admit the new microtonal vocabulary to the body of music. His admission here that he, at least, is ready, hints of the loneliness of his continual musical journeys. When he was a student of Nikolai Rimsky-Korsakov in St. Petersburg, Russia, he was in a fertile environment, surrounded by others eager to imagine intonationally on a grand scale. Stravinsky's music would remain in conventional notation, but it would permit a harmonics interpretation, with a 128 tuning interpretation, possible by the scale formed by the eighth octave of the overtone series.

Hermann von Helmholtz's famous book "On the Sensation of Tone," expected to be in the personal library of Charles Ives, demonstrated that modern conventional notation allows for three (3) different interpretations of its symbology: 1. Conventional equal temperament allows for a common pitch for sharps and their nearest flats. 2. Meantone and just intonation, where sharps are pitched lower than their nearest flats. And 3. Pythagorean tuning in which sharps are pitched higher than their nearest flats. Charles Ives idealized #3, and

I propose that Igor Stravinsky idealized #2, but to imagine higher harmonics than had previously entered much of contemporary theory, practice, or research.

When Stravinsky brought up his observance of a Japanese Kuramatengu play, he wasn't expecting his listening audience to be familiar with that particular type of musical presentation with its distinctive sounding Noh flute. Rather, he was emphasizing that his prediction of pitch was deeply anchored in world music, and neither restricted to either the present day, or to European culture. The world of cultural microtonal music includes, but is not limited to, Dastgah (Iran), Maqam (Egypt, Turkey, Syria), Pelog & Slendro (Indonesia), Higher Harmonics (Lithuania), and Equiheptaphonic-7-tone equal temperament (Thai, North Solomon Islands, Puna of Panama).

Stravinsky then announced he has the mental ability to strip the Japanese Noh flute of all its cultural accoutrements, to the exclusion of pitch expressivity, so that he can compare them in his mind, one abstract tuning to the next. Here we have evidence of Stravinsky's ability to abstractly retain and compare 2 different flute traditions, separated by several hours, for their expressivity, all while mentally removing other musical considerations. Stravinsky's last sentence is startling coming from a European composer, as he found modern tuning left him wanting.

> I was shocked, music apart—I think I could keep the music apart anyway—by the expressive poverty of the *tuning* (Igor Stravinsky).

(The italics for the word "tuning" in the quote belong to either the Stravinsky or the publisher. They are not mine.)

As for the use of 128 tuning, found ordered in the eighth octave of the overtone series, I offer the following evidence for its appropriateness. As Stravinsky used chromatic notation it is only possible to be taken literally with the acceptance of greater than 12 notes and intervals in his musical vocabulary. Yet Stravinsky did use equal temperament as well. 128 tuning provides for the major third, perfect fourth, and the tritone of equal temperament.

The simple use of the tritone in equal temperament is measured as less than a cent in difference from the position of the 181st harmonic, well within 128 tuning which reaches the 255th harmonic. As the best representative of the harmonic series of all the notes in the temperament of 12-tone equal temperament, the tuning Stravinsky expected to receive in his performances, Stravinsky nevertheless uses the tritone as a consonance in the opening of the Rite of Spring. After an outline of A minor in the unaccompanied bassoon solo,

the melody at last resolves to D# - the tritone - as a comfortable and pleasant consonance. As a D#, interpreted as a harmonic, this tritone is 10 cents flatter than the Eb at 600 cents.

The interval that first alerted me to the possibility of understanding Stravinsky through a microtonal lens was his consonant use of the tritone. The tritone, the result of bisecting an octave, had been used by other composers besides Stravinsky as a consonance, certainly by Jazz musicians who modulate by tritones. Leonard Bernstein's West Side Story's famous "Maria" melody has a tritone as its second interval, which is always sung lovingly and without any accent. Tritones, as a traditional dissonance, are typically accented. "Maria" is distinctive in its use of a consonant tritone in a song.

Leonard Bernstein's broadcast of his Harvard Lectures titled "The Unanswered Question" maintained that the piano was representative of the overtone series, with nary a mention of its classic equal temperament (although he did mention "theoretical" microtonal music more than once). Bernstein spoke sparingly about higher overtones, although he did argue for the 19th harmonic (which he confused with the 18th harmonic) as the basis for Western music's use of the minor third. The minor third is traditionally taught as arriving from an undertone derivation. In contradistinction, Bernstein properly acknowledged that major and minor thirds occur simultaneously in the overtone series, with the minor third described as "sad" precisely because it is so far away from the fundamental when it first appears. The 19th harmonic is only two cents shy of modern equal temperament at 298 cents and is covered well in 12 edo (equal divisions of the octave) at 300 cents, especially when vibrato is involved.

The major third of equal temperament measures 400 cents and is historically taught as a compromise derived from the fifth harmonic tempered 14 cents sharp. 14 cents is quite a bit of stretching for a harmonic, so much so that I question whether we don't need to look for a different source. As it happens, the 161st harmonic at 397 cents only needs to be tempered three cents sharp. Despite the newness of the number 161, this interval makes much more sense as the true modern source of the major third. (The 5th harmonic is no doubt beautiful and useful for early music, music which utilized an undertone series for its derivation of the 6/5 minor third of 316 cents and the 5/4 perfect fourth of 498 cents.)

The minor sixth is best represented by the 203rd harmonic. Equal temperament's minor sixth is tempered two cents higher in temperament. The major sixth is best represented by the 215th harmonic, this time tempered two cents lower in temperament.

The perfect fourth in equal temperament is measured at 500 cents. Early music produced the *raison d'être* for its perfection as due to its derivation in the undertone series, and as the result of the subtraction of a perfect fifth taken from an octave, leaving a historic perfect fourth at 498 cents. However, the 171st harmonic is only a single cent sharper than equal temperament at 501 cents, not even noticeable to traditional listeners.

The major seventh is best represented by the 121st harmonic at the end of the seventh octave of the overtone series, and equal temperament's version has tempered it sharp by 3 cents. Fundamentally, there are 5 out of 12 notes of 12-tone equal temperament found as harmonics exclusively in the eighth octave of the overtone series, and they are already a part of contemporary music practice. These are the major third, perfect fourth, major sixth, minor sixth, and the tritone. 128 tuning removes all traces of temperament from contemporary music and is meant as an advancement in music in the spirit of Stravinsky's emphasis on pitch.

The minor second is best represented by the 17th harmonic in 128 tuning, placing it five cents sharper than equal temperament. (It would be one cent lower than a 271st harmonic from a projected ninth octave of the overtone series, but that entails a projected 256 tuning. My composition "Asteroid Belt" for cello makes exclusive use of the virgin notes of the ninth octave of the overtone series, and is to be premiered on September 5, 2021 by Dave Eggar on Zoom. Contrasting the lowest semitone which has the least amount of alternatives in 128 tuning, is the leading tone G# intervals have many variants of semitone available as befits its role.

The minor seventh is best represented in 128 tuning by the 57th harmonic at 1001 cents. (A complete list of all 128 pitches is attached at the end of this paper.) Equal temperament tempers the minor seventh found in the overtone series flat by a single cent. The major seventh is best represented by the 121st harmonic which is measured at 1103, only 3 cents tempered down to the 1000 cents of equal temperament.

Lastly, the whole tone is measured at 105 cents by the 17th harmonic and may be notated by a Bb. With the whole tone we have the most tempered of the harmonics that could stand in for 12-tone equal temperament, a deviance of 5 whole cents. The tuning chart affixed to the beginning of this article includes only the known notes found in Igor Stravinsky's scores, 24 different notations total.

One piece of aural evidence is a miniature bassoon duet by Igor Stravinsky titled "Lied Ohne Name" (1918), published by Boosey & Hawkes (1979). I first played the one-page score in NYC, recording it with my colleague, bassoonist Sara Schoenbeck. It has since been released as a video on the AFMM channel on YouTube. It has both the C# and the Db working tonally as distinctive.
Igor Stravinsky - LIED OHNE NAME - YouTube

St. Petersburg Recital Poster designed by Ciarán Ó Meachair

The evidence continues with a solo recital that I gave at the Nicolai Rimski-Korsakov Home Museum in St. Petersburg in 2012. During the Sunday Recital, I asked the full audience if I might be permitted to perform Stravinsky's "Leid Ohne Name" ("Song Without Name") for them twice, once in conventional tuning, and once in 128 tuning. And with their eager approval, I continued to everyone's evident amazement to demonstrate the "expressive" difference in the music, this time with Russian bassoonist Rezeda Gabdrakhmanova. (I had previously compiled a book of bassoon fingerings in 128 tuning for the bassoon based on an A at 440 and could pass this to other bassoonists for study.) The comparison to the Russian concert goers was clear, as was their obvious preference for their collective 128 experience.

I can indeed imagine all of the great works of Stravinsky being performed in the future within a microtonal dimension. In fact, since writing a Masters thesis at Columbia University, "Phenomenology and its Application to Microtonal Music," I believed all music was microtonal. After all, I was in the

Ethnomusicology department of the General School of Graduate Studies and I could define microtonal music as if it was a universal, except for 12-tone equal temperament. After 40 years of directing the American Festival of Microtonal Music Inc. in New York City (since 1981), I developed a definition of microtonal music for a new virtual microtonal university that starts September 5, 2021, on Zoom. This definition allows me to see Igor Stravinsky as a microtonalist in spirit even as he never produced a piece of obvious microtonality in his lifetime.

> All music is microtonal music cross-culturally. Twelve-tone equal temperament is, in itself, a microtonal scale, only it enjoys exorbitant attention and hegemonic power, so we focus on the other tuning arrangements.

Of course, I recognize the liberties that a talented modern orchestral musician may take in order to acquire greater expression in the playing of a piece of music, often starting with instrumental tone. However, as the short Stravinsky bassoon duo "Leid Ohne Name" previously demonstrated, "Firebird" and the "Rite of Spring" would also benefit from losing its temperings, the deliberate out-of-tune-ness inflicted for an earlier historical compromise, for the powerful justness of 128 tuning's intonation.

128 tuning allows for the simultaneity of any and all of its pitches, in any combinations, to have the sensibility of being a single chord. The greater counterpoint provided by the added microtonal vocabulary removes the dull identity-less harmonies of conventional equal temperament that Stravinsky found boring and dull. The full *Gestalt* of an harmonics-rich tuning, on top of the already established brilliance of Stravinsky's imaginative rhythms and orchestration, further enriches the charms of tonality.

> Wagner may have been Stravinsky's *bête noire* but, like all great artists who came after Wagner, Stravinsky benefitted from Wagner's model, even if he rejected his aesthetic ("A Violent Luxury: Robert Craft and Igor Stravinsky" by John Browening).

Thanks to Richard Wagner, any other composer to follow in his tradition, certainly one who sat at the piano to compose, would find each note related to every other note in a unified field theory for harmony using the tuning system of 12-tone equal temperament.

Finally, it is the power of Slavic and Baltic folk musics that provided the true foundation needed to bring out his musical ideas, although Stravinsky was known to credit his dreams at night for his font of creative ideas. It just so happens that there is a particular Baltic folk music that is rich with higher

harmonics. Young Igor Stravinsky likely picked up on the higher harmonic microtonal music of Lithuanian folk music, as he paid attention to these European roots throughout his youth.

According to Lithuanian composer scholar Vytautas Germanavičius in a recent July 3, 2021 Zoom presentation titled: Identification of Microtonal Intervallic Relations in Lithuanian Vocal and Instrumental Folk Music and their Application in Music Composition, folk music in his country may normally reach the 31st harmonic in the polyphonic Sutartinės. Using a *Melodyne*, Vytautas Germanavičius analyzed numerous Lithuanian music types for their specific harmonic identities, and generously shared his data for this paper.

Number of harmonics identified in recorded samples of 39 sutartinės, 34 monodies, 16 horns, 7 panpipes, 3 kanklės (stringed instrument)

Harmonics:	**1**	**3**	**5**	**7**	**9**	**11**	**13**	**17**	**19**	**21**	**23**	**25**	**27**	**29**	**31**
Sutartinės:	39	2	3	1	1	1	8	4	2	1	1	5		13	1
Monodies:	34	4	2		2	5	2	3	5	6	1	2		7	
Horns:	16	1	4	2			3	1	1	4	1			3	
Panpipes:	7	1	1		1	2	1							1	1
Kanklės:	3	4	2												

The lecture further discussed Lithuanian wooden trumpets that are pre-tuned to higher harmonic proportions. The instruments are rather solid so that children can readily play them, and they are an old part of the Lithuanian culture. The concept, as I understand it, is that people learned to sing these same higher harmonic instrument relationships from the pre-tuned wind instruments, only to expand upon them. Germanavičius found higher harmonics were the most common:

> In this table you can see the number of overtones with their serial numbers that were detected and calculated when analyzing the vocal and instrumental music samples. I identified the most common 9 overtones (Nos. 29, 13, 21, 17, 19, 25, 3, 11, and 5), (B♭+, G#+, -F, C#, E♭, G#+, G, F+, E) and additionally 5 microtonal overtones Nos 29, 13, 21, 25, 11 (B♭+, G#+, -F, G+, F+,) in vocal music, as well as

not so frequently used overtones Nos. 7, 23, and 31 (-B♭, -G, B+). For instrumental music were identified 3 microtonal overtones Nos 29, 21 and 13 (Bb+, E+, G#+). And for all samples commonly used microtonal overtones are Nos 29, 21, and 13 (Bb+, E+, G#+) (Germanavičius).

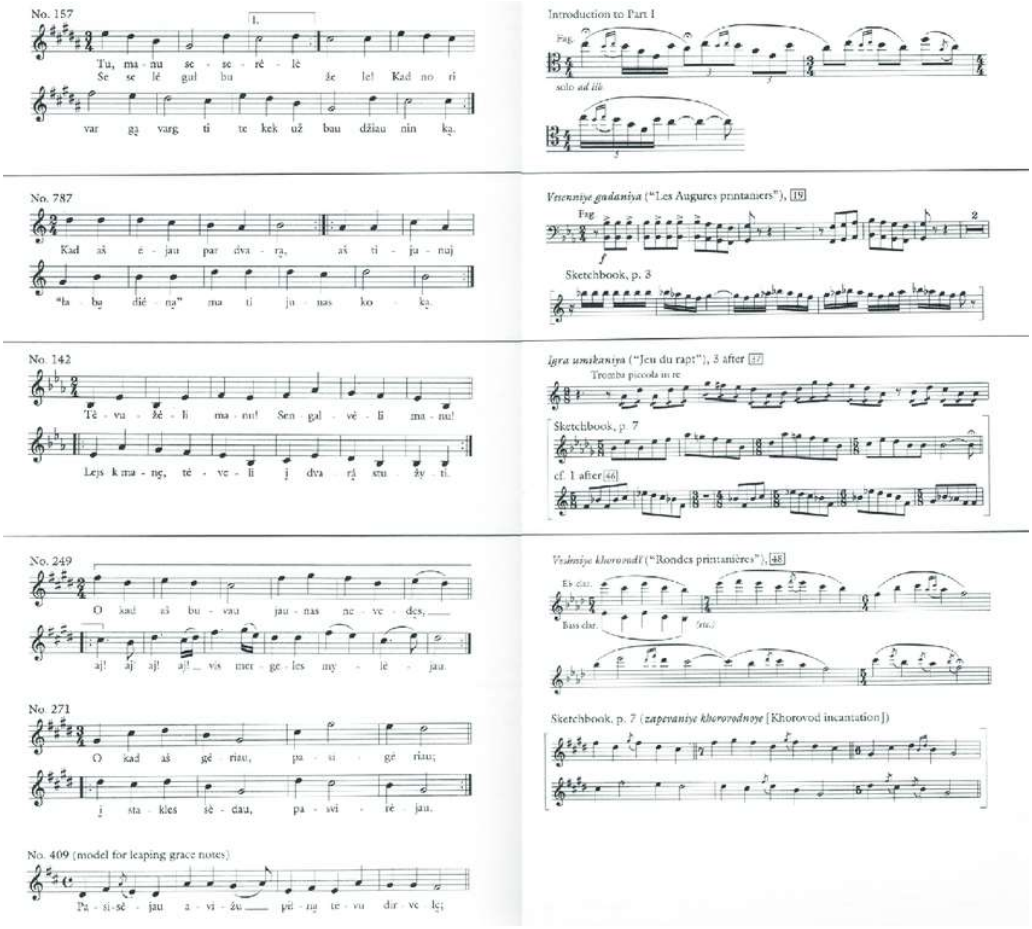
Only a few days after the Lithuanian harmonics lecture, composer scholar Ben Lunn in Scotland sent me two YouTube videos, which serve as great ambassadors to the rich treasure of higher harmonic folk music. My thanks to Ben Lunn for providing these links:

wooden trumpets: https://youtu.be/JXPZYuU-xzU

a cappella voices: https://youtu.be/zeEnhlRteiA

Lithuanian folk song motifs and music ideas posted from Juška's Anthology correspond to Igor Stravinsky's melodies in The Rite of Spring as identified by prominent contemporary musicologist Richard Taruskin (1996).

Lithuanian folk songs from Juška's anthology corresponding with... | Download Scientific Diagram (researchgate.net)



Lithuanian musicologist Rūta Stanevičiūte has recently written about microtonal music from a Lithuanian perspective. In the published article "Microtonal Music: From the Baltic to the Adriatic and beyond the Atlantic" Rūta Stanevičiūte focuses on the greater question, not dissimilar to that of Igor Stravinsky, and also with the power of the Lithuanian folk tradition in harmonics behind them.

MICL - Music Information Centre Lithuania | Rūta STANEVIČIŪTĖ | Microtonal Music: From the Baltic to the Adriatic and beyond the Atlantic

I am grateful to have had the opportunity to have been quoted as a feature on just that very question, the future of pitch, in the Stanevičiūte article published by the Lithuanian Music Centre.

> Our ears are expanding in correspondence with our minds and appreciating finer degrees of musical intervals is a natural consequence. Hegemonic 12-tone equal temperament was the opposite direction having reduced our appreciation of intervallic specialness in lieu of uniformity of irrationality.
>
> Johnny Reinhard, composer, performer, Founder of the American Festival of Microtonal Music.

"Eighth Octave of the Overtone Series Tuning," otherwise known as "128 tuning" for its number of pitches in the scale is ideal for its inclusion of 12-tone equal temperament relationships. As indicated in Robert Craft's question, 128 tuning is exactly the answer to the "radical exploitation" of pitch.

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128 Notes of Eighth Octave Overtone Tuning

Harmonic	Cents	Name of interval
1	0	unison
129	13	sixteenthtone
65	27	eighthtone
131	40	smaller quartertone
33	53	quartertone
133	66	large quartertone
67	79	small semitone / 3-eighthtones
135	92	minor semitone
17	105	Bb, major semitone
137	118	large semitone
69	130	big semitone
139	143	small three quarters of a tone
35	155	large three quarters of a tone
141	167	diminished whole tone
71	180	small whole tone
143	192	minor whole tone
9	204	B, major whole tone
145	216	large whole tone
73	228	whole plus eighthtone
147	240	5ET diesis
37	251	five quarters of a tone
149	263	diminished minor third
75	275	low minor third
151	286	small minor third
19	298	minor third
153	309	low just minor third (referencing 316)
77	320	high just minor third (referencing 316)
155	331	large minor third
39	342	big minor third
157	354	neutral third
79	365	tiny major third

159	375	eighthtone flat major third
5	386	C#, just major third
161	397	ET major third
81	408	Pythagorean ditone
163	418	large Pythagorean ditone
41	429	Db
165	440	small quartertone sharp major third
83	450	quartertone sharp major third
167	460	tiny fourth
21	471	low fourth
169	481	minor fourth
85	491	major fourth
171	501	ET perfect fourth
43	512	perfect fourth, D
173	522	fourth plus comma
87	532	fourth plus a fifthtone
175	541	fourth plus small quartertone
11	551	eleventh harmonic
177	561	tiny tritone
89	571	low tritone
179	581	minor tritone
45	590	D#
181	600	Eb, ET tritone
91	609	large tritone, Eb in tonal music
183	619	big tritone
23	628	eighthtone high tritone
185	638	quartertone and sixteenth flat dominant
93	647	quartertone flat dominant
187	656	tiny dominant
47	666	small dominant
189	675	eighthtone low dominant
95	684	irregular perfect fifth
191	693	sixth comma flat fifth
3	702	perfect fifth
193	711	poodle fifth
97	720	large fifth
195	729	howling dominant
49	738	sixthtone high dominant
197	746	three quartertones high perfect fifth
99	755	quartertone high perfect fifth
199	764	quartertone and 16th tone high fifth

25	773	quartertone and eighthtone high fifth
201	781	almost minor sixth
101	790	tiny minor sixth
203	798	ET minor sixth
51	807	minor sixth
205	815	just minor sixth
103	824	large minor sixth
207	832	big minor sixth
13	841	thirteenth harmonic
209	849	quartertone high minor sixth
105	857	quartertone plus minor sixth
211	865	almost major sixth
53	874	tiny major sixth
213	882	small major sixth
107	890	just major sixth
215	898	ET major sixth
27	906	major sixth
217	914	sixthtone high major sixth
109	922	eighthtone high major sixth
219	930	eighthtone and 16th tone high major sixth
55	938	large major sixth
221	945	big major sixth
111	953	three quartertone sharp major sixth
223	961	small harmonic seventh
7	969	harmonic seventh
225	977	large harmonic seventh
113	984	tiny minor seventh
227	992	small minor seventh
57	999	G, minor seventh
229	1007	large minor seventh
115	1015	big minor seventh
231	1022	double perfect fourth
29	1030	eighthtone high major seventh
233	1037	eighth- and 16th tone high minor seventh
117	1044	three-eighths flat major seventh
235	1052	quartertone flat minor seventh
59	1059	tiny major seventh
237	1066	diminished major seventh
119	1074	eighthtone flat major seventh
239	1081	small major seventh
15	1088	major seventh

241	1095	large major seventh
121	1103	ET major seventh
243	1110	big major seventh
61	1117	Ab, large minor seventh
245	1124	eighthtone plus major seventh
123	1131	leading tone major seventh
247	1138	sharp leading tone major seventh
31	1145	hyper leading tone major seventh
249	1152	quartertone flat octave
125	1159	three-eighths flat octave
251	1166	eighthtone flat octave
63	1173	small octave
253	1180	comma flat octave
127	1186	dipped octave
255	1193	preoctave