Marc Sabat

Asking ocean

for solo string quartet
and 18 instruments

PLAINSOUND MUSIC EDITION
for Harry Partch
who opened a door and went outside

(1901-1974)
About the music

Asking ocean (2016) is a work for solo string quartet and ensemble based on a previous work, Euler Lattice Spirals Scenery (2011). This string quartet was composed in Rome during a one-year residency at the Villa Massimo, and premiered by Sonar Quartett on 20 October 2011. The musical form follows from establishing and exploring microtonal variations of intonation, based upon an interlocking network of harmonically related pitches tuned in extended just intonation.

The work is divided in seven parts, played mostly without pause:


The form of the earlier composition has been extended with additional material. The initial tuning of open strings in “Prelude”, beginning with the Kammerton “A”, interweaves passages establishing the tuning relationships of the scordatura string instruments and natural trumpet. In the first “Drawing”, the winds join, tuning with the Pythagorean bordun tones of the quartet open strings and sketching melodic fragments touching the higher harmonics 5, 7, 11.

The “Vivier” sections features the quartet musicians playing solo without ensemble, exploring natural harmonics of their open strings in a sustained ecstatic melody. The following “Interlude” is a brief second intonation, featuring the tuning of the scordatura viola da gamba, harp and harpsichord, which become a kind of microtonal continuo ensemble in the following “Johnston” section. Here instruments from the larger ensemble join, support and at times reveal the string quartet’s gradual microtonal journey through Leonhard Euler’s harmonic lattice of major and minor triads linked by common tones. They colour and extend the quartet’s pure, consonant world of untempered major and minor triads, including recurring echoes of dissonant microtonal commas and higher harmonic partials tuned above and below the fundamental pitches. As the quartet gradually and imperceptibly moves away from the conventionally tuned pitches, these “near-tempered” tones are taken up by other instruments, suggesting distant harmonic relationships connecting the lattice-map of harmonic space. At the same time, the scordatura instruments with fixed pitches based upon these higher harmonics help to support and anchor the quartet’s microtonal modulations. In the following pages, a diagram of the 99 tones and the nearby higher partials is included.

“Flowers” adds an entirely new section in which the quartet takes the role of a sotto voce cantus firmus, playing a quartertone chorale slowly spiralling downward over the course of five transformations, with freely ornamented overlays played by changing intrumental subgroups of the ensemble collective. Each time the uppermost chorale voice falls an octave, until finally, the Ivesian harmony of the quartet is revealed, quiet and alone. The “Drawing 2”, backwards and transformed, suddenly closes the music box, bringing us back to the A with which we began.
About the notation

The use of extended just intonation applies both to vertical, harmonic structures and to melodic sequences of tones, asking players to hear and play many pitches which depart from conventional tempered tones. There is no fixed system, scale or number of tone-divisions, instead the entire tonal continuum is imagined as a fabric connected by rational interval relationships based on interlocking harmonic series. These relationships are indicated in the score by attaching small numbers to each pitch, indicating cents (1/1200 octave), measured as deviations from the nearest tempered pitch. When the deviation from the spelling of the pitch would have exceeded ±50c, the nearest sounding pitch-class is written to facilitate work with an electronic tuner.

The ensemble chooses its Kammerton frequency based on the tuning of the fixed pitch percussion instruments, so that each individual player may rehearse using a clip microphone and electronic tuning device set to this chosen reference. In a performance, it is likely that the overall tuning will deviate at times, so it is important to explore several possible alternate fingering scenarios to be able to flexibly adapt to unexpected changes in the intonation.

More important than static, absolute pitch height is the players' perception and musical articulation of consonant harmonic relationships, which are dynamic and moving interactions of tones and their harmonics. Several complementary notations indicate the intervallic relationships which allow pitches to be adjusted in context. The accidentals used are based on the Extended Helmholtz-Ellis JI Pitch Notation, which uses different symbols to show the characteristic tuning of various natural harmonic series primes:

3 (Pythagorean, fifths and fourths) is represented by using the conventional series of flats, naturals, sharps: therefore flats are tuned lower than enharmonically similar sharps by a Pythagorean comma, approximately 1/9 tone (23.5c);

5 (Ptolemaic, the consonant thirds and sixths) by attached arrows indicating the syntonic comma, lowering the Pythagorean ditone by approximately 1/9 tone (21.5c) to make a major third;

7 (Septimal, the bluesy low natural seventh and minor third) by Tartini's 7-like half-arrows indicating the septimal comma, lowering the Pythagorean intervals by approximately 1/7 tone (27c);

11 (Undecimal, the natural fourth-plus-quartertone) by Richard Stein's reverse flat and cross indicating the 32 : 33 quartertone (53c);

13 (Tridecimal, the neutral sixth) by quartertone symbols with a second vertical stroke indicating the 26 : 27 thirdtone (65c);

T (equal tempered half- and quartertones) are given by conventional accidentals with a small horizontal line; sometimes also combined with cents deviations to indicate an exact microtone.

Please also see the following legend with symbols of the Helmholtz-Ellis Notation.

To help read the microtonal accidentals, or to clarify the characteristic sound or function of certain pitches, additional numerical notations are used. Readily tunable harmonic (vertical) pitch relations are written as frequency ratio fractions in boxes, representing simple consonant intervals. For example, a natural major third might be written as 5/4 (the interval between harmonics 4 and 5 of the series). In the following pages tables of tuneable intervals and of the harmonic series in HE notation are included to provide examples of these ratios.

Another indication used in the score consists of a harmonic series number (3, 5, 7, 11, 13) combined with either "u" or "°" to indicate the function of a tone. For example, 7° means "sounds like a natural 7th harmonic above something" and u11 (under-11) means "tuned a quartertone plus fourth below something, which would then sound as its 11th harmonic".

Melodic intervals are often written as ratios and cent distances positioned between notes, using a colon notation. For example, the diatonic semitone 15 : 16 = 112c.

In general, the composition attempts to provide consonant pitches in the instrumentation to allow the various microtones to be realised by ear, however, the sometimes dense microtonal counterpoint creates beatings and collisions which may disorient the ear. The style of articulating pitches in this context is perhaps closer to that in Byzantine song or Turkish, Arabic, Persian or Indian traditions, where the microtonal sruti-region of a complex pitch relationship is brought into awareness, and its exact, precise tuning found in the course of a subtle portamento into the center of pitch, rather than the Western convention of experiencing an "in tune" / "out of tune" dichotomy based on static pitch. The intention of the intonation is to maximise the resonance and sensation of both consonance and dissonance, the impression that melody and harmony are interwoven in a beautiful, at times complex network of relationships perceptible to the ear, interacting tonally at all times.
About the instruments

A number of instruments are given special scordatura tunings to more reliably provide some fixed microtonal pitches. On the following pages, charts are provided describing details of the various scordature. Small sequences of chords and little examples combining the instruments are included in the table and may be used freely, modified and extended as needed when tuning before a rehearsal or performance. All of the preparatory sounding of the tuning, hearing the intervals and their manifold relationships unfold may be considered a kind of ongoing overture-extension to the written piece, played ad libitum, and flowing into the explicitly composed “intonations”.

For the woodwind players, the use of instruments with dedicated quartetone keys (for example, Kingma System flutes, Howarth-Redgate oboes, etc.) is highly advised to come as close to the required pitches as possible. Adjustments of embouchure, though absolutely necessary when producing the pitches, are not sufficiently accurate or reliable used on their own to realise this score with the necessary accuracy. Seeking out alternate fingerings with clear and steady timbre (even if unusual or melodically quite varied) is recommended. Conventional fingerings should be tested with a tuner to determine their tendencies, which will vary from instrument to instrument.

The brass use valve tunings based on just ratios as described in the tables, and unconventional valve combinations are used to provide a larger microtonal gamut. Suggested fingerings to get close to desired pitches are given in the score, but players are encouraged to seek out other, possibly better solutions which facilitate the accurate and expressive realisation of the written pitches. Sometimes it may be more musical to use more lip adjustment or a temporary change of valve-slide position to obtain a suitable timbre or to articulate small microtonal variations. Mutes which allow accurate tuning may be used when their colour benefits balance and harmonic clarity, the realisation of an appropriate dynamic, ad libitum, but they are not specified in the score.

The tempered (fixed-pitch) percussion – Glockenspiel, Vibraphone, Crotales and Marimba – should be chosen so that their frequencies are as close to equal-tempered tuning as possible, sharing the same reference frequency in Hz. This frequency will determine the Kammerton shared by the ensemble when setting tuning meters and used for tuning the scordatura fixed pitch instruments.

The percussionists are also asked to assemble a heterogeneous set of tuned objects to form a specific microtonal scale and additionally to lower 5 tones of the marimba to the pitch-height of the natural 7th harmonic. The pedal harp and harpsichord are tuned microtonally, as are the ensemble strings: violin, viola, cello and a 7-string bass viola da gamba with double frets.

The harpsichord and the harp are to be subtly reinforced with amplification. The impression for the ensemble and the audience should be of a natural, acoustic balance.

The dynamic level is, for the most part, soft. The ensemble shades and colours, only rarely envelopes, the solo string quartet, which (even when very soft) should remain at the centre of the music. Written dynamics are mere suggestions to phrasing and articulation, and may be interpreted with freedom. Because there are many sustained tones, musicians may breathe or change bow whenever needed. Seek timbres which maximise harmonic interaction and blend with each other and with the other instruments.

Regarding the flow of time, the perception of intonations and modulations, swiftly but fully and clearly revealed, should inform pacing. The music is never metronomic, with the exception of the “Vivier” movement for solo quartet. In “Flowers”, the time should flow particularly slowly and flexibly. Each “bar”, conducted and felt mostly in 1, is part of a larger grouping of bar-units, which articulate an underlying harmonic chorale. Time may be plastic rather than strict, responsive to the density of material and the particular circumstances of each performance. The vertical coordination between instruments may at times need to be clearly, precisely realised, and at other times may take place more freely, independently.

To provide an overview of fermatas and of the harmonic skeleton, there is a two-stave cue line provided in the score. This is given simply as an aid to conducting the work and to pointing out some of the tonal references or composite melodic lines, and as not intended as a full particell of “primary” material to be highlighted. In the “Johnston” movement, each bar is based on one central tone, above or below which a triadic harmony and various higher partials are articulated. These central tones are indicated either with “1°” (above which harmonic intervals form a major triad) or “1” (below which subharmonic intervals form a minor triad).

The music is dedicated to Harry Partch, who introduced the 11-limit.

Berlin, November 2016
STAGE PLAN

Conductor

Piano (without lid)

Harp (amplified)

Harp (amplified)

Glock

Vibes

Perc1

Fl1

Ens Vl

Fl2

Ens Vla

Tb

Tp2

Tuba

Tp1

Ob

Sax

C11

C12

SQ Vl1

SQ Vl2

SQ Vlc

Ens Vl

Ens Vc

Gamba

Hn

Perc2

Crotales

Marimba

Tuba
An informal introduction to the Helmholtz-Ellis Accidentals
by Marc Sabat

Berlin, April 2009

In learning to read HE accidentals, without having to rely on an electronic tuning device, it is important to be familiar with three things:

First, to keep in mind the natural tuning of intervals in a harmonic series, which deviate from the tempered system.

Second, to get to know how the accidentals refer to these overtone relationships.

Third, to observe that each written pitch may be related to many other pitches by natural intervals, and to tune it accordingly.

In most cases, this approach will allow the player to quickly and intuitively play just intonation (JI) pitches quite accurately. Any remaining adjustments can be made by ear, based on the specific sound of JI intervals.

Just intervals are readily learned because they are built up from simple, tuneable harmonic relationships. These are generally based on eliminating beating between common partials, finding common fundamentals and audible combination tones, and establishing a resonant, stable sonority which maximizes clarity: both of consonance and of dissonance.

A well-focussed JI sound is completely distinct from the irregular, fuzzy beating of tempered sounds. Just consonances, when marginally out of tune, beat slowly and sweetly and may be corrected with the most subtle adjustments of bowing or breath. Just dissonances produce a sharply pulsing regular rhythm and have very clear, distinct colors.

To become familiar with the notation and sounds of JI, the fundamental building blocks are prime number overtones 3, 5, 7, 11 and 13, each of which is associated with a specific pair of accidentals and a basic musical interval.

3 is associated with the signs flat, natural, sharp and refers to the series of untempered perfect fifths (Pythagorean intonation). Generally, A is taken as the tuning reference, and the central pitches C-G-D-A-E can be imagined as the normal tuning of the orchestral string instruments. The just C is rather lower than tempered tuning because of the pure fifths. The further this series is extended, the greater the deviation from tempered tuning: the flats are lower, the sharps higher.

5 is associated with arrows attached to the flat, natural, sharp signs and refers to the pure major third. These arrows correct the Pythagorean intervals by a Syntonic Comma, which is approximately 1/9 of a wholetone or 22 cents. So, for example, the note E-flat arrow-up is a just major third below G, and the note F-sharp arrow-down is a major third above D. In most music, flats are often raised by a comma and sharps are lowered. Because of the open string tuning, it is common to sometimes raise F and C (to match A and E) and to sometimes lower A and E (to match F and C).

Corrections by one Syntonic Comma have been used throughout Western music history and are relatively familiar to the ear. However, traditionally these corrections have been hidden by players, for example in Meantone Temperament where fifths are mistuned narrow by 1 comma so that the third C-E ends up sounding pure. More recently, the currently prevailing Equal Temperament has made us accustomed to beating thirds, so at first the pure intervals may seem unfamiliar. To play the arrows accurately, one must carefully learn the sound of the consonant major and minor thirds and sixths, and learn to articulate comma differences clearly.

7 is associated with a Tartini sign resembling the numeral. It corrects the Pythagorean intervals by a Septimal Comma, which is approximately 1/7 of a wholetone or 27 cents. When the Pythagorean minor third is lowered by this amount, it becomes a noticeably low third often heard in Blues music.

11 is associated with the quartertone signs (cross and backwards flat). The accidental is used to raise the perfect fourth by 53 cents, producing the exact tuning of the 11th partial in a harmonic series. The sound is most easily learned by playing one octave plus one fourth and raising it by a quartertone.

13 is associated with the thirdtone signs (cross and backwards flat, each with 2 verticals). The accidental is used to lower the Pythagorean major sixth by 65 cents, producing the exact tuning of the 13th partial in a harmonic series. The sound is most easily learned as a neutral-sounding sixth, one-third of the way between the just minor and just major sixths (closer to minor than to major).

The following table presents the accidentals together with their associated ratios and cents deviations. To calculate the cents deviation from Equal Temperament of a specific written pitch (if desired) the following shortcut may be used:

1.) Find the cents deviation of the Pythagorean pitch, by calculating how many fifths it is away from A, multiplying by 2, and using a plus sign if it is on the sharp side and a minus if it is on the flat side.

2.) For each microtonal accidental, add or subtract its approximate cents value (as given above), keeping in mind whether the accidental is raising or lowering the pitch.

The resulting value should be a cents deviation within 1 or 2 cents accuracy, which is an acceptable starting point for fine-tuning by ear.
The exact intonation of each pitch may be written out by means of the following harmonically-defined signs:

Pythagorean series of fifths – the open strings
(... c g d e ...)

lowers / raises by a syntonic comma
81:80 = circa 21.5 cents

lowers / raises by two syntonic commas
circa 43 cents

lowers / raises by a septimal comma
64:63 = circa 27.3 cents

lowers / raises by two septimal commas
circa 54.3 cents

raises / lowers by an 11-limit undecimal quarter-tone
33:32 = circa 53.3 cents

lowers / raises by a 13-limit tridecimal third-tone
27:26 = circa 63.3 cents

lowers / raises by a 17-limit schisma
236:215 = circa 68 cents

raises / lowers by a 19-limit schisma
113:112 = circa 3.4 cents

raises / lowers by a 23-limit comma
536:529 = circa 16.3 cents

In addition to the harmonic definition of a pitch by means of its accidentals, it is also possible to indicate its absolute pitch-height as a cent-deviation from the respectively indicated chromatic pitch in the 12-tone system of Equal Temperament.

The attached arrows for alteration by a syntonic comma are transcriptions of the notation that Hermann von Helmholtz used in his book “Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik” (1863). The annotated English translation “On the Sensations of Tone as a Physiological Basis for the Theory of Music” (1875/1885) is by Alexander J. Ellis, who refined the definition of pitch within the 12-tone system of Equal Temperament by introducing a division of the octave into 1200 cents.

The sign for a septimal comma was devised by Giuseppe Tartini (1692-1770) – the composer, violinist and researcher who first studied the production of difference tones by means of double stops.
**VORZEICHEN**

**EXTENDED HELMHOLTZ-ELLIS JI PITCH NOTATION**

für die natürliche Stimmung
konzipiert von Marc Sabat und Wolfgang von Schweinitz

*Die Stimmung jedes Tons ist mit folgenden harmonisch definierten Vorzeichen ausnotiert:*

- $\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\flat\fla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23-LIMIT TUNEABLE INTERVALS below “A4”

tested and notated in three gradations of difficulty (large open notehead = easiest; small black notehead = most difficult)

by Marc Sabat (violin/viola) with assistance from Wolfgang von Schweinitz (cello), Beltane Ruiz (bass), Anais Chen (violin)—Berlin, 2003

0 +12 +31 +16 C# -41 +4 +27
-26 -49 -6

-2 -28 -3 Eb +49

+2 +33 +42 +4 G +35

-37 -26 -11 -49 -18 -33

-19 -6 -14 -82

-2 -28 -17 -3 +17 +2 +46

2/5  7/17  5/12  8/19  3/7  4/9  5/11  6/13  1/2
+14 -36 -16 +2 +33 +4 G +35

12/23  8/15  7/13  6/11  5/9  4/7  7/12  3/5  8/13
-26 -48 -18 -31 +16 C# -41

5/8  7/11  9/14  2/3  11/16  9/13  7/10  5/7  8/11
-14 D# -49 D# -37 +17

3/4  10/13  7/9  4/5  9/11  5/6  8/7  7/8  1/1
+2 +46 +14 +33 

-35  -47 -16
23-LIMIT TUNEABLE INTERVALS above “A3”

notated using the Extended Helmholtz-Ellis II Pitch Notation with cents deviations from 12 tone equal temperament based on $A = 0$ cents

microtonal accidentals designed by Marc Sabat and Wolfgang von Schweinitz, 2004
THE HARMONIC SERIES 1 - 64 above “A0” (overtone row)

notated using the Extended Helmholtz-Ellis II Pitch Notation
microtonal accidentals designed by Marc Sabat and Wolfgang von Schweinitz, 2004
SCORDATURE
Brass

Valve-side tuning for double horn with extended length 5th valve and quarteitone valve to produce a dissonant subharmonic series of fundamentals


Please check white noteheads first, then verify the dissonant series, making compromises where necessary.

The 1st valve is tuned slightly high for flat Bb (Bb-45) and F is tuned flat (but 4 valves and 4 holes on the double horn to that the unprepared 5 partials D-2 and A-7 match the open strings. The 1st valve is also tuned slightly lower that in its combination I-2 produces a just minor third 6-5 = -516c.

The specific frequencies of the valves tuned to this just minor third are as follows:

- 1st valve: 649.4 c
- 2nd valve: 499.5 c
- 3rd valve: 450.0 c
- 4th valve: 409.8 c
- 5th valve: 370.0 c

The player is encouraged to find the best sounding alternate fingerings by experimentation using this table as a starting point.

Please check white noteheads first, then verify the descending series, making compromises where necessary. The 2nd valve is also tuned slightly lower than in its combination I-2 produces a just minor third 6-5 = -516c.

The specific frequencies of the valves tuned to this just minor third are as follows:

- 1st valve: 628.4 c
- 2nd valve: 500.3 c
- 3rd valve: 450.0 c
- 4th valve: 409.8 c
- 5th valve: 370.0 c

The player is encouraged to find the best sounding alternate fingerings by experimentation using this table as a starting point.

Please check white noteheads first, then verify the descending series, making compromises where necessary. The 3rd valve is also tuned slightly lower than in its combination I-2 produces a just minor third 6-5 = -516c.

The specific frequencies of the valves tuned to this just minor third are as follows:

- 1st valve: 608.4 c
- 2nd valve: 500.3 c
- 3rd valve: 450.0 c
- 4th valve: 409.8 c
- 5th valve: 370.0 c

The player is encouraged to find the best sounding alternate fingerings by experimentation using this table as a starting point.

Please check white noteheads first, then verify the descending series, making compromises where necessary. The 4th valve is also tuned slightly lower than in its combination I-2 produces a just minor third 6-5 = -516c.

The specific frequencies of the valves tuned to this just minor third are as follows:

- 1st valve: 588.4 c
- 2nd valve: 500.3 c
- 3rd valve: 450.0 c
- 4th valve: 409.8 c
- 5th valve: 370.0 c

The player is encouraged to find the best sounding alternate fingerings by experimentation using this table as a starting point.

Please check white noteheads first, then verify the descending series, making compromises where necessary. The 5th valve is also tuned slightly lower than in its combination I-2 produces a just minor third 6-5 = -516c.

The specific frequencies of the valves tuned to this just minor third are as follows:

- 1st valve: 568.4 c
- 2nd valve: 500.3 c
- 3rd valve: 450.0 c
- 4th valve: 409.8 c
- 5th valve: 370.0 c

The player is encouraged to find the best sounding alternate fingerings by experimentation using this table as a starting point.

Natural trumpet in Bb. Trumpet in Eb. Trumpet in F. Various pitches within one bar to be produced by slight embouchure adjustment. Please adjust pitches when playing to produce the harmonic series as close to its untempered tuning, indicated in cents.

In the table below they are also indicated by white noteheads with boxed numbers indicating harmonics of the quartertone-high C, 11° over Pythagorean F. Please check white noteheads first, then verify the descending series, making compromises where necessary.

Both white noteheads first, then verify the descending series, making compromises where necessary.

The player is encouraged to find the best sounding alternate fingerings by experimentation using this table as a starting point.

Please check white noteheads first, then verify the descending series, making compromises where necessary. Please check white noteheads first, then verify the descending series, making compromises where necessary. Please check white noteheads first, then verify the descending series, making compromises where necessary.

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The player is encouraged to find the best sounding alternate fingerings by experimentation using this table as a starting point.
Percussion

Percussion select fixed pitch instruments (cymbals, vibraphone, glockenspiel, marimba) with the same reference frequency and verify that the pitches match closely in all registers. The common frequency of A4 will determine the choice of ensemble instruments.

The marimba has five specially prepared tones, lowered about 50c to match the natural harmonic sevenths of the respective tempered fundamentals, using plasticine or similar material. Additionally, a scale of various tuned objects is to be chosen by the two players. Any materials (metal, glass, tubes, boxes, glass, wooden blocks, etc.) must be included.

Choose mainly ringing sounds with, for the most part, somewhat longer decays, ranging in spectrum from a pure tone to somewhat complex mixtures of harmonics, but always with salient pitch. Please measure the frequencies precisely, while playing at a generally soft dynamic; each sound should give the impression of having a primary or fundamental frequency at the pitch and in the octave written.

Fine-tune as needed by applying small amounts of plasticine or similar materials. Please retune the following five marimba tones by adding a little plasticine or similar mass to the bars in such a manner to lower the fundamental without losing too much natural resonance.

Because of the marimba’s tempered tuning and inharmonicity, these cent values may be slightly tempered, but should not deviate too far from 50c. They should sound “in tune” with each other (as fourths and fifths) and with the respective harp, harpsichord, ensemble viola/violin tones indicated below.

The common frequency of A4 will determine the choice of ensemble instruments.

Please choose instruments as close in tuning to the equal tempered pitches (b) as possible.

The following pitches of marimbas occur. Please choose instruments as close in tuning to the equal tempered pitches (b) as possible.

Lowest marimba pitch used in the work: C2d

Please measure the frequencies precisely, while playing at a generally soft dynamic; each sound should give the impression of having a primary or fundamental frequency at the pitch and in the octave written.

Fine-tune as needed by applying small amounts of plasticine or similar materials.

Please retune the following five marimba tones by adding a little plasticine or similar mass to the bars in such a manner to lower the fundamental without losing too much natural resonance.

Because of the marimba’s tempered tuning and inharmonicity, these cent values may be slightly tempered, but should not deviate too far from 50c. They should sound “in tune” with each other (as fourths and fifths) and with the respective harp, harpsichord, ensemble viola/violin tones indicated below.
Harp / Harpsichord

Chromatic pedal harpsichord in a modern tuning, the cents values given are based on an “ideally adjusted” pedal mechanism producing tempered alterations of 100c.

In practice, these cents values may require compromise in order to obtain good octaves and fifths in the various pedal settings.

Pitches repeat in all octaves of both manuals.

The same tuning of the pitches repeats in all octaves.

Please find a tuning which optimises the sweetness of as many of the chords as possible.

The following sequence of chords moves through the main triads.

Note that the fillings between similar pedal settings [4/3/2] are the most predominant.

The following sequence of chords moves through the main consonances.

Please find a tuning which optimises the sweetness of as many of the chords as possible.

The two 8’ registers are to be assigned to the two manuals (uncoupled) and tuned differently from each other as indicated below.

The sounding pitch is always based on the note-names of the actual sounding pitches, even if the spelling intervals are unusual.

The following sequence of chords moves through the main consonances.

Pedal indications for changing pitches are given in boxes below the scordatura staff.

Spelling of played pitches in the score is always based on the note-names of the actual sounding pitches, even if the spelling intervals are unusual.

Continuity pedalling is indicated by notes in brackets.

The following sequence of chords moves through the main consonances.

Please find a tuning which optimises the sweetness of as many of the chords as possible.
Strings

Viola da gamba in a temperament tuning. The four open strings are retuned as indicated below:

String parts are retuned in the same order and parts at sounding pitch (rounded) and at playing pitch (unsounded).

Pitches in the unsounded stave are indicated exactly, using Helmholtz-Ellis accidentals and cents.

Pitches in the unsounded stave are indicated using exact melodic cents, Roman numerals, harmonic numbers, and ratios, to help realise the microtonal tunings.

Vocal, viola, violoncello in a temperament tuning.
The four open strings are retuned as indicated below:

Pitches in the unsounded stave are indicated exactly, using Helmholtz-Ellis accidentals and cents.

Pitches in the unsounded stave are indicated using exact melodic cents, Roman numerals, harmonic numbers, and ratios, to help realise the microtonal tunings.

VIOLIN

The players must produce the sounding pitches in these cases by ear:

VIOLA da gamba

The following sequence of double-stop moves through the main triadic consonances:

Please find a tuning which optimises the sequential form of those dyads.
53-TONE 5-LIMIT EULER LATTICE (SHADED) WITH 46 ENHARMONIC BORDER TONES & 23-LIMIT HARMONICS / SUBHARMONICS FROM D

Marc Sabat (2016)
Tempo ad lithium, take time necessary to sound a precise, stable intonation * Within each bar, repeat and move through the patterns freely as required, going back if and when needed

<table>
<thead>
<tr>
<th>Natural</th>
<th>Transposing Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trumpet</td>
<td>(2)</td>
</tr>
<tr>
<td>Cues</td>
<td></td>
</tr>
<tr>
<td>Violoncello</td>
<td></td>
</tr>
</tbody>
</table>

* In the course of this section, the open strings are to be tuned just; tuning in cents relative to 12-tone equal temperament; players should use clip microphones and digital tuning meters or software with precise cents reader calibrated to the community agreed standard (this determined by the fixed pitch permutation).

The solo string quartet is tuned in Pythagorean fifths (E₂, A₂, D₂, G₂, C₂, G₂) and the ensemble strings in scordatura tunings as indicated — the written patterns may be interleaved dynamically and repeated freely in the manner of normal tuning procedure, to achieve the most precise tuning as easily as possible; the sound of actually tuning the strings by adjusting the pegs is an intentional part of the music; accuracy is facilitated by using fine tuners for each string.

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*Suspecting statics, repeat and move through the patterns freely as required.
Pythagoras Drawing 1

Tempo ad libitum, vary from bar to bar as desired, swinging, like a French Overture

*Grace notes are not to be deliberately synchronized between the instruments.
Each player may place them freely at the indicated beats.
This section is played on open strings and natural harmonics wherever possible, with the exception of occasional stopped pitches.
Interlude (intonation)

Harpsichord (sound)

Harpsichord (scordatura)

Bass

Gamba

Violoncello

Violin

Violin 1

Violin 2

Viola

Violin (sound)

Violin (scordatura)

Viola (sound)

Viola (scordatura)

Bass Gamba

Bass Gamba (sound)

Bass Gamba (scordatura)

take time necessary to sound a precise, stable intonation

Libero, tempo ad libitum come prima:

take time necessary to sound a precise, stable intonation

Libero, tempo ad libitum come prima:
supporting and seeking out the consonance and dissonance of the changing harmonies.

Quasi Chorale, tempo libero: with an even, sustained tone, in Rpn.