Tuning for a Three-key chromatic autoharp - Bob Lewis May 16, 2021

I will begin by defining my terms. A chromatic autoharp for our purposes does not play in every key and is limited in stock models to 15 or 21 chords. The number of key signatures covered by either one is C plus 2 flats and 2 sharps (Bb, F, C, G, D). The 21 chord adds one flat and one sharp (Eb and A, majors only) to complete the array of keys commonly found in printed compositions, uncomplicated and generally playable sheet music.

To apply the term three-key to a chromatic merely refers here to the keys that are tuned sweeter without making the others unplayable. The number is three, because once moving beyond that, the tuning is difficult to distinguish from Equal Temperament ("standard"). Those remaining keys would be nice to have, but a player would naturally gravitate to the three that have been favored by the temperament. Happily, those keys would be the ones most used. However, once going down this road and recognizing which keys sound better and why, one might have at least two instruments to separate sharp keys from flat, while including C on any one of them, i.e. a BbFC that can still play a good G and a CGD that can still play a good A.

The standard model does not play a good Eb, so I have not included that here. Eb is a wonderful key and vocal range, but the autoharp's note and string array in the lower end would need to be customized along with all the felting, chord selection, and chord layout to do it justice and bring it alive. I have a special AbEbBb setup that accomplishes this, giving up support for C, but that is yet another autoharp to own, maintain, or carry around.

The Setup

This is only a tuning scheme, a temperament, with nothing to change on the instrument, which could be nonstandard for other reasons. However, consideration should be given to locating the chord bars for the favored keys in an area over the strings that will not cause any harmonics (chiming of notes that do not belong to the chord spelling) to be too prominent. More or less in the center of the key series will usually be optimal. For example, if more flat key, like BbFC, the chords for those might be moved down the line one tier. Whatever got pushed off the end in so doing becomes more flats or diminished 7ths on the other end that had been vacated.

Before EbBbFCGDA
After AbEbBbFCGD
Or Cdim7 EbBbFCGD

The Temperament

There is all sorts of theory involved here, not the least of which is mathematics, but the essential application is quite straightforward. I will be borrowing from C. Di Veroli – Unequal Temperaments: Theory, History and Practice, although his analysis leads to exactly the same result as Thomas Young in 1800, the second of two temperaments named for him. Di Veroli refers to the scheme as 1/6 comma attenuated, while I will refer to it as Young II.

The temperament is based upon reduction of the fifth intervals from pure by 1/6 of the Pythagorean comma (3.91), a story in itself as a sidebar. Equal Temperament has fifths already reduced by 1/12, so to use a common tuner to accomplish the settings, all numbers are stated +- from ET. For example, A could be 0, while E could be -2 (rounded from 1.955, half of the 3.91).

The scheme here is that if all the keys were pleasing (sweet), the instrument would be incompatible with other instruments. The following illustrates what is achieved if the fifth is regular (same size) for every one of them:

Notes in order of fifth intervals, values rounded:

Eb 12
Bb 10
F 8
C 6
G 4
D 2
A 0
E -2
B -4
F# -6
C# -8
G# -10

Using the notion that there should be a 6-cent limit in the deviation from Equal Temperament, beneficial to sonority but not disturbing in most circumstances, the following alteration gradually retracts (attenuates) the 2-cent increment once reaching 6:

Eb 0
Bb 2
F 4
C 6
G 4
D 2
A 0
E -2
B -4
F# -6
C# -4
G# -2

This is precisely what Young II offers. Valotti is similar but favors C instead of Young's G. Now let's analyze intervals to see the benefits and limitations here.

Chord Analysis of Young II

It needs to be understood that a good major third interval is not 400 cents (four half steps, 100 each) as in ET but rather 386 cents as in Just Intonation (-14). Good minor thirds are more sharp that ET, with a pure minor being +16. Most tuning schemes attempt to preserve some of JI while recognizing the impracticality of JI for general purposes. JI has some intervals that are virtually unplayable, while modifications to it attempt to make every chord in a scale acceptable. The usual approach is to take something away from (flatten) the fifth intervals. If all fifths are modified alike, the scheme is a "regular" temperament. If some keys are better than others, some fifths of a different size, the schemes are "irregular" temperaments. Young II is irregular but based in regular logic and indeed regular for the central, most pleasing keys, before the 6-cent limit is reached and attenuation begins.

When referring to a temperament or chord or interval as "pleasing", the intent is to describe what many refer to as "sweet", better than Equal Temperament, which for chording is quite edgy or tense and compromised (not sweet per se).

To analyze chords for the sake of cursory evaluation of a temperament we look at triads comprised of fifths, major thirds, and minor thirds. A major chord is a major third plus a minor third (M+m). A minor chord is a minor third plus a major third (m+M).

We can list triads as each starting on a root of one of the notes listed above and obtaining the value shown. For example, C Major (CEG) would be +6-2+4, with the major third of -8 and minor third of +6...a pleasing chord. A perfect C would be +6-8+8 and useful only on a single key F, C, or G solo instrument that cannot play all its minors in tune, thus the compromises and tuning schemes.

Majors (want a flattened third)

EbGBb 0+4+2 perfect fifth, sharp third (+4)
BbDF 2+2+4 perfect fifth, ET third (+0)
FAC 4+0+6 perfect fifth, mildly sweet third (-4)
CEG 6-2+4 modified fifth, sweet third (-8)
GBD 4-4+2 modified fifth, sweet third (-8)
DF#A 2-6+0 modified fifth, sweet third (-8)
AC#E 0-4-2 modified fifth, mildly sweet third (-4)
EG#B -2-6-4 modified fifth, mildly sweet third (-4)
BD#F -4+0-6 modified fifth, sharp third (+4)
F#A#C# -6+2-4 modified fifth, sharp third (+8)
C#E#G# -4+4-2 modified fifth, sharp third (+8)
G#B#D# -2+6+0 modified fifth, sharp third (+8)

You will see that those with rather sharp thirds will be roots of minors rather than majors. Thus F# and C# will be minor chords as below, with G# not a useful root of either major (Ab) or minor (for any key of E outside the range of this temperament). Moving the zero value from A to E would support the key of E at the expense of Bb. Then G# would become the root of a useful chord, G#m, accompanied by E Major and B7 (D# comes into play rather than Eb).

This scheme as shown supports 5 major keys happily, and positioning of the zero value in the series determines which keys are in that set. In this common A=0 convention, G is the best, with neighbors C and D almost as good, leaving F and A as quite usable. These are the settings one will find as the default on any tuner that provides Young II as a preset. Be aware that the earlier Young tuning is sometimes listed as "Young" and is not the same as Young II, the one that was actually adopted to some degree in its day and with which Young collaborated with Valotti (Valotti/Young is a C-friendly tuning).

Minors (want a sharpened third)

EbGbBb 0-6+2 perfect fifth, flat third (-6)
BbDbF 2-4+4 perfect fifth, flat third (-6)
FAbC 4-2+6 perfect fifth, flat third (-6)
CEbG 6+0+4 modified fifth, flat third (-6)
GBbD 4+2+2 modified fifth, mildly flat third (-2)
DFA 2+4+0 modified fifth, mildly sweet third (+2)
ACE 0+6-2 modified fifth, sweet third (+6)
EGB -2+4-4 modified fifth, sweet third (+6)
BDF# -4+2-6 modified fifth, sweet third (+6)
F#AC# -6+0-4 perfect fifth, sweet third (+6)
C#EG# -4-2-2 perfect fifth, mildly sweet third (+2)
G#BD# -2-4+0 perfect fifth, mildly flat third (-2)

Am, Em, Bm, F#m are the winners in this analysis, with Dm, and C#m better than ET and useful. That would provide all relative minors for the keys of C, G, D, and A. Again, moving the zero value from A would determine which other key sets might be supported instead. In common practice, this default of A=0 is what many autoharp players would favor for the keys used most in social playing and on common sheet music.

Finally, one should note that the resulting temperament of the key of G here is precisely the same as what many refer to as the common diatonic tuning of Silbermann, but only the sweeter "+" version based on the Pythagorean rather than the "-" version based on the smaller syntonic comma. There is actually an attenuated syntonic version of 1/6 SC for chromatic. The fifth increment is simply 1.6 instead of 2.