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# Plainsound Sonata "Arcadia"

for Marco Fusi's viola d'amore

11-limit Just Intonation Study

based on the classical 5-limit Dorian mode

op. 64

2018

*for Marco Fusi*

PLAINSOUND MUSIC EDITION

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# NOTES

*This intonation study features the timbre of the most consonant 11-limit quartertone harmonies, all of which may be tuned by ear: the octave-expanded quartertone-augmented fourth (11/4) and its octave expansion (11/2), the neutral seventh (11/6) and its octave expansion (11/3), and the neutral ninth (11/5).*

*The piece also provides some practice material for the refinement of the melodic ear – with a focus on the size of the diatonic semitone (16:15 or 112 cents, i.e. the difference between a perfect fourth and a pure major third) and on the subtle distinction between the major whole tone (9:8 or 204 cents, i.e. the difference between a perfect fifth and a perfect fourth) and the minor whole tone (10:9 or 182 cents, i.e. the difference between a perfect fourth and a pure minor third). – These two whole tone steps constitute the basis for the performance practice of non-tempered just intonation, and they have a distinctly different melodic character or feeling, even though their difference in size is but a syntonic comma (81:80 or 21.5 cents). The major whole tone (8:9) sounds strong (like the sun) and straightforward (“Beethoven”), whereas the minor whole tone (9:10) sounds soft (like the moon) and very touching (“Schubert”).*

*The distinction between the two different whole tones may best be practiced within a tonal context that can establish a secure “key feeling”. So this piece is composed in the traditional 5-limit Dorian mode with its two alternative tunings for the 6<sup>th</sup> and the 4<sup>th</sup> scale degree – simultaneously based on G in the treble voice and on D flattened by a quartertone in the lower voice – and it is a challenging experiment for the performer to try maintaining a reliable melodic key feeling even under the unfamiliar circumstances of quartertone bitonality.*

## TUNING INSTRUCTIONS

*The seven strings are tuned in pure major and minor thirds to the pitches A – F – D – Bb – G – Eb – C by carefully optimizing the unisons between their partials (please see the next pages for details).*

*Regular viola strings should be used for the strings I, III, V, and VII.*

*String II should be a standard viola d’amore F# string, lowered by a chromatic semitone (25:24 or 71 cents).*

*String IV should be a standard viola d’amore low A string, raised by a diatonic semitone (15:16 or 112 cents).*

*String VI should be a standard viola d’amore low D string, raised by a diatonic semitone (15:16 or 112 cents).*

*The seven sympathetic strings should be custom-made from harpsichord strings, as Marco Fusi suggested. They must be tuned according to the non-tempered diatonic scale degrees of F major, lowered by a just 11-limit quartertone (33:32 or 53 cents), using either a tunable synthesizer or the playback of previously recorded drones with the seven reference pitches, played on the viola d’amore (please see the next pages for details).*

PERFORMANCE DURATION *circa 15 minutes*

# ACCIDENTALS

*for microtonal just intonation*

## EXTENDED HELMHOLTZ-ELLIS JI PITCH NOTATION

*The exact intonation of each pitch is written out by means of the following harmonically defined accidentals:*

♭♭   ♭   ♮   ♯   ×   *Pythagorean series of perfect fifths, based on the open strings*  
( ... c g d a e ... )

♭↓   ♮↓   ♯↓   ×↓   ♭↑   ♮↑   ♯↑   ×↑   *lowers / raises the pitch by a syntonic comma:*  
**81 : 80 = circa 21.5 cents**

♭↓↓   ♮↓↓   ♯↓↓   ×↓↓   ♭↑↑   ♮↑↑   ♯↑↑   ×↑↑   *lowers / raises the pitch by two syntonic commas:*  
**circa 43 cents**

†   †   *raises / lowers the pitch by an 11-limit quarter-tone:*  
**33 : 32 = circa 53.3 cents**

*The following accidentals are not used in the score, but some of them are needed to notate the difference tones in the "Table of the featured 11-limit consonances" on the last three pages of the preface:*

⌊   ⌋   *lowers / raises the pitch by a septimal or 7-limit comma:*  
**64 : 63 = circa 27.3 cents**

⌋   ⌋   *lowers / raises the pitch by two septimal commas:*  
**circa 54.5 cents**

≠   ≠   *lowers / raises the pitch to diminish the Pythagorean major sixth 27:16 by a 13-limit third-tone to represent the 13:8 median sixth:*  
**27 : 26 = circa 65.3 cents**

≈   ≈   *lowers / raises the pitch to diminish the 16:15 diatonic semitone by a 17-limit schisma to represent the 17:16 semitone:*  
**256 : 255 = circa 6.8 cents**

∕   ∖   *raises / lowers the pitch to augment the 32:27 Pythagorean minor third by a 19-limit schisma to represent the 19:16 small minor third:*  
**513 : 512 = circa 3.4 cents**

↑   ↓   *raises / lowers the pitch to augment the Pythagorean tritone 729:512 by the 23-limit comma to represent the 23:16 augmented tritone:*  
**736 : 729 = circa 16.5 cents**

*These 'Helmholtz-Ellis' accidentals for just intonation were designed in collaboration with Marc Sabat.*

*The attached arrows for pitch alterations by a syntonic comma are transcriptions of the notation used by Hermann von Helmholtz 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" (published 1875/1885) was made 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 accidental sign denoting an alteration by a septimal comma was devised by Guiseppe Tartini (1692-1770), the composer, violinist and researcher who investigated the difference tones created by double-stops.*

### **Pitch-bend information:**

*In addition to the harmonic definition of a pitch by means of its accidentals, it is also possible to specify its absolute pitch-height as a cents-deviation from the respectively indicated chromatic pitch in the standard 12-tone System of Equal Temperament. – Such additional pitch-bend numbers are not included in the score, as every pitch can be tuned by ear, so that there is no need for rehearsals with the aid of a tuning device. But they are given for the pitches of the seven sympathetic strings (please see the chart on the next page).*

## Tuning of the strings

partial unisons:  $\frac{1}{2}$   $\frac{1}{3}$   $\frac{1}{4}$   $\frac{1}{5}$   $\frac{1}{6}$   $\frac{1}{7}$

viola d'amore

440 Hz

DRONE

difference tones:  $\frac{5}{4}$   $\frac{6}{5}$   $\frac{5}{4}$   $\frac{6}{5}$   $\frac{5}{4}$   $\frac{6}{5}$

The tuning of the 7 strings may also be established, or rechecked, with this drone.

1760.00 Hz  
586.667 Hz  
195.556 Hz

## Tuning of the sympathetic strings

10:9 (182c) 9:8 (204c) 16:15 (112c) 45:32 (590c) 9:8 (204c) 10:9 (182c) 4:5 (386c) 5:6 (316c) 4:5 (386c) 5:3 (884c) 4:5 (386c) 5:6 (316c)

8<sup>va</sup> bassa ad libitum

53 cents lower than Bb string  
53 cents lower than D string  
53 cents lower than F string  
53 cents lower than D string  
32 cents lower than C string  
39 cents higher than Eb string  
32 cents lower than G string

227.556 Hz 284.444 Hz 341.333 Hz 426.667 Hz 256.000 Hz 320.000 Hz 384.000 Hz  
or: 113.778 Hz 142.222 Hz 170.667 Hz 213.333 Hz 128.000 Hz 160.000 Hz 192.000 Hz

DRONE 1 640.000 Hz  
426.667 Hz  
142.222 Hz

DRONE 2 768.000 Hz  
512.000 Hz  
341.333 Hz  
227.556 Hz

The seven sympathetic strings can be tuned with either one of these drones (more conveniently with Drone 2) which can be generated with a precisely tunable synthesizer, like Marc Sabat's additive synth for microtonal MIDI playback called "31-Limit Helmholtz-Ellis Calculator", which runs on Max/MSP and can be downloaded for free at his website "[www.marcsabat.com/#writing](http://www.marcsabat.com/#writing)".

Both drones may also be played on the viola d'amore, recorded on two or on four tracks which are then mixed together. Headphones should be used in this step by step procedure for the playback of a previously recorded track to optimize the intonation (please see below for details).

## Procedure for tuning and recording the drones

Slow partial unison record drone on track 1

Listen to the playback of track 1 at low volume and record drone on track 3

Listen to the playback of track 1 at low volume and record drone on track 4

Listen to the playback of track 1 at low volume and record drone on track 2

(↑) 1 ("+17c" only, i.e. "almost nothing") tuned a twelfth (3/1) above the pitch on track 1

(↑) 1 ("+5c" only, i.e. "the slightest bit lower") tuned a minor sixth (8/5) above the pitch on track 1

↓ 1- ("32c") tuned a major sixth (5/3) and a minor whole tone (10/9) below the pitches on track 2

## The 5-limit Dorian mode

The traditional 5-limit Dorian mode - notated here on D - is transposed up a perfect fourth in the treble voice, and down by an 11-limit quartertone (with the frequency ratio 33 : 32 or 53 cents) in the bass voice. It has two different pitch classes for its 6th scale degree (the minor sixth and the major sixth) and also two alternative tunings for its 4th scale degree which are a Syntonic comma apart from each other. - When B flat is used, tuned as a pure minor sixth above the tonic D, the mode sounds like the Aeolian mode on D, with a comma-augmented fourth between G and C. But when B natural is used, it is tuned as a perfect fifth above the 2nd scale degree E to serve as the diatonic semitone below C; and whenever the 4th scale degree G appears in conjunction with this Pythagorean Sixth (27/16), it is tuned as a pure major third below B and a perfect fourth below C, and therefore raised by a Syntonic comma, so that the 4th scale degree is now represented by a comma-augmented fourth. In this solo piece, the Aeolian minor sixth is featured in the lower octave register (together with the lower G), and the Dorian major sixth and the raised fourth appear in the upper octave. (Perhaps it should also be mentioned here that the idiomatic Dorian "Amen Cadence" with a major subdominant triad preceding the tonic minor triad could only come about once the mode was transformed and reinterpreted within the realm of Meantone Temperament.)

Pythagorean Sixth 27:8 (2106c)

5:6 (316c) 8:5 (814c) 5:6 (316c) 4:5 (386c) 5:6 (316c) 4:5 (386c) 5:6 (316c) 4:5 (386c) 27:8 (2106c) 8:9 (204c) 15:16 (112c) 9:10 (182c) 8:9 (204c)

15:16 (112c) 8:9 (204c) 9:10 (182c) 8:9 (204c) 15:16 (112c) 8:9 (204c) 9:10 (182c) 8:9 (204c) 15:16 (112c) 4:5 (386c) 9:8 (204c)

## "How to think of the notes" - Pitch Repertoire and Finger Positions

Except for the three notes marked with an asterisk in this chart (G-4, G-3, and D-3), all stopped notes in the piece are lowered by an 11-limit quartertone (frequency ratio  $32/32$  or 53 cents). These pitches may be tuned by ear as an 11-limit quartertone consonance ( $11/2$ ,  $11/3$ ,  $11/4$ ,  $11/5$ , or  $11/6$ ) below a natural harmonic played on an adjacent string. In the 1st position (quartertone-flat), the 1st and the 4th finger remain in the same position on all strings, whereas the positions of the 2nd and 3rd finger are generally a chromatic semitone ( $24:25$  or 71 c) apart from each other on adjacent strings. - The cent numbers in quotation marks must be adjusted, because they do not refer to the distance between the finger position of the stopped note to the node of the nearby natural harmonic, but to the finger position for the corresponding stopped note (the perfect fourth, or the pure minor third), which is located a little bit closer to the nut than the corresponding node for harmonic # 4 or # 6. - Therefore the finger movement from the node of harmonic # 4 to the slightly higher stopped note "39 c up" is actually a little bit smaller than the finger movement "32 c down", and the very small finger movement "17 c up" from harmonic # 6 feels like almost nothing. These finger movements should first be studied in the low register (e.g. as in measure 13 - 19 or 42 - 45).

The score is organized into seven systems, labeled I through VII, corresponding to the strings. Each system shows the pitch repertoire for that string, with notes and fingerings indicated. Brackets below the staves indicate intervals and their cent values. Some notes are marked with an asterisk (\*).

**String I:** Notes include  $8^{va}$  (b $\flat$ ),  $11:12$  (151 c),  $15:16$  (112 c),  $9:10$  (182 c),  $8:9$  (204 c), and  $21.5$  c. Fingerings: 1, 2, 3, 4. Annotations: "53 c down" or: the slightest bit lower than harmonic 7, "53 c down", "53 c down".

**String II:** Notes include  $9:10$  (182 c),  $54:55$  (32 c) \*,  $11:12$  (151 c),  $9:10$  (182 c),  $8:9$  (204 c),  $15:16$  (112 c), and  $17$  c. Fingerings: 1, 2, 3, 4. Annotations: "17 c up" (slightest bit), "39 c up", "53 c down".

**String III:** Notes include  $11:12$  (151 c),  $15:16$  (112 c),  $8:9$  (204 c),  $9:10$  (182 c), and  $32$  c. Fingerings: 1, 2, 3, 4. Annotations: "53 c down" or: the slightest bit lower than harmonic 7, "32 c down", "53 c down".

**String IV:** Notes include  $11:12$  (151 c),  $9:10$  (182 c),  $8:9$  (204 c),  $15:16$  (112 c), and  $17$  c. Fingerings: 1, 2, 3, 4. Annotations: "17 c up" (slightest bit), "39 c up", "53 c down".

**String V:** Notes include  $11:12$  (151 c),  $15:16$  (112 c),  $8:9$  (204 c),  $9:10$  (182 c), and  $53$  c. Fingerings: 1, 2, 3, 4. Annotations: "53 c down" or: the slightest bit lower than harmonic 7, "32 c down", "53 c down".

**String VI:** Notes include  $11:12$  (151 c),  $9:10$  (182 c),  $8:9$  (204 c),  $15:16$  (112 c), and  $32:33$  (53 c) \*. Fingerings: 1, 2, 3, 4. Annotations: "17 c up", "39 c up", "53 c down".

**String VII:** Notes include  $11:12$  (151 c),  $32:33$  (53 c) \*,  $5:6$  (316 c),  $80:81$  (21.5 c),  $24:25$  (71 c),  $9:10$  (182 c), and  $24:25$  (71 c). Fingerings: 1, 2, 3, 4. Annotations: "32 c down", "53 c down".

(The notes in brackets are not used in the piece.)

Table of the featured 11-limit consonances  
with their lowest common partials and most prominent difference tones  
14 short introductory etudes

**1**

partials

*Slow*

viola d'amore

difference tones

repeat ad lib.

33:32

**2** **3**

VI VII VI 11/4 11/4 11/3 VII VI VII 11/4 11/4

04 02 04 04 (↓) 03 (close to 2) 02 01 02

(↑) 1 ("+17c" only, slightest bit up)

**2** **3**

**4**

V VI V 11/4 11/4 VII 11/6 VII 11/3 V

04 02 04 04 04 01 (-2-) 02

↑ 2 ("+39c")

**4**

5 6

VI 4-7 VI 11/4 11/4 IV V IV 11/4 IV 11/4 VI 11/6

°2 °1 °2 °4 °2 °4 °4 °4

(↓) 1 ("5c" only, the slightest bit down)

↓ 2 ("32c")

5 6

7

V IV V 11/4 11/4 VI V VI 11/4 11/4

°2 °1 °2 °1 °3 °1

(↑) 1 ("17c" only, slightest bit up)

↓ 3 ("53c")

7

8

III IV III 11/4 III 11/4 V 11/6 4/3 IV 9/4 11/5 11/5

°4 °2 °4 °4 °4 °4

↑ 2 ("39c")

1

↑ 1 (+39c)

8

44:45



9 10

IV 4 - 7 11/4 11/4 II III II 11/4 IV 11/4 VI 11/6

°2 °1 °2 °4 °2 °4 °4 °4

(↓) 1 ("5c" only, the slightest bit down) ↓ 2 ("32c")

9 10

11 12

III II III 11/4 11/4 I II I 11/4 I 11/4 III 11/6

°2 °1 °2 °4 °2 °4 °4 °4

(↑) 1 ("17c" only, slightest bit up) ↑ 2 ("39c")

11 12

13 14

II 4 - 7 11/4 11/4 II I II 11/5 11/5

°2 °1 °2 °2 °4 °2

(↓) 1 ("5c" only, the slightest bit down) ↑ 3

13 14



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based on the classical 5-limit Dorian mode

for Marco Fusi's viola d'amore

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op. 64 (2018)

*circa 56 con tempo rubato \**

partial unisons:

viola d'amore

*per lo più: piano sonore (molto d'arco), e sempre non vibrato \*\**

All natural harmonics may be played as loud as possible. This objective will determine the bow's contact position on the string and the timbre of each bass note.

\*\*) i.e.: no frequency vibrato, please! - But the occasional use of some subtle amplitude vibrato (once the intonation has been established) is encouraged and recommended: periodic or aperiodic changes of bow pressure, bowing speed, or bow position (distance from the bridge and angle of the bow, controlling the amount of hair on the strings) produced by the right hand, or by shaking the instrument underneath the bow with the left hand, arm and shoulder, or with the head and chin (which probably works best) - whenever there is enough time to create a vibrating sound. If a personalized form for such a humble amplitude vibrato can be found and executed with comfort, then it is a nice option for some of the drawn-out sounds notated with dotted and double-dotted half notes.

\*) The rhythm, which is very simple and nearly always the same, should be counted and fully established. Then the pulse may always be freely molded "with stolen time" at the performer's discretion, or suspended with a short fermata on any sound - however it may be needed in the moment for the response to the way the notes are speaking.

III IV V VI VII VI V VII VI V IV

01 02 01 02 01 02 01 02 01 02

III II I III II IV III

01 02 01 02 01 02 01 03 01 03 01 03

*espr.*

V IV VI V VII VI VII VI VII 8/3 1-4/3

01 03 01 03 01 04 04 03 02 03 2

*ritenuto*

VI 16/3 11/2

(↓) 03 -1 ↓ 1 (-53c)

*marcato* *più forte*

33:32 (-53c)

11 *arco*

*pizz. (on the sympathetic strings)*

*8<sup>va</sup> bassa ad libitum*

VII VI

04 03

13

VII VI 11/4 V VII

(↑) 04 02 (↑) 04 ↓ 2 ("32c") 02 (↑) 04 ↑ 2- ("39c") 04 01

*simile*

16

V IV VI IV III V VI

04 02 (↓) 04 04 02 (↑) 04 04 01

↓ 2 ↑ 2-

19

V 11/6 III II IV II I III

04 04 02 (↓) 04 02 (↑) 04 04 01

↓ 2 ↑ 2-

22 *ritenuto* *a tempo*

III II 11/5 III

04 01 3 02 (↓) 04 01 02 01

↓ 2

*dolcissimo* *sonore*

25 *ritenuto* *a tempo* *ritenuto* *a tempo*

III

-3 04 02 ↓ 2- ("53c") 04 03 (↓) (close to 2)

(↑) 1- ("17c" only, slightest bit up) *dolcissimo*

colla parte

28

10:9 (182c) II III I 15:16 (112c)

(↑) 02 04 02 02 04

-1 -2 espr. ↓ 1- (-71c) dolcissimo ↑ 2- 3 simile ad lib.

This phrase may also be played while quietly singing along.

31

9:8 (204c) III II IV 9:8 (204c)

04 02 (↓) 04 02 04 04

-2 ↑ 1- (+71c) -2 -1 -1 ↓ 2 ↓ 1- (-71c)

34

IV III V 15:16 (112c) IV 11/3

02 (↑) 04 02 04 04 04 (↓) 03 (close to 2)

-1 ↑ 2- 3 ↓ 2- (-71c)

37

9:10 (182c) V VI V 15:16 (112c)

02 (↑) 04 02 04 04 (↓) 03 (close to 2) ↓ 1- (-71c)

↑ 1- (+71c) -1

40

VI VII VI VII 9:10 (182c)

02 (↓) 04 02 04 (↓) 03 (close to 2) ↑ 1- (+71c) 02 (↑) -1

-1 ↓ 2- -1

43

V VI VII VI 15:16 (112c)

(↓) 03 02 03 ↓ 2 ('-53c') 1- (↓) 03- -1

1- -1

46

*pizz. (on the sympathetic strings)*

*8<sup>va</sup> bassa ad libitum*

*arco*

VII VI

04 03

48

*partial unisons:*

1- -1-

1- 2 -1-

*più forte*

51

$\frac{9:10}{(182c)}$   $\frac{8:9}{(204c)}$

VII VI VII VI VI VII

3- 04 (↑) 04 04 04 03 03 04 03

*piano* *marcato* *marcato*

54

V VI V VI V IV V IV V III IV III V

04 03 04 03 03 04 03 04 04 03 04 03 04 03 02 03

*marcato*

(↑) 2- ("+17c", slightest bit up)

57

*colla parte*

VI

$\frac{15:16}{(112c)}$   $\frac{10:9}{(182c)}$

VI

1- 02 (↑) ↓ 2 ("124c") 4 3 02- (↑) -1-

4

60

*colla parte*

$\frac{9:10}{(182c)}$   $\frac{8:9}{(204c)}$

1- 2-

*più forte* *piano* *marcato*

63

*ritenuto* *a tempo*

V V IV V IV V IV

04 (↑) 03 (↓) 04 03 04 03 04 03 03

3- ↓ 4 ("53c") -2-

66 *ritenuto*

III IV III II III I II I III

04 03 04 03 04 03 04 03 02 03 -2 1-

*marcato* (†) 2- ("+17c" only, slightest bit up)

69 *a tempo*

1 2- 3- 4 4 (same position) 3- (-92c) -2

-3 -2

*più forte* *piano*

72 *ritenuto* *a tempo*

III II I II I III II I I III II IV III

04 03 04 04 03 02 04 1- 0 03 03 (↓) 04 03 04 03 04

*espr. (climax)*

75 *ritenuto* *a tempo*

V IV 11/5 11:12 (151c) 4 (-53c) 3 4 3 (-71c) 4 3 (+71c)

03 04 1 1

*marcato* *espr.*

77 *ritenuto* *a tempo*

V IV VI V VII VI VII VII

2 (↑) 04 03 04 01 03 01 (↓) 04 04 03 2-

10:11 (+165c) 33:32 (-53c)

79

-2 4/3 VI 03 (↓)

1- 11:12 (151c)

*più forte*

82 *pizz. (on the sympathetic strings)*

8va bassa ad libitum