

**m i c h a e l   w i n t e r**

**l o w e r   l i m i t**

**a** math professor friend once jested that if you want to find all the words that rhyme with “orange” you simply make a list of all words, then cross out the ones that don’t rhyme with orange. (It turns out there is an archaic word, “sporange.”) Why this would come to mind when talking to Michael Winter about his music perhaps has something to do with the humor being focused on the nature of lists, and also something to do with the attention it calls to the kinds of ideas that are best explored by exhausting all possibilities. The immersive sonic textures that characterize Winter’s music are crafted from comprehensive lists of data, with each composition encompassing a musical question that is addressed algorithmically. A performance lasts for as long as it takes to answer the question, expressing all results as elegantly as possible. The pieces are long, but none are any longer than they need to be to illuminate the ideas they express.

Winter leaves room for unanticipated results by keeping things open, notably in the instrumentation, which, rather than specifying instruments, tends to designate certain properties such as “plucked strings,” or “sustaining instruments.” In this way, each performance offers a different manifestation of the same underlying structure. For Winter, beauty is the experience of something new, and to experience something new is to evolve. This virtue of possibility is clear in the scores. *lower limit*, for example, has four options for instrumentation and four for tuning, yielding 16 interpretations solely based on those two parameters. Even though Winter allows for a great many possibilities, the recordings here evince a highly tuned aesthetic filter. All of the five works included in this collection use plucked string instruments (guitar, virginal, and harp) and pure tones (ebowed guitar and pure tones). Together, they form a metacomposition, bound together by two versions of *necklaces*.

The titles describe the processes that form each work: *necklaces* represents picking patterns with *aperiodic necklaces* (strings of data with specific constraints on rotation and symbolic permutation), and in *mass and band* a constraint akin to a band pass filter is applied to an Ockeghem mass. Likewise, in *chorale and finely tuned resonators*, instruments resonate the harmonics of a chorale, and *quieting rooms* makes use of phase cancellation to quiet a room. The title of the piece *lower limit* (and this CD) refers to Winter’s intention to use the smallest amount of code possible—in other words, to find the lower limit for programming a composition. This idea, in fact, applies to all of the pieces here, since all are concerned with how to express ideas in a maximally efficient way.

Winter’s influences are clear in these pieces. The aesthetics are formed by his involvement in the community of young experimental composers in Los Angeles in the late 2000s, a community that was focused on *the wulf*.—composers such as Catherine Lamb, Tashi Wada, and Mark So. Much of that music works with duration and economy. Winter’s concerns and approaches to tuning and form arise from his work and close association with James Tenney, Larry Polansky, Gregory Chaitin, and Tom Johnson. At CalArts, Winter studied with Tenney, whose description of form in terms of shape and structure was influential, as well as Polansky’s work, “Morphological Metrics: An Introduction to a Theory of Formal Distances,” which furthers Tenney’s ideas of shape. As a companion piece to Polansky’s metrics, Winter furthers Tenney’s ideas on structure in his dissertation, *Structural Metrics*. During that time at UC Santa Barbara, Winter came into contact with mathematician Gregory Chaitin and his work on algorithmic information theory and metabiology. The influence of the composer Tom Johnson, in particular his use of combinatorics as a compositional scheme, has also been important to Winter.

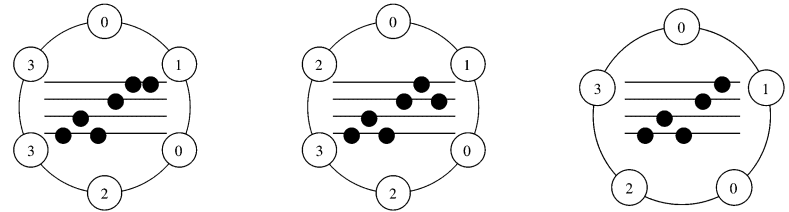
### **lower limit, necklaces** and **quieting rooms**

The mathematical conception of *necklaces* (2014) and *lower limit* (2011/2014) was influenced both by Tom Johnson's work with combinatorics and Polansky's metrics. The musical application of combinatorics (mathematical study of the question, "How many different ways can you...?") is elegantly and beautifully exemplified by Johnson's *The Chord Catalogue*, which didactically presents all 8178 chord combinations available in one octave on the piano. Winter's first piece using combinatorics is *maximum change*, which comprises the 256 ways that, assuming maximal change, a 4-note chord can be orchestrated across 4 instruments. *necklaces* and *lower limit* proceed similarly, each beginning with a question whose answer exhausts the possible variations of a short musical gesture: patterns in *necklaces*, tuplets in *lower limit*.

Winter uses combinatorics to create a set of data, or list, and then arranges and organizes that data, shaping it in time, often using graphs to visualize the form. In *necklaces*, for example, the central question is, "How do different picking patterns sound compared to each other?" Specifically: "How many unique 6-note picking patterns are there across four strings tuned to the same pitch?" The first step to sonifying this question is to identify all unique picking patterns (combinatorial constraint). That list data is arranged so as to favor minimal change (local morphological constraint), represented as a graph through which Winter traces a *Hamiltonian path* where each point is touched once and only once, determining the linear sequence of picking patterns. The narrow focus on a single pitch calls attention to subtle variations in tuning, tension, and string gauge, with continuously changing resultant spectra.

The picking patterns in the score are all representatives of different aperiodic necklaces, arranged such that each is minimally different from the preceding pattern. From one picking pattern to the next, only one thing will be

altered, either by the addition or subtraction of a note, or by a change of string for one note. According to Winter, one of the challenges of composing the piece was finding a sequence of patterns that would satisfy both conditions of representing an aperiodic necklace and being minimally different from the neighboring patterns—a puzzle that was solved through brute force. Circular graphics show a picking pattern in two ways: in the center by tablature, surrounded by a circle of the four strings numbered 0–3. The circularity of the numbers communicates that the pattern is the same when rotated. *necklaces* was premiered by Michael Winter and Mark So on March 22, 2014 at the wulf.



Three consecutive picking patterns in *necklaces*

On track 1, *necklaces* sounds simultaneously with *quieting rooms* (2012), an installation employing a crude genetic algorithm that attempts to put two signals out of phase and thus quiet the room. Inspired by metabiology, *quieting rooms* models an asexual organism that mutates from one generation to the next. The fitness function is "quietness." As the "organism" mutates the signals learn to be out of phase with each other. At the beginning of a life cycle, one speaker plays sine tones with randomly generated frequencies, amplitudes, and phases. The other speaker mimics the first, playing the same

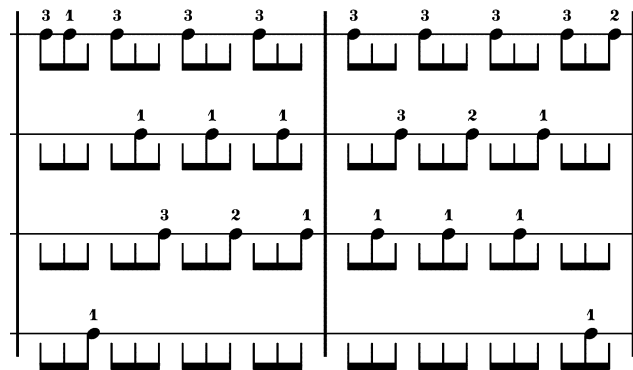
frequencies with the same amplitudes, but with different phases. The first speaker is the constant and the second is the variable. The organism's task is to mutate the phases of the second speaker such that phase cancellation increases and the room gets quieter. When the organism has quieted the room, the cycle begins again. The first realization of the installation was on December 13, 2012, at ArtShare in Los Angeles. In the recording that occurs with *necklaces*, the piece is realized in a somewhat abstract way, internally on the computer itself, without the effect of an actual room.

Possible realizations of *lower limit* vary greatly with respect to tuning and instrumentation. In the score, Winter designates four parts to be played on one, two, or four like-sounding instruments, or on combinations of different, unduplicated instruments. The sustain of the tones lengthens from part to part, with part 1 having the shortest tones and part 4 the longest. The use of digital reverb is encouraged to accentuate the effect. Pitches are derived from the harmonic series, but aside from that the tuning is flexible. Four options are listed in the score.

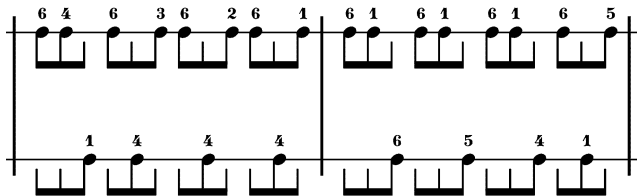
1. Twelve adjacent partials of the same fundamental
2. Variations of a trio of pitches derived through different tuning constraints (one player tunes the three pitches in 5-limit tuning, another in 7-limit, etc.)
3. All players play the same three partials of the same fundamental
4. Any 12 harmonics ordered from shortest to longest decay

The fourth option was suggested by Cristián Alvear, who also requested the version of the piece for two guitars that appears on this CD. In this recording, the two guitars are tuned to harmonics 2–13 of *d*. Together they form a single

line over 27 minutes, weaving through all possible sequences of triplets in such a way that one performer never plays the same note twice in a row. The resulting sound is a hypnotic melody whose tones hocket through what sometimes sound as twisted scalar melodies and other times as arpeggiated chords above a pedal tone.



Excerpt from the four-part version of *lower limit*



The same excerpt collapsed to two parts

### ***chorale and finely tuned resonators, mass and band***

*chorale and finely tuned resonators* (2013) and *mass and band* (2011) answer the question, “What does music sound like if you remove the fundamentals and listen only to the harmonics?” by recomposing extant musical material. The analysis identifies prominent harmonics of the chord progressions of Renaissance and Baroque liturgical music: *mass and band* treats the *Kyrie* from Ockeghem’s *Missa Prolationum* (15th century) and *chorale and finely tuned resonators* treats a Bach chorale (18th century). The particular chorale is not specified by Winter, but he claims that it can be identified by reverse-engineering the piece.

For both pieces, the first step is to analyze the notated pitches and calculate all the harmonics that would theoretically arise from them, but what is done with that data from there differs between the two, resulting in two different sonic textures. *chorale and finely tuned resonators* calls for swelling sustains and *mass and band* emphasizes decaying attacks. Both pieces provide time windows during which certain pitches are available, but they differ in that *chorale and finely tuned resonators* tones can begin anywhere within that

window, while in *mass and band* the onset of a tone is articulated where it appears in the score. In preserving the placement of note entrances, *mass and band* preserves some of the rhythmic content of the *Kyrie*, a mensuration canon that makes use of *rhythmic dilation* to create four parts out of two, setting the cantus and contra melodies in two different meters apiece: 2/2 and 3/2 for the cantus, 6/4 and 9/4 for the contra.

*chorale and finely tuned resonators*, commissioned by guitarist Chaz Underriner, is for eight sustaining instruments. The score states, “ideally, the piece should be played by humans, but any number of the parts may be electronically synthesized or prerecorded.” For the premier on December 13, 2013, Underriner realized the piece for three guitars and five synthesized parts. For this recording, he uses eight guitars. Instruments play in just (or near-just) intonation, acting like finely tuned resonators that sound harmonics found in the Bach. In the score, space is proportional to time with measures lasting roughly 4 seconds, but there is no actual pulse and the entrance and exit points of each tone are only loosely connected to the source material. The Bach chorale is repeated several times over the course of the piece, treated with longer durations of tone at the beginning, and increasingly shorter tones until the end.

Tones should be “swelled, entering and exiting as subtly as possible,” and for most of the piece, the guitars create swelling, sustained tones with ebows. Near the end they switch to plucked strings with bright metallic attacks that are then swelled by volume pedals. This shift, developed by Underriner, accommodates an increase in note density that occurs in the last 20 measures of the piece. Because of the ebow there is a lag between the activation of the string and the emergence of tone, so as the notes get closer together the lag interferes with the timing of note entrances. This timbral shift, a by-product of adapting the piece for guitar, is a striking example of the way the unanticipated features of instrumentation influence the sound.

8ve  
-14  
15

8ve  
-14  
15

1

-31  
7

1

b  
12

8ve  
-54  
13

-31  
14

First 3 measures of *chorale and finely tuned resonators*:  
sparse with long note durations

8ve  
-14  
-14

3 3 9 5 3 5

4 4 2 2 1 2 2

8ve  
-14  
-14  
-14  
-14  
-31

7 10 5 5 5 7

-54  
-14  
8ve

11 8 5 3 6 8

8ve  
8ve  
-54

9 4 1 8 2 11

-31  
-31  
8ve  
-31

7 7 3 1 6 7

-31  
8ve  
-31  
-31  
8ve  
-14

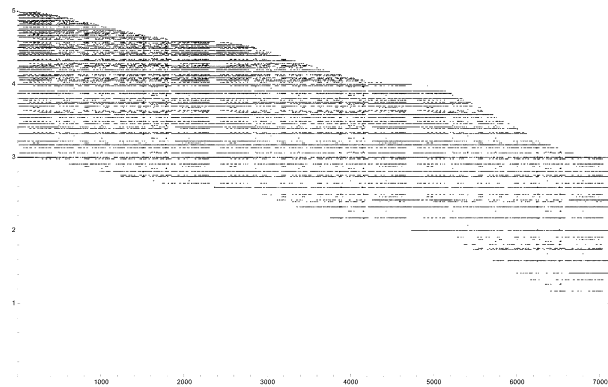
7 2 11 7 7 5

8ve  
-14  
-31  
-31  
-14  
-54

6 5 7 1 7 15 13

Last 3 measures of *chorale and finely tuned resonators*:  
dense with short note durations

In *mass and band*, the score states that the top three of the five parts in the piece are to be played on “one or more plucked string instruments,” or, in contrast, “a minimum of three sustaining instruments.” Yet despite this openness, the piece has thus far has only been realized for virginal and harp, by Bryan Parks and Colleen Thorburn, who premiered it on November 12, 2011, without using *any* of the top three parts, playing just the bottom two that are strictly designated to be played on virginals, harpsichords, or harps. The virginal is tuned to many harmonics derived from the *Kyrie*, as a number of pitches have different tunings from one octave to the next. The harp’s tuning is determined by first choosing a pedal setting, then tuning available notes accordingly and disregarding the rest. The pitches are harmonics of a transposed version of the Ockeghem, set two octaves and a minor third below. A process analogous to a band pass filter then oscillates downwards through this note information, selecting a limited range of harmonics. Then, the most prominent harmonics in the local ranges are identified and assigned to instruments.



Descending harmonic range in *mass and band*

A comparison of the openings of the *Missa Prolationum Kyrie* and *mass and band* demonstrates how the virginal and harp entrances correlate with the introduction of new pitches in the mass. The *Kyrie* begins on *d*, and in *mass and band* the piece begins with retuned *c*, *d*, and *g* that are harmonics above that *d*. Then, when the pitch changes to an *a* on beat 3 of Cantus 1, the virginal plays a high *b-flat*, and likewise, when Cantus 2 and Contra 1 change pitch on beat 4, a lower *b-flat* is played. The empty space in the score that follows is filled in by improvised harp and virginal rearticulations of the opening pitches, which can be rearticulated for as long as the *d* is sounding in the Ockeghem. When the chord changes to *F# minor* (on the last beat of the excerpt), *x*-shaped noteheads indicate that the *c*, *d*, and *g* are no longer available. The meandering sonic result of *mass and band* achieves the meditative quality that pervades all these pieces, a quality that is one of the great virtues and beauties of Winter’s music.

mass and band

Virginal

Harp

Missa Prolationum, Kyrie (transposed down two octaves and a minor third)

Cantus 1

Cantus 2

Contra 1

Contra 2

mass and band compared to *Missa Prolationum Kyrie*

—Laura Steenberge

*Laura Steenberge is a composer and performer based in Los Angeles. She has recently recorded a collection of pieces for harmonica, forthcoming on Nueni Recs., and developed a monthly podcast, the Imaginary Music Radio Hour, hosted by NTS.*

**Michael Winter:** My work often explores simple processes where dynamic systems, situations, and settings are defined through minimal graphic- and text-based scores that can be realized in a variety of ways. To me, everything we experience is computable. Given this digital philosophy, I acknowledge even my most open works as algorithmic; and, while not always apparent on the surface of any given piece, the considerations of computability and epistemology are integral to my practice. I often reconcile epistemological limits with artistic practicality by considering and addressing the limits of computation from a musical and experiential vantage point and by collaborating with other artists, mathematicians, and scientists in order to integrate objects, ideas, and texts from various domains as structural elements in my pieces.

I have performed across the Americas and Europe at venues ranging in size from small basements to large museums to outdoor public spaces. In 2008, I co-founded the wulf., a Los Angeles-based organization dedicated to experimental performance and art. As a laboratory and hub for exploring new ideas, the wulf. has become an experiment in alternative communities and economies. Similarly, my work subverts discriminatory conventions and hierarchies by exploring alternative forms of presentation and interaction.

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**Cristián Alvear** (guitar) is a Chilean musician dedicated to the performance and recording of experimental and contemporary music. He serves as curator of the experimental music festival Relincha in Valdivia, Chile, and he conducts, along with Santiago Astaburuaga, LOTE, an ensemble dedicated to realizing experimental scores. He frequently performs in Chile as well as international festivals and concert venues in Europe, South America, and Asia.



Chilean musician and improviser **Vicente Araya** (guitar) is dedicated to the performance of contemporary and experimental music. He studied guitar at the Music Institute of the Pontificia Universidad Católica de Chile with Chilean guitarists Diego Castro and Sebastián Montes. In parallel, he graduated with a degree in geography, which continues to influence his musical style conceptually. Considerations of space and complexity are integral to his musical practice.

**Brian Parks** (virginal) is a Fellow of the American Guild of Organists and has premiered keyboard and other works by Michael Winter, Tom Johnson, and Christopher Adler. He also curates workshops for the algorithmic-musically-curious whenever he senses interest. At Wesleyan University, he took masters degrees in experimental composition and ethnomusicology and filled Just Visiting appointments teaching harpsichord, music theory, and Ghanaian drumming/singing. Ron Kuivila, Abraham Adzenyah, and Ronald Ebrecht are central pedagogues in his life.

Harpist **Colleen Potter Thorburn**'s playing has earned her national recognition as a winner of the American Harp Society's Anne Adams competition. She has performed with the Eastern Connecticut Symphony Orchestra, the Richmond Symphony Orchestra, and the Philadelphia Orchestra, and is a founding member of the new-music duo Apple Orange Pair with horn player Emily Boyer, with whom she has premiered over nineteen new chamber works. She has taught harp on the faculties of Virginia Commonwealth University, Liberty University, and Bluefield College in Virginia, and holds a Doctor of Musical Arts degree from the Yale School of Music.

Guitarist **Elliot Simpson** has given premieres of works by some of the iconic composers of our time and has worked closely with many other prominent young composers in the creation of new pieces. He has appeared in arts capitals

around the world in master classes, workshops, and performances ranging from early music to free improvisation. His recordings can be found on the Microfest, EMI, Soundset, and Hermes record labels. Originally from New Mexico, Simpson studied with David Tanenbaum at the San Francisco Conservatory of Music and with Zoran Dukic at the Royal Conservatoire of The Hague.

**Chaz Underriner** is a composer, intermedia artist, and guitarist based in Florida. His work explores the notions of landscape and portraiture through the juxtaposition of video projections, audio recordings, and live performers. Underriner has collaborated with numerous choreographers, experimental filmmakers, animators, and writers. His work has been programmed at Gaudeamus Muziekweek (Utrecht, Holland), the Los Angeles Philharmonic's National Composer's Intensive, the International Computer Music Conference, the Impuls Festival (Graz, Austria), the Morley College Engine Room Sound Art Exhibition (London), the National Building Museum (Washington, DC), Ostrava New Music Days (Czech Republic), and Dogstar Orchestra (Los Angeles).

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Producer: Michael Winter  
*necklaces* (with *quieting rooms*)  
Recorded November 7, 2016, at Studio Loos, The Hague, The Netherlands.  
Recording Engineer: Elliot Simpson. With thanks to Dario Giustarini.

*chorale and finely tuned resonators*  
Recorded November 29, 2016, at the Art Institute of Dallas.  
Recording Engineers: Janel Trevino and Juan Espinoza  
Mixing Engineer: Chaz Underriner

*mass and band*  
Recorded November 18, 2016, at Alpsmedia Studios, Atlanta, GA.  
Recording Engineer: Christopher Alpiar

*lower limit*  
Recorded January 4, 2017, at INUACC in Santiago, Chile.  
Recording Engineer: Cristián Alvear

*necklaces* (solo version)  
Recorded February 5, 2017, at Studio Loos, The Hague, The Netherlands.  
Recording Engineer: Elliot Simpson. With thanks to Dario Giustarini.

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Contemporary/Winter, Michael

**m i c h a e l w i n t e r**

(b. 1980)

**l o w e r l i m i t**

**l o w e r l i m i t**

1. *necklaces (with quieting rooms)* (2014) 16:00  
Elliot Simpson, guitar
  2. *mass and band* (2011) 11:46  
Brian Parks, virginal; Colleen Potter Thorburn, harp
  3. *chorale and finely tuned resonators* (2013) 9:35  
Chaz Underriner, guitars
  4. *lower limit* (2011/2014) 26:56  
Cristián Alvear, guitar; Vicente Araya, guitar
  5. *necklaces (solo version)* (2014) 13:11  
Elliot Simpson, guitar
- TT: 77:46



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