Playing Melodically and Harmonically in Tune

Michael Kimber

One of the goals of scale and arpeggio practice is the perfection of intonation in all keys, throughout the entire range of the instrument. Good intonation depends on a number of factors, including:

1) continual, intent listening, both to ourselves and to others with whom we are playing
2) ability to match, adjust, and reproduce pitches with precision
3) excellent pitch memory and relative pitch (not the same as absolute or perfect pitch)
4) a clear awareness of intervals
5) a comfortable and reliable technique
6) a thorough familiarity with the fingerboard
7) an artistic desire to create beautiful sounds
8) sensitivity to melodic and harmonic influences.

The importance of the first seven points is commonly understood. The eighth point, sensitivity to melodic and harmonic influences, is generally not so well understood, however. Hopefully the following explanation will help.

As electronic tuning devices become more and more widespread, these tend to be accepted as the standard for correct intonation. However, these devices represent only one scale, and an artificial one at that: the scale of equal temperament, the present-day basis of tuning pianos and other keyboard instruments. Equal temperament, a scale of twelve equal semitones, enables keyboard instruments to sound tolerably well in tune in any key. However, fitting all intervals of all keys into a scale of only twelve equally-spaced notes per octave requires compromises in the tuning of every interval except the octave. In other words, every equal-tempered interval is actually slightly out of tune! Consequently, perfect adherence to equal temperament alone will not result in perfect intonation.

The fixed scale of equal temperament can only hint at the sound of beautiful intonation. Playing in tune is an art. It depends on finding what sounds best in any given situation, and that is subject to tonal, acoustical, expressive, and even psychological considerations. While an overall consistency of pitch is certainly desirable, intonation cannot be inflexible; pitches sometimes need to be inflected very slightly upward or downward in order to be in tune.

The need for such inflection of pitch can easily be demonstrated. With your instrument well tuned, play first finger E on the D string, tuning it first as a double stop with open A, then as a double stop with open G. The E which is in tune with open A will sound too high when played with open G; it must be lowered in order to sound in tune. The higher E agrees with the violin's E string, tuned in a series of perfect fifths which includes C, G, D, A, and E. The lower E fits harmonically into the C major triad (C-E-G) and agrees with the fifth harmonic partial E of the C harmonic overtone series.

Some simple computations will explain this phenomenon. The upper note of a harmonically pure perfect fifth vibrates at 3/2, or 1.5, times the frequency of the lower note . Every time we tune upward a pure fifth, we multiply the frequency by 1.5. After tuning upward through four fifths (C-G, G-D, D-A, and A-E) we arrive at an E with a frequency 1.5^4, or 5.0625, times that of C. This disagrees with the E in the harmonic series of C, which vibrates exactly 5 times the frequency of C. This audible discrepancy—5.0625 vs. 5—known as the syntonic comma accounts for the difference between the two pitches of E noted above. It is at the root of most of the intonation adjustments we need to make in order to play double stops and chords in tune.

After tuning twelve pure perfect fifths another discrepancy appears: B# comes out higher than C. In fact, every sharp in this tuning is slightly higher than its enharmonic flat or natural, and every flat is correspondingly lower, by an amount known as the Pythagorean comma—about the same size as the syntonic comma heard above.

In equal temperament the discrepancy of the Pythagorean comma is avoided by using tempered (slightly mistuned) perfect fifths: 1.4983071 instead of 1.5. Even though this distributes the enharmonic discrepancy among all the notes of the scale so that it is not too noticeable, we string players cannot ignore the cumulative effect of this small alteration of the fifths.

When listening and playing melodically, we tend to follow the Pythagorean scale based on pure fifths (starting from our open strings); our sharps are a shade higher, our flats a shade lower, than in the scale of equal temperament. However, when we are more focused on harmonic blend, as in double stops and chords, we may favor just intonation, which actually involves some reversals of these Pythagorean tendencies. Because our music is a blend of melody and harmony working in tandem, *our intonation must weave an artistic path from one tendency to the other*.

This is not to say that electronic tuners are of no use. Pitch matching is an essential skill. When playing with keyboard accompaniment, we may even wish to follow equal temperament quite closely. However, we must not content ourselves with the misleading notion that the ability to match precisely every note on the tuner—or the piano—represents the achievement of perfect intonation; it does not!

To summarize, good intonation requires an ability to adjust to contrasting ways of tuning intervals:

1) Pythagorean tuning—harmonic ratios of 3 and 2, which organize a framework of melodic pitch relationships emphasizing the distinction between major and minor intervals;
2) just intonation—harmonic ratios involving 5 as well as 3 and 2, resulting in harmonically tuned thirds and sixths having a more subtle distinction between major and minor; and
3) equal temperament—essentially an adaptation of Pythagorean tuning (the fifths being tuned slightly narrow) to fit keyboard instruments having twelve fixed pitches per octave.

The Pythagorean comma, which results from tuning twelve pure fifths, causes sharps to be 24% higher than their enharmonic flats, a phenomenon consistent with melodic expressive tendencies, including but not limited to the “high leading tone.” In melodically expressive *Pythagorean intonation* the differences between major and minor intervals are somewhat more pronounced than in equal temperament.

The syntonic comma, the discrepancy between the fifth harmonic partial and the tuning of four pure fifths, causes sharps to be generally *lower* than their enharmonic flats, requiring a 22% reversal of melodic expressive tendencies when tuning double stops and chords to achieve the purest harmonic agreement. In harmonically pure *just intonation* the differences between major and minor intervals are slightly less pronounced than in equal temperament.

Equal temperament allows for no melodic or harmonic tendencies. Enharmonics such as G sharp and A flat are identical in pitch. Octaves are nominally in tune. Fourths and fifths are 98% in tune; major seconds 96%; thirds and sixths are in tune 92-94% melodically, only 84-86% harmonically; semitones 90% or less in tune. While equal temperament may earn a grade of A or A- overall, it is *not* perfection.

A word of caution: the differences between melodic and harmonic intonation and equal temperament are quite subtle. Exaggerated attempts to play melodically or harmonically are likely to result in simply being out of tune. The awareness that intonation needs to be sensitive to contrasting melodic and harmonic influences can enhance our understanding, but it must never be a substitute for intent listening.

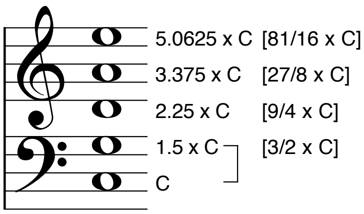
The chart on the following page illustrates fundamentals of melodic intonation, harmonic intonation, and equal temperament.

Melodic and Harmonic Intonation in Relation to Equal Temperament

When playing melodically we are influenced by the compelling relationships among perfect intervals—fourths, fifths, and octaves. When tuning chords and double stops we are influenced by the harmonic series, including harmonically pure thirds and sixths. When playing with keyboard accompaniment we are influenced by equal temperament. To play in tune we must weave an artistic path among these influences, listening intently and adjusting to achieve the most musically satisfying effect at any given moment.

1 · MELODIC INTONATION

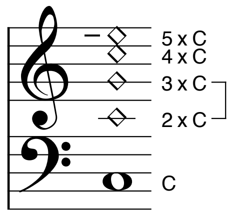
Harmonically Pure Perfect Fifths
(Basis of Pythagorean Intonation)



compare:
5.0625 x C ≠ 5 x C
E ≠ E–
The difference is 21.5 cents*
—the *syntonic comma.*

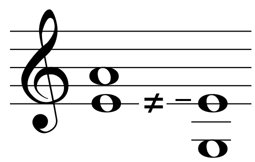
2 · HARMONIC INTONATION

The Harmonic Series
(Basis of Just Intonation)

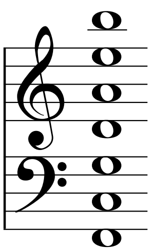


Every note we play is actually a series of harmonics extending even beyond the pitches shown here. When we tune harmonic intervals, as in double stops and chords, it is agreement among harmonics that informs us that the notes are in tune with each other.

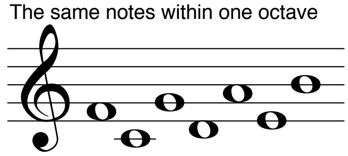
Pythagorean E is higher than the E– of the harmonic series of C. While melodically desirable, E is not in tune harmonically with the C (or G). Adjustment is needed when both E and C (or G) are sounding at the same time. We can observe this by playing the two double stops at right. The E must be adjusted!



Pythagorean Tuning Extended to Yield
the Seven Notes of the C Major Scale

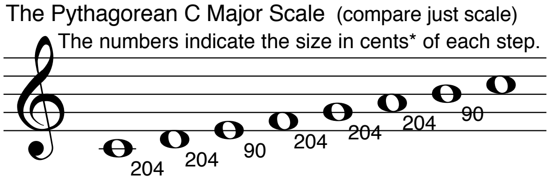


The same notes within one octave



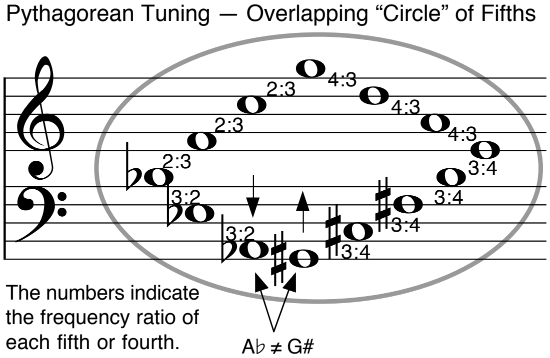
These pitches, in stepwise order, form the Pythagorean C major scale below.

The Pythagorean C Major Scale (compare just scale)
The numbers indicate the size in cents* of each step.



Notice consistently wide whole tones and narrow semitones, reflecting our "expressive" melodic tendencies.

Pythagorean Tuning — Overlapping "Circle" of Fifths

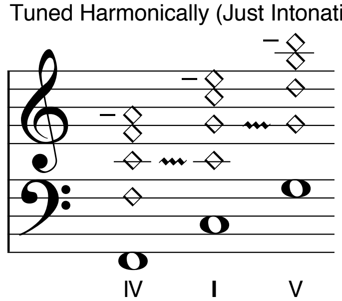


The numbers indicate the frequency ratio of each fifth or fourth.

The ♭/# difference is 23.5 cents* — the *Pythagorean comma.*

The Pythagorean comma reflects our melodic tendencies to play sharps higher than flats and to emphasize major/minor distinctions. (Harmonically we must often do the reverse.)

The Primary Triads (I, IV, V) in C Major
Tuned Harmonically (Just Intonation)

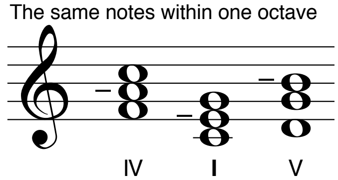


⁓ = partials that coincide when tuning pure fifths

The roots of the primary triads are pure perfect fifths apart. The third and fifth of a just triad are tuned in relation to the harmonic partials of its root.

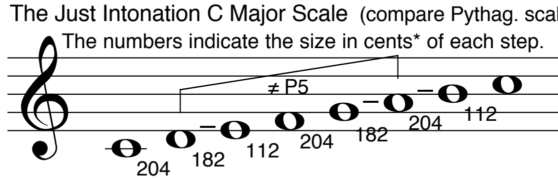
Note that the third of the just triad is a comma lower than if it had been derived by tuning only perfect fifths (Pythagorean).

The same notes within one octave



The pitches of these primary triads provide the notes of the just intonation C major scale below.

The Just Intonation C Major Scale (compare Pythag. scale)
The numbers indicate the size in cents* of each step.



Note that the interval from D to A– is a comma narrower than a true fifth, requiring adjustment when both notes are sounding at the same time. Most players find the 182-cent whole tones and 112-cent semitones melodically less satisfying than their Pythagorean counterparts.

3 · EQUAL TEMPERAMENT

Equal temperament is the present-day [mis]tuning of keyboard instruments. It avoids the Pythagorean comma by using fifths that are about 2 cents (1/12 comma) narrow. Unlike historic keyboard temperaments, it makes no attempt to provide any harmonically pure thirds. Equal temperament, with its 12 equal semitones, only approximates true intervals, although it does so equally in all keys. **Good intonation is better!**

* There are 1200 cents in an octave — 100 cents in each semitone on the piano.