Microtonality in Western Music

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In traditional Western musical practice, composers rarely deviate from the dominant tuning system at the time, whether it be Quarter Comma Meantone Temperament or 12-tone Equal Temperament. Since Western music usually divides an octave into 12 notes, music that divides an octave into more than 12 notes are usually referred to as "microtonal music." Recently, however, the term "microtonality" is used to describe any musical practice that deviates from the 12-tone Equal Temperament.

In this article, we will first look at the mathematical background of denoting microtonality, and then two ways of implementing microtonality in Western music: alternative equal temperament and just intonation [1].

Disclaimer

This article will examine microtonal music from a Western perspective. In many cultures in the world, the octave is not divided into 12 tones, so in their perspective, microtonal music might be the norm [2].

Cents

In the 12-tone Equal Temperament, an octave is divided into 12 equal intervals, each called a semitone, and each with a ratio of $\sqrt[12]{2}:1$. To better denote the deviation from the 12-tone equal temperament and help the intuition of musicians, a notation system called Cent is developed.

The motivation of the cent system is to transform the multiplicative ratio values of intervals into their additive logarithms. Each semitone's ratio is equal to 100 cents, and the formula for this transformation is as follows:

$$k(r) = 100 \log_{\sqrt[12]{2}} r = 1200 \frac{\ln r}{\ln 2}$$

where k denotes the interval in cents and r in ratios.

Then our cent values have the additive property:

$$k(r_1) + k(r_2) = 1200 \frac{\ln r_1}{\ln 2} + 1200 \frac{\ln r_2}{\ln 2} = 1200 \frac{\ln r_1 + \ln r_2}{\ln 2} = 1200 \frac{\ln(r_1 r_2)}{\ln 2} = k(r_1 r_2)$$

Now, we can use the cent values to examine several ways Western musicians implement microtonality.

Alternative Equal Temperament

The most intuitive way to compose microtonal music is to use n-tone Equal Temperament (denoted n TET below for brevity), where n is a number different from 12. This divides the octave equally into n equal units. In this paper, we will discuss two n TET system most common to Western Music: 24 TET and 19 TET.

24 TET

24 TET is the most common alternative equal temperament system in Western music, predominantly because of its ability to preserve all original tones in 12 TET. An intuitive way of thinking about it is to insert one additional note into each semitone in the 12-tone Equal Temperament. Each unit in 24 TET has an interval of $\frac{1200}{24} = 50$ cents.

Classical musicians usually compose and play music in 24 TET by using two pianos, one of which tuned a quarter tone below, such as Ivan Wyschnegradsky's *24 Preludes for Quarter-Tone Piano*. In the third prelude in this collection, Wyschnegradsky utilizes the dissonance and out-of-tune character of the quarter tone to accentuate the eeriness of his melody.

19 TET

19 TET is another very common alternative equal temperament in Western music, with each unit having an interval of $\frac{1200}{19} = 63.16$ cents. 19 TET's popularity stems from the fact that composers can build a major scale from the notes in 19 TET [3]. In the 12 TET major scale, the intervals are whole steps (2 semitones/units) and half steps (1 semitone/unit):

Interval	W	W	H	W	W	W	H
Units	2	2	1	2	2	2	1

In the 19 TET major scale, however, the intervals are large steps (3 units) and small steps (2 units). So instead of a $2:1$ ratio between the larger interval and the smaller interval, major scale in 19 TET has a $3:2$ ratio:

Interval	L	L	S	L	L	L	S
Units	3	3	2	3	3	3	2

Below is a comparative list of the notes diatonic to C Major as well as their interval to C in 12 TET and 19 TET:

Note	C	D	E	F	G	A	B
12 TET Interval	0	200	400	500	700	900	1100
19 TET Interval	0	189.48	378.96	505.28	694.76	884.24	1073.72
Deviation	0	-10.52	-21.04	+5.28	-5.24	-15.76	-26.28

Although some notes have large deviations from their 12 TET counterparts, this is still a very successful alternative equal temperament.

Just Intonation

Just intervals are intervals between the harmonic series. Since the harmonic series have frequencies that are integer multiples of the base frequency, just intervals are all rational. Also, since the harmonic series are theoretically infinite, there are theoretically infinitely many just

intervals. However, since 12 TET is based on the integer powers of $\sqrt[12]{2}$, we have lost every non-octave-based just interval. This means the just intervals can be considered microtonal:

- 3:2 “Perfect Fifth” – 701.96 (1.96 cents sharp)
- 5:4 “Major Third” – 386.31 (13.69 cents flat)
- 6:5 “Minor Third” – 315.64 (15.64 cents sharp)
- 15:8 “Major Seventh” – 1088.27 (11.73 cents flat)

Therefore, composers can implement microtonality using just intervals, and the results are usually called just intonated music.

One example of just intonated music is Ben Johnston’s *String Quartet No.7*. Johnston utilizes the versality of fretless string instruments – violin, viola, and cello – to compose a piece of music that completely disregards the 12-tone Equal Temperament. To someone most familiar with traditional Western music, this piece of music often sounds strange and out-of-tune, since it is composed outside of the grid of 12 TET, and indeed any kind of equal temperament. Yet because it utilizes just intonation, the music also sounds harmonious. This juxtaposition of strangeness and harmony creates a beautiful soundscape in this piece of music.

Another example of just intonation is Jacob Collier’s arrangement of the Christmas carol *In the Bleak Midwinter*. In his arrangement, he uses just intonation to modulate from the key of E Major to G Half-Sharp Major. This modulation happens over the course of four chords, and it is accomplished by raising the notes a little bit sharper in each chord according to just intonation, and through these 4 chords, he raised the notes 50 cents sharper in total, resulting in the key of G Half-Sharp Major [4].

Conclusion

In many ways, music is a science. Therefore, musicians are able to produce great results by following the rules. However, music is also an art, so breaking the rules can sometimes result in many beautiful things as well, even if the rules broken are as fundamental as the tuning system.

References

[1] “Microtonality in Western Music.” *YouTube*, uploaded by David Bennett Piano, 22 May 2020, https://www.youtube.com/watch?v=q1XOnIk2ai8&t=137s

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[4] “How to Modulate to G 1/2 Sharp (Jacob Collier-style).” *YouTube*, uploaded by David Bruce Composer, 12 July 2019, https://www.youtube.com/watch?v=Xd54l8gfi7M&t=671s