

Reverse Gravity

for three retuned, computer-driven pianos

by Kyle Gann

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Technical Specifications

The 33-pitch tuning of the three pianos (the same in every octave) is as follows, given first in the number of cents above E-flat, and then as ratios to the E-flat 1/1:

Piano	1		2		3	
D	1088	15/8	977	225/128	1044	117/64
Db	969	7/4	938	55/32	906	27/16
C	857	105/64	773	25/16	840	13/8
B	738	49/32	755	99/64	729	195/128
Bb	702	3/2	590	45/32	609	91/64
A	551	11/8	551	11/8	481	169/128
Ab	471	21/16	440	165/128	408	81/64
G	386	5/4	320	77/64	342	39/32
Gb	204	9/8	275	75/64	275	75/64
F	155	35/32	192	143/128	192	143/128
E	92	135/128	53	33/32	27	65/64
Eb	0	1/1	1103	121/64	1173	63/32

Note that no string needs to be raised higher than its natural tuning except for the B-flat on piano 1, which is 2¢ sharp (or if one prefers, 2¢ could be subtracted from all quantities).

For electronic realization of the piece, it can prove helpful to reconfigure the tuning as a reference pitch in cycles per second for each piano, and ratios derived from that standard:

Tuning pitch:	38.891 cps	36.7641 cps	38.2833 cps
D	15/8	225/121	13/7
Db	7/4	20/11	12/7
C	105/64	200/121	104/63
B	49/32	18/11	65/42
Bb	3/2	180/121	13/9
A	11/8	16/11	169/126
Ab	21/16	15/11	9/7
G	5/4	14/11	26/21
F#	9/8	150/121	25/21
F	35/32	13/11	143/126
E	135/128	12/11	65/63
Eb	1/1	1/1	1/1

In the configuration of certain tuning softwares, the following sequences might facilitate getting the required tuning:

Piano 1:

38.891 = Eb0

1/1, 135/128, 35/32, 9/8, 5/4, 21/16, 11/8, 3/2, 49/32, 105/64, 7/4, 15/8

Piano 2:

36.7641485 = Eb0

1/1, 12/11, 13/11, 150/121, 14/11, 15/11, 16/11, 180/121, 18/11, 200/121, 20/11, 225/121

Piano 3:

38.283333 = Eb0

1/1, 65/63, 143/126, 25/21, 26/21, 9/7, 169/126, 13/9, 65/42, 104/63, 12/7, 13/7

For purposes of analysis, the entire scale (which I refer to as my 8x8 scale) is given below, grouping its pitches into eight harmonic series' on the 1st, 3rd, 5th, 7th, 9th, 11th, 13th, and 15th harmonics of E-flat, and naming each pitch in a typographical equivalent of Ben Johnston's just-intonation notation:

Pitch name	Ratio	Cents	1/1	3/2	5/4	7/4	9/8	11/8	13/8	15/8
Db^^-	121/64	1103						11		
D	15/8	1088	15	5	3					1
Db13	117/64	1044					13		9	
C#+	225/128	977								15
Db7	7/4	969	7			1				
C^	55/32	938			11			5		
C+	27/16	906		9			3			
C7+	105/64	857				15				7
Cb13	13/8	840	13						1	
B	25/16	773			5					
Bb^	99/64	755					11	9		
Cb77+	49/32	738				7				
Bb13	195/128	729							15	13
Bb	3/2	702	3	1						
Bbb713	91/64	609				13			7	
A+	45/32	590		15	9		5			3
Ab^	11/8	551	11					1		
Abb1313	169/128	481							13	
Ab7+	21/16	471		7		3				
G^	165/128	440						15		11
G+	81/64	408					9			
G	5/4	386	5		1					
Gb13	39/32	342		13					3	
Gb7^	77/64	320				11		7		
F#+	75/64	275			15					5
F+	9/8	204	9	3			1			
Fb13^	143/128	192						13	11	
F7+	35/32	155			7	5				
E+	135/128	92					15			9
Eb^	33/32	53		11				3		
Eb13	65/64	27			13				5	
Eb	1/1	0	1							
Eb7+	63/32	1173				9	7			

In Johnston's notation, + raises a pitch by 81/80, # raises it by 25/24, b lowers it by 24/25, 7 lowers it by 35/36, ^ raises it by 33/32, 13 raises it by 65/64, and F-A-C, C-E-G, and G-B-D are all perfectly tuned 4:5:6 major triads.

A couple of notes on listening to *Hyperchromatica*:

Some people think the piano sounds seem “funny” or “unreal.” It is essential to the timbre of a normal piano that the intervals are slightly out of tune, and surrounded by the fuzziness of the resulting beats. Remove that out-of-tuneness and the piano can sound different than you’re used to. It has always been common for me to play La Monte Young’s *The Well-Tuned Piano* for people and have them respond, “Isn’t that electronic?” “It sounds more like bells than a piano.” Often one’s unfamiliarity with pure tuning is misperceived as a deficiency in the piano sound. Relatedly, when I issued a disc of Disklavier music in 2005, people sometimes commented, “Too bad you couldn’t use a real piano, because the electronic sounds are off-putting.” In fact, the Disklavier *was* a real, acoustic piano, with pluckable strings. It was tuned to 18th-century well temperament, the notes went by *very* fast, and so the divergences from normalcy made people’s brains convince them that it was an electronic piano, which was a false perception. Give yourself some time to listen to the pieces over and over, and you’ll probably get used to them. I can guarantee, after hundreds of listenings myself, that the harmonies make their own purely-tuned sense, and that their logic sinks in once you can anticipate what’s going to happen. One of the purposes of these pieces is to expand your musical perception.

The Disklavier (computer-driven piano, the digital manifestation of the player piano) is a different medium than the human-played piano. One can, and must, write for it differently. With a couple of deliberate exceptions, these pieces are not playable by humans. The composer forbids performance by humans (which can’t happen anyway), and will not cooperate with any such attempt. The computer-driven version is the final manifestation, and the only one contemplated or permitted. These pieces were written, after years of profound thought and experimentation, specifically for the Disklavier medium, without any compromise in what the music was intended to achieve. If it bothers you that the music you are listening to isn’t being played by humans, there are millions of piano recordings made by humans; go listen to them. There is too much music in the world for anyone to waste time listening to any music wishing it were something other than what it is. This music is produced mechanically, for mechanical rhythmic capabilities that I savor. I make this music public on the chance that there might be a handful of other people on the planet for whom the possibilities opened up here in terms of rhythmic and harmonic language might more than compensate for the loss of a few habitual comforts. If you are not one of those rare people, you can do the composer a favor by moving on without comment. I guarantee you will not alter his mind on the matter.

- Kyle Gann

Reverse Gravity

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♩ = 72

Piano 1

mf *mf*

p

Piano 2

♩ = 72

mf

Piano 3

p

4

♩ = 70

Pno1

3 5 3

p

Pno2

p

♩ = 70

mf 5

p

2

6

mf

pp

p

$\text{♩} = 72$

$\text{♩} = 72$

3

8

mf

pp

pp

$\text{♩} = 71$

$\text{♩} = 73$

5

3

5

3

11 $\text{♩} = 74$ $\text{♩} = 75$ 3

Pno1

Pno2

Pno3

14 $\text{♩} = 72$ $\text{♩} = 72$

Pno1

Pno2

Pno3

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16 (b) $\text{♩} = 74$

Pno1

Pno2

Pno3

pp

$\text{♩} = 74$

3 11 3 11 11

3 11 11

3 11 11

3 11 11

19 (b) $\text{♩} = 73$ $\text{♩} = 72$ $\text{♩} = 73$

Pno1

Pno2

Pno3

The musical score is divided into three systems, each for a different piano (Pno1, Pno2, Pno3). Pno1 features complex rhythmic patterns with dynamics like *ff* and *ffz*, and articulation such as slurs and accents. Pno2 has a more melodic line with slurs and a triplet. Pno3 includes a triplet and a double bar line. The score is marked with a tempo of quarter note = 73 and a time signature change from 3/4 to 4/4. The piece is in a key with one flat (B-flat).

22 $\text{♩} = 74$ $\text{♩} = 75$ $\text{♩} = 76$

Pno1

Pno2

Pno3

$\text{♩} = 74$ $\text{♩} = 75$ $\text{♩} = 76$

p *11* *11* *11*

11

11 *11* *11*

11

The score is divided into three systems, each for a piano (Pno1, Pno2, Pno3). Each system contains three measures. The first measure of each system has a tempo marking of quarter note = 74. The second measure has a tempo marking of quarter note = 75. The third measure has a tempo marking of quarter note = 76. The time signature changes from 4/4 to 3/4 in the third measure of each system. Pno1 features a melodic line in the right hand and a bass line in the left hand, with dynamic markings *p* and *11*. Pno2 features a melodic line in the right hand and a bass line in the left hand, with dynamic markings *p* and *11*. Pno3 features a melodic line in the right hand and a bass line in the left hand, with dynamic markings *11*. There are also some triplets and slurs in the Pno2 part.

25 $\text{♩} = 77$ $\text{♩} = 78$ $\text{♩} = 79$

Pno1

Pno2

Pno3

28 $\text{♩} = 72$

Pno1

Pno3

♩ = 70

31

Pno1

Pno2

Pno3

♩ = 72

33

Pno1

Pno2

Pno3

p

35

Pno1

Pno2

pp

p

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37 $\text{♩} = 75$

Pno1

Pno2

Pno3

p *mf* *mf* *p* *mf*

11 11 11 5:3 5:3

The image shows a musical score for three piano parts, labeled Pno1, Pno2, and Pno3. The score is written in treble and bass clefs. Pno1 starts at measure 39 with a key signature of one flat. Pno2 and Pno3 have their own key signatures and clefs. The score includes various musical notations such as notes, rests, and dynamic markings like *mf* and *ff*. There are also some unusual markings, such as a double bar line with a vertical line through it, and some notes with a vertical line through them. The score is divided into two systems, with the first system containing measures 39-40 and the second system containing measures 41-42.

41 $\text{♩} = 77$

The musical score is divided into three systems, each for a different piano part (Pno1, Pno2, Pno3).
- **Pno1:** Starts in 3/4 time at measure 41. It features a rest in the first measure, followed by a note with a slur and a fermata. The second measure has a rest. The third measure changes to 4/4 time and contains a series of notes with a slur and a fermata. The fourth measure continues with notes and a slur. Dynamic marking: *mf*.
- **Pno2:** Starts in 3/4 time. It has a note with a slur and a fermata in the first measure, followed by a rest. The second measure has a note with a slur and a fermata. The third measure changes to 4/4 time and has a rest. The fourth measure has notes with a slur and a fermata. Dynamic marking: *mf*.
- **Pno3:** Starts in 3/4 time. It has a note with a slur and a fermata in the first measure, followed by a note with a slur and a fermata. The second measure has a note with a slur and a fermata. The third measure changes to 4/4 time and has a note with a slur and a fermata. The fourth measure has notes with a slur and a fermata. Dynamic marking: *mf*.
The score includes various musical notations such as rests, notes, slurs, and dynamic markings like *mf*. The time signature changes from 3/4 to 4/4 between measures 42 and 43.

44 $\text{♩} = 75$

The musical score is divided into two systems. The first system contains measures 44 and 45. Measure 44 is in 3/4 time, and measure 45 is in 4/4 time. The tempo is marked as quarter note = 75. Pno1 (bass clef) plays chords in measure 44 and a melodic line in measure 45. Pno2 (treble and bass clefs) features a triplet in measure 44 and a melodic line in measure 45, with a *mf* dynamic marking. Pno3 (treble and bass clefs) has a complex melodic line in measure 44 with a triplet and rests in measure 45. A second tempo marking $\text{♩} = 75$ is placed above the Pno3 staff in measure 45.

The image shows a musical score for three piano parts, labeled Pno1, Pno2, and Pno3. The score is written in treble and bass clefs. Pno1 starts at measure 46 and includes a dynamic marking of *mf* and a tempo marking of $\text{♩} = 74$. Pno2 includes a triplet marking of 3 and a fingering of 5. Pno3 includes a tempo marking of $\text{♩} = 74$ and a fingering of 5. The score features various musical notations such as slurs, ties, and articulation marks.

49 $\text{♩} = 73$ $\text{♩} = 72$ $\text{♩} = 70$

Pno1

Pno2

Pno3

p

p

p

p

52 $\text{♩} = 68$

Pno1

Pno2

Pno3

ff

f

ff

ff

54

Pno1

Pno2

Pno3

ff

f

ff

f

ff

ff

11

3

3

3

3

57

$\text{♩} = 71$

Pno1

Pno2

Pno3

ff

$\text{♩} = 71$

Detailed description: This is a musical score for three pianos, labeled Pno1, Pno2, and Pno3. The score is divided into two measures. Measure 57 starts with Pno1 playing a complex rhythmic pattern featuring triplets and a quintuplet. Pno2 and Pno3 are silent in this measure. In the second measure, Pno1 continues with a triplet and a quintuplet, while Pno2 and Pno3 play sustained notes. Dynamics include *ff* (fortissimo) for Pno2 and Pno3. A tempo marking of $\text{♩} = 71$ is present at the top right and bottom right of the score.

59 $\text{♩} = 68$

The musical score is divided into three systems, each for a different piano part:

- Pno1:** Features a complex melodic line in the right hand with slurs and dynamics. The left hand provides a steady accompaniment with slurs and dynamics.
- Pno2:** Features a melodic line in the right hand with slurs and dynamics. The left hand provides a steady accompaniment with slurs and dynamics.
- Pno3:** Features a melodic line in the right hand with slurs and dynamics. The left hand provides a steady accompaniment with slurs and dynamics.

The score includes various musical notations such as slurs, dynamics (mf), and articulation marks. The tempo is marked as $\text{♩} = 68$.

61

Pno1

Pno2

Pno3

5

11 3 3

11

11

5

5

3/4

3/4

3/4

64

Pno1

Pno2

Pno3

mf

66 $\text{♩} = 72$

Pno1

mp

Pno2

mp

mp mp

Pno3

$\text{♩} = 72$

mp

mp

mp

69

Pno1

Pno2

Pno3

mp mp

The musical score is for three pianos (Pno1, Pno2, Pno3) in 5/4 time, starting at measure 69. The score is written in a key signature of one flat (B-flat major or D minor). Pno1 has a treble and bass staff. Pno2 has a treble and bass staff. Pno3 has a treble and bass staff. The score includes various musical notations such as chords, triplets, and dynamics. The dynamics *mp* (mezzo-piano) are indicated in the second measure of Pno1. The score is divided into two measures per piano part.

71

$\text{♩} = 72$

Pno1

Pno2

Pno3

11

11

9

11

9

11

9

11

9

74

The musical score is divided into three systems, each for a different piano (Pno1, Pno2, Pno3). Each system consists of a grand staff with a treble and bass clef. The first system (Pno1) starts in 5/4 time and changes to 4/4. The second system (Pno2) also starts in 5/4 and changes to 4/4. The third system (Pno3) starts in 5/4 and changes to 4/4. The score features various musical notations including notes, rests, and dynamic markings such as '11' and '9'. The piece is titled 'Reverse Gravity'.

76

Pno1

Pno2

Pno3

Detailed description of the musical score: The score is for three piano parts, Pno1, Pno2, and Pno3, in a 5/4 time signature. Pno1 consists of three staves (treble, treble, and bass). The top treble staff contains a melodic line with ornaments (double dots) and fingerings of 11. The middle treble staff contains a line with a triplet of 3 and a fingering of 9. The bass staff contains a few notes with a fingering of 9. Pno2 consists of a single bass staff with a series of chords and notes, some with ornaments. Pno3 consists of three staves (treble, treble, and bass). The top treble staff contains a line with ornaments and fingerings of 11. The middle treble staff contains a line with a fingering of 9. The bass staff contains a few notes with a fingering of 9.

26

77

$\text{♩} = 67$ $\text{♩} = 64$ $\text{♩} = 59$ $\text{♩} = 55$ $\text{♩} = 50$ $\text{♩} = 45$ $\text{♩} = 38$ $\text{♩} = 64$

Pno1

Pno2

Pno3

p p

p

79

Pno1

Pno2

Pno3

p

p

5 5 5

82 $\text{♩} = 67$ 27

Pno1

Pno2

Pno3

85 $\text{♩} = 64$

Pno1

Pno2

Pno3

89

Pno1

Pno2

Pno3

The musical score consists of three parts: Pno1, Pno2, and Pno3. Pno1 is written for two staves (treble and bass). The treble staff begins at measure 89 with a triplet of eighth notes (F#4, G4, A4) followed by a half note (Bb4) and a quarter note (A4). The bass staff has a rhythmic accompaniment of eighth notes: Bb2, Gb2, Fb2, Gb2, Fb2, Gb2. Pno2 is written for two treble staves. The upper staff has a melodic line starting at measure 90 with a half note (F#4) and a quarter note (G4), followed by a triplet of eighth notes (A4, Bb4, A4). The lower staff has a rhythmic accompaniment of quarter notes: F#4, G4, A4, Bb4. Pno3 has a single treble staff with a single quarter note (F#4) at the beginning of measure 90. The score concludes at measure 91 with a 3/4 time signature.

Musical score for three pianos (Pno1, Pno2, Pno3) in 4/4 time, measures 92-95. The score includes dynamics like *mp*, *p*, and *pp*, and tempo markings of 66 and 64 bpm.

Pno1: Measures 92-95. Measure 92 starts with a *mp* dynamic. Measure 93 has a tempo marking of $\text{♩} = 66$. Measure 94 has a tempo marking of $\text{♩} = 64$. Measure 95 ends with a *p* dynamic.

Pno2: Measures 92-95. Measure 92 starts with a *p* dynamic. Measure 93 has a *mp* dynamic. Measure 94 has a *pp* dynamic. Measure 95 ends with a *p* dynamic.

Pno3: Measures 92-95. Measure 92 starts with a *p* dynamic. Measure 93 has a tempo marking of $\text{♩} = 66$. Measure 94 has a tempo marking of $\text{♩} = 64$. Measure 95 ends with a *p* dynamic.

96

Pno1

Pno2

Pno3

The musical score consists of three systems, each for a piano (Pno1, Pno2, Pno3). Each system has a grand staff with a treble and bass clef. Measure 96 is marked at the beginning. Pno1 features a triplet of eighth notes in the treble clef, followed by a half note with a sharp sign. Pno2 has a half note with a sharp sign in the treble clef and a half note with a flat sign in the bass clef. Pno3 has a half note with a flat sign in the treble clef and a half note with a sharp sign in the bass clef. The score includes various musical notations such as slurs, triplets, and dynamic markings like 'pp' and 'ff'.

The musical score consists of three staves, Pno1, Pno2, and Pno3, with the following details:

- Pno1:** Starts at measure 99. Features a dynamic marking of *99* and a *7* (seven) performance instruction. The notation includes complex chords and melodic lines.
- Pno2:** Features a dynamic marking of *11* (fortissimo) and a *7* (seven) performance instruction. The notation includes sustained chords and melodic fragments.
- Pno3:** Features a *7* (seven) performance instruction. The notation includes a rhythmic pattern of eighth notes in the bass line and sustained chords in the treble.

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