An Introduction to the String Quartets of Ben Johnston

by Sharan Leventhal

Ben Johnston's (b. 1926, Macon, Georgia) enigmatic string quartet cycle constitutes a milestone in 20th Century chamber music.[1] But the works are rarely performed. While the compositions' thorny rhythms are likely a deterrent for many performers, what ultimately keeps this music out of the repertoire is Johnston's bold exploration of pitch and harmony. All but the first of Johnston's 10 quartets are written in extended just intonation (JI), a scheme that not only requires a developed sensitivity to the subtle nuances of the overtone series, but also a head for mathematics.

Fueled by an early interest in Debussy, the acoustical studies of Helmholtz and ignited by contact with iconoclast Harry Patch, Johnston has dedicated his artistic life to the exploration of musical proportionality as it relates to pitch, rhythm and form. His work invites us to consider what might have happened if Western music had embraced the anomalies of the harmonic series rather than manipulating it to fit the limitations of keyboard instruments. The quartets open a path into an uncharted tonal future. The final movement of his 10th quartet, for example, is a virtual travel log from then to now—a set of variations beginning in a Renaissance style and progressing forward through the centuries into a parallel musical universe.

This article offers a brief introduction to the JI system of Johnston's string quartets, my experience working with the composer, strategies on how to approach this repertoire, and reflections on teaching these pieces to college-level students.

Early encounters

My first contact with this extraordinary music was in 2001, playing String Quartet No. 4 (1973) on a program with Milwaukee-based new music ensemble Present Music. My colleagues (violinist Eric Segnitz, violist Brek Renzelman and cellist Karl Lavine) and I found playing the piece so enjoyable that Segnitz decided to research Johnston's chamber music. Discovering that String Quartet No.10 (1995) had yet to be premiered, we contacted Johnston, who was then living in Rocky Mount, North Carolina, and persuaded him to coach our performance.

The premiere took place in April 2002 in the Calatrava wing of the Milwaukee Art Museum. For us, the performance was an unforgettable experience. Upon completing the first movement, the audience of nearly 1,000 took a collective gasp and then broke into wild applause and shouting. So it went for every movement. In the flush of excitement that followed, Segnitz contacted various record labels with a proposal to record Johnston's three quartets based on folk material. We came to an understanding with New World Records and agreed (with the composer's encouragement) to expand the project into a three-disc set of the entire cycle. We had no idea what we had gotten ourselves into.

The easy part was giving our new ensemble a name: Kepler Quartet. The reference was appropriate. After all, it was German astronomer, scientist and mystic Johannes Kepler who demonstrated that the ratios between a planet's fastest and slowest orbital velocities are directly correlated with musical intervals (Harmonices Mundi, 1619).

Things quickly became more difficult. Initially, Johnston, informed by past experiences with performers, encouraged us just to play until it "felt right." Although we initially proceeded that way, we became increasingly dissatisfied. If we were going to realize the composer's intentions, we needed to unravel the intricacies of his daunting notational system. As that process developed, and as our own abilities to hear overtone relationships gradually evolved, we realized we were entering an entire new universe of sound. Johnston had been delighted with the result. "[With their] fastidious accuracy of the microtonal pitches, they've actually created an entirely new language." [2]

Ascertaining and executing the proper pitch relationships was challenging, and doing so within the confines of musical time increased the difficulty by orders of magnitude. We learned that playing in extended JI is to be immersed in a flexible, and occasionally surging, sea of pitch. Johnston's music demands an almost Zen-like commitment to the moment. It requires thinking pitch intervals along an ever-expanding and contracting vertical plane.

"The overtone series is there for everybody because you can't get rid of it." – Ben Johnston, author's conversation (1/8/14)

Everyone who has a peripheral knowledge of music theory has had some exposure to the overtone series.

As Western music now functions primarily within the equal temperament system (ET), few of us have bothered to consider the overtone series' implications. Even fewer have spent time listening to, and assimilating, those implications.

The pitch of a string is determined by the rate at which it vibrates. On the violin, for example, the D string vibrates in a single arc from one fixed end to the other at a rate of 293 cycles a second. That perceived pitch is what we call the fundamental. However, the string is simultaneously vibrating in smaller divisions (halves, thirds, etc.). Each of these segments creates its own pitch as well. These are the overtones.

Overtones vibrate in direct proportional relationship with the fundamental. For example, each half vibrates twice as fast as the whole (2:1), which produces the first overtone, the octave. Three equal divisions of the string creates a vibration ratio of 3:2. From this you get the second overtone, the fifth (one octave higher). Each subsequent division produces another overtone, which is always higher in pitch than the previous one. All of these overtones can be expressed in terms of mathematical ratios. Because the vibrations of the overtones are perfectly synchronized with the fundamental, there are no interference patterns in the sound waves. The intervals are pure; their sound is smooth and harmonious.

The overtone series is the kernel from which our Western harmonic language has grown. We experience simple pitch relationships—ratios of 2:1, 3:2, etc.—as consonant, and our scales emerged from these relationships. Yet the intervals derived from these naturally occurring phenomena are irregular. Fixed-pitch instruments cannot adjust to the particular characteristics of successive fundamentals. Therefore, temperament systems, which manipulate the distance between intervals within the octave, were devised to mitigate dissonance when moving between different tonal centers.

There have been many different temperament systems. ET, for example, was stated theoretically as early as 1581, but it only was standardized in 1917, with the contribution of piano tuner William Braid White.[3] Until the 20th Century, most musicians favored other temperaments. Additional conceptual systems continue to exist alongside ET, including Harry Partch's 43 tones per octave, JI compositions for fixed-pitch instruments and Johnston's application of extended JI.

The chart below (Figure 1) demonstrates the difference between a C major scale in equal temperament and the same scale realized in just intonation. Each deviation from ET to JI is listed in cents, a unit of measurement used in ET that divides the octave into 1,200 equal parts. For the sake of clarity, all measurements will be rounded to the nearest cent.

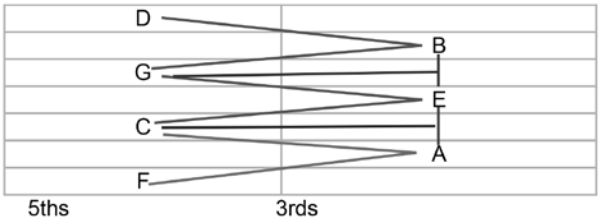
Pitches	C-C	C-D	C-E	C-F	C-G	C-A	C-B	C-c
Interval	Unison	Major 2nd	Major 3rd	Perfect 4th	Perfect 5th	Major 6th	Major 7th	Octave
Ratio of vibrations	1:1	9:8	5:4	4:3	3:2	5:3	15:8	2:1
Deviation from ET	0	+4	-14	-2	+2	-16	-12	0

Figure 1: Ratios for the just-tuned C major scale

In ET, the circle of fifths returns to the point at which it began. But in JI, pitches do not line up so neatly. The "circle" of fifths becomes a spiral, one that coils outward to new pitches and harmonies. Rather than returning to its initial starting point, moving upward by fifths in JI creates a "comma."[4] If you progress through a cycle of 12 pure fifths, the final C will be about 22 cents higher than the initial C. This is called a Pythagorean comma. There are other ways of producing a comma. For example, the syntonic comma is the difference between rising through four perfect fifths versus rising two octaves and a pure major third (C-G-D-A-E versus C-C-C-E). Rising by the former method creates an E that is about 22 cents higher than the latter method.

Just tuned scales are built from consonant triads, as follows:

Figure 2



F/A/C: C/E/G: G/B/D are just tuned major triads

A/C/E: E/G/B are just tuned minor triads

Johnston extends this chain of consonant triads through a succession of connected blocks, each a syntonic comma apart.

Figure 3:

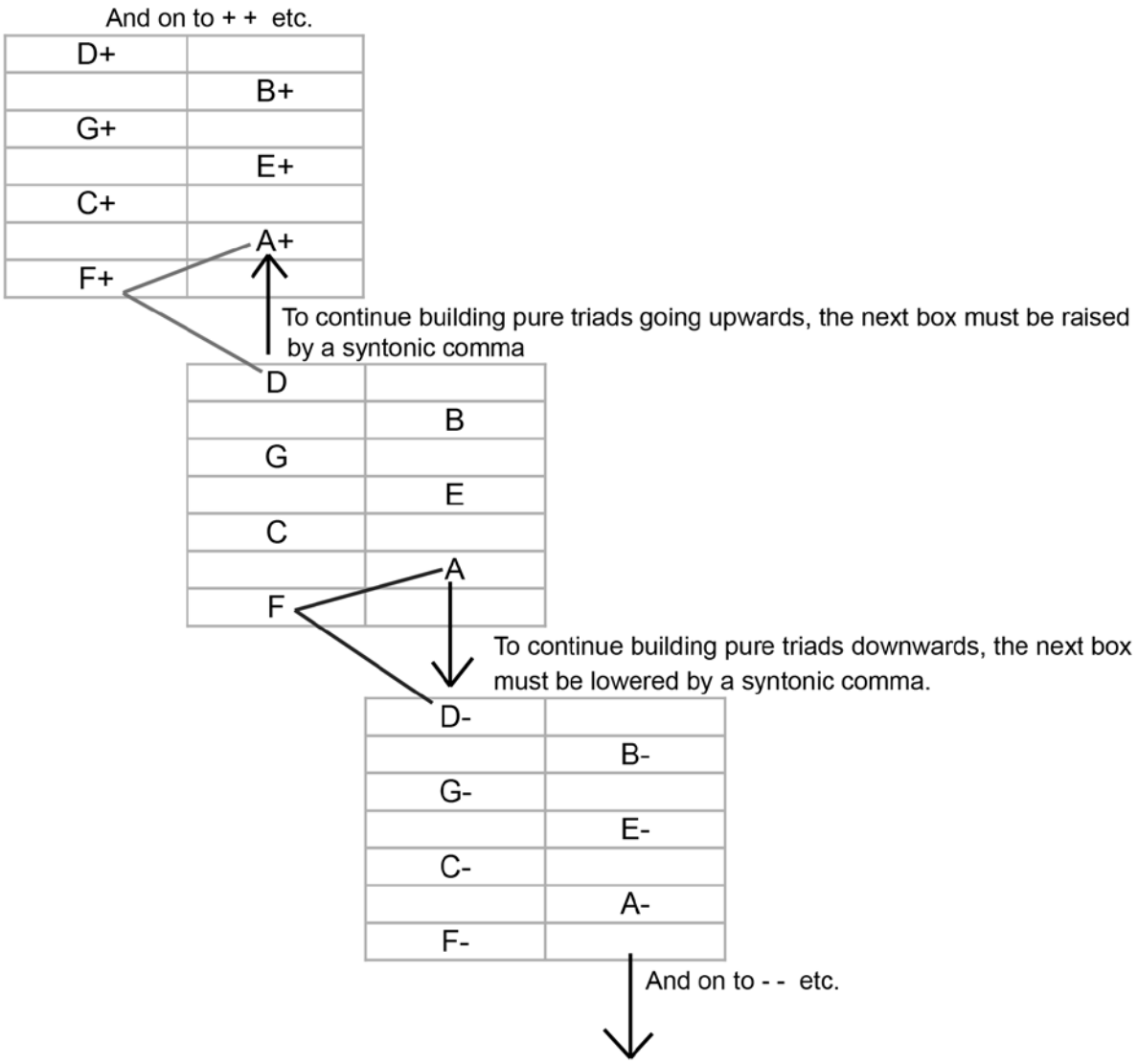
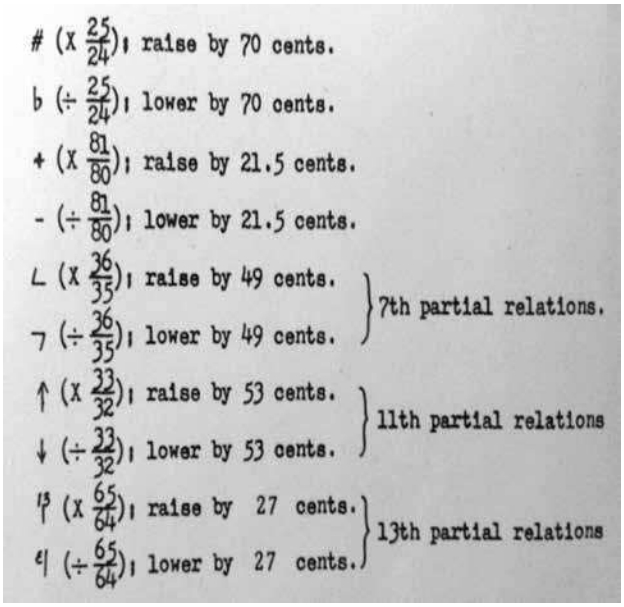


Figure 4: Johnston's notation chart from the score of SQ10

These successive boxes must be a syntonic comma apart to keep the triads in line with the natural laws of the overtone series.

At times, Johnston creates alternative scales using pitches derived from the overtone series. For example, he uses the 11th and 13th partials for the 4th and 6th degree of a scale, thus substituting a 4:3 relationship with 11:8 and 5:3 with a 13:8 . Interestingly, the 11th partial produces a neutral third between the 2nd and 4th degree of the scale (D and F↑ in a C scale), an interval that is present in many folk traditions

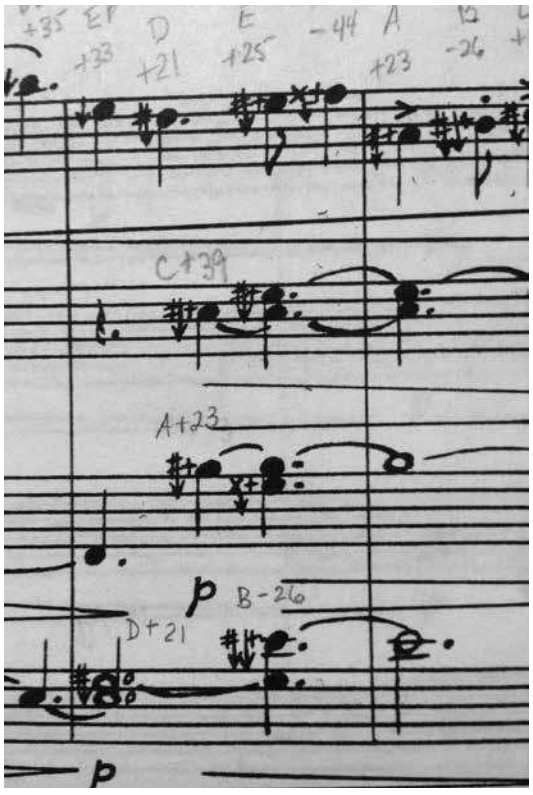
In order to communicate pitches with such precision, it was necessary for Johnston to invent a more nuanced system of accidentals, or chromas. (See Figure 4.)



Learning the score

Johnston orients his pitch universe around middle C as placed in our A-440 ET system, at 261.62 Hz. Because he uses just-tuned intervals, E strings are 14 cents lower than ET and A strings are tuned 16 cents lower (see Figure 1). To maintain pure fifths, D, G and C strings must be tuned down a syntonic comma (see Figure 3): D- (-18), G- (-20) and C- (-22).

Figure 5: Measure 532 from String Quartet No. 6



One must sit down with a pencil and paper and decipher the pitches, which means doing the math. Most of the notes have modifiers. Many have more than one. There are combinations in which some raise and others lower the pitch. Once the correct modification (number of cents up or down) is determined, that must be added to or subtracted from the pitch as it normally sounds in a just-tuned C scale. Therefore, a collection of accidentals such as #↓+ (plus 70 cents, minus 53 cents, plus 22 cents, see Figure 4) results in a pitch rise of 39 cents. If this particular grouping of chromas were to precede an A, the final deviation will be a rise of only 23 cents from the equal tempered A 440, because the just-tuned A is already 16 cents lower. Similarly, the same modifiers in front of an F result in an F that is 37 cents higher (the pure F in a C scale being two cents lower). At first exposure, this orthography may seem unnecessarily complicated. It is not. The beauty of the notation is that the function of each note is immediately apparent. With sufficient experience, one comes to know what it should sound like, even without figuring the exact deviation.

"If you do it right, the plot thickens. If you do it wrong, the plot sickens." – Ben Johnston

As far as we know, no one had bothered to be so scrupulously accurate with Johnston's string quartets before Kepler began recording. Simply deciphering the pitches was a huge undertaking. As for realizing them, technology came to the rescue in the form of chromatic tuners. Of course, the goal is to develop a heightened awareness of how pitches interact. But for us, using visual aids to confirm what we hear remains extremely helpful. Getting four people to modulate to a chord on the thirteenth partial can be quite challenging.

Once we have clarified the score, we comb through every single note with the composer. Sometimes we find copy errors. When revisiting his work, Johnston might not remember what was on his mind when writing a particular passage. The litmus test is sound. In very rare instances, the results do not stand up to inspection. In such cases he will rewrite passages that he now deems unsuccessful. (It is quite remarkable to hear him sing the correct pitches.) Playing the "correct" pitches is only part of the solution. A chord that is "in tune" can still sound incorrect if it isn't voiced properly. Particular voicings can either support or interfere with the interactions Johnston is trying to express.

This process of checking through is arduous work. At present, we are tackling String Quartet No. 6, a single-movement palindrome inspired by Wagner's never-ending melodies. It took Kepler three full days, working note by note with Johnston, to cover the music up to measure 298—the midpoint. Only then could we begin to actually learn the piece.

Curiously, considering his remarkable specificity in the realm of pitch, Johnston allows the performers great latitude when it comes to articulation, and, to some degree, dynamics. We make choices as a group, getting Johnston's okay before finalizing any decisions. However, there are many possible solutions. His major concerns are that the performers express the proper emotion—and that repeated sections are played differently the second time around.

The long-term result of living with this notation is extreme ear training. Because most serious string quartet players have wrangled with pure thirds and sixths (major or minor), these are the easiest intervals to assimilate. One also learns what a pure dominant 7th sounds like, what the pure 11th and 13th partials sound like (F +51 and A +11 respectively from a C fundamental). Eventually, one comes to feel these various pitch relationships on a visceral level.

Over time, we members of the Kepler Quartet have learned

to anticipate the rising and sinking "tidal" motion of Johnston's shifting harmonies as the music slips from one tonal center to another. As we experience harmonic motion, we shift our individual pitches accordingly. Through this process, our notions of what constitutes harmonic dissonance and consonance have expanded greatly.

These days, we work with Johnston at a church in rural Wisconsin. The sessions have *Field of Dreams* overtones, (so to speak,)—play it and they will come. There we are, in the middle of a cornfield, the door opens and visitors from across North America sit down to listen. I get the oddest sensation that the project is like a loadstone—the center of an alternate universe in which, if we stayed long enough, the church would fill with a congregation of seekers, including ghosts of the past and muses for the future.

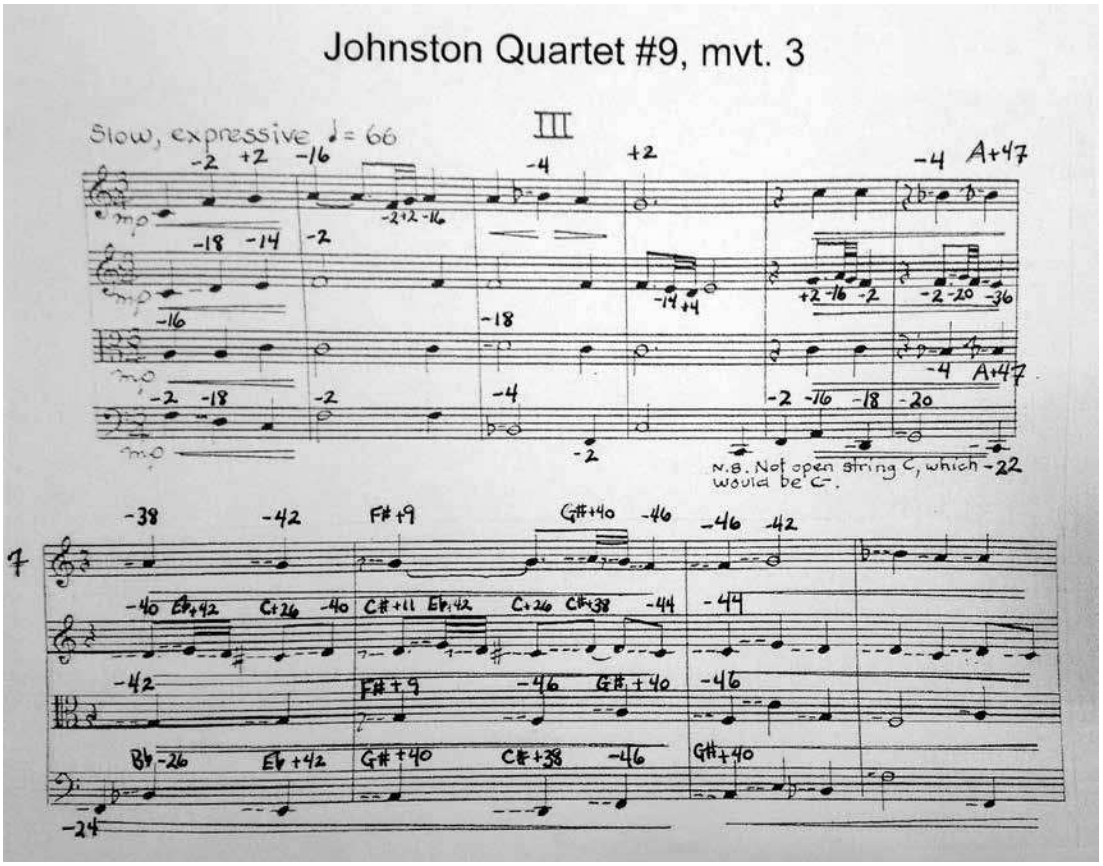
"Nothing will ever be the same." – Nora Karakousoglu (MM, 2013, the Boston Conservatory)

I am continually grateful that chance set my foot upon this path. I see my own growth reflected in the students I have introduced to Johnston's work.

Getting students to move outside of years of ET training takes some doing. My first time teaching the simple reality of a just-tuned dominant chord was unforgettable. The students found placing a pure major 3rd fairly easy (-14 cents), but the 7th (-31 cents) was another matter. Once the chord was in place and everyone settled into its sound, I asked the person playing the 7th to bring the pitch back up to 0 on the tuner. As the sound distorted more and more on its way back to ET's version of "in tune," the look of horror on their faces was quite entertaining.

When teaching a chamber music class on Johnston's string quartets, I like to assign the 9th quartet. (This quartet has 153 pitches in the octave.). The 1st movement (a set of variations) opens with a simple and direct introduction of the C major just-tuned scale. This is sustained throughout, along with a dalliance with the syntonic comma. The groups that have tackled it often are tripped up by Johnston's rhythmic complexity—proportional rhythms based on the same numerical relationships as those that rule the overtones. We tend to spend most of our time on the third movement, which is a 63-measure ABA hymn-like melody marked "slow, expressive." The structure is clear and familiar. In the first eight bars, however, Johnston modulates from F major to F-major (down one syntonic comma) to F--major (down two syntonic commas). The effect is remarkable. There is a strong physical sensation of having dug a hole, and crawled in. By measure 14, he modulates back up to F major, climbs out of the hole and emerges back into the sunshine.

Figure 6:



The first time the Johnston string quartet class was offered, one dedicated quartet was so captivated by the process that the students decided to stick with it for the entire school year. By the end of the second semester the group "owned" the third movement. As a teacher, it was an exciting moment. I knew that I had helped them to hear in new ways. Violinist Adrianne Pope (BM, 2012, the Boston Conservatory) said, "Before studying Ben Johnston's 9th String Quartet, I saw intonation as right or wrong, in tune or out of tune. I have learned that playing 'in tune' is relative." The group's final recital, which

included Haydn Op. 9, No. 4 in D Minor, reflected that understanding. Adrianne and her colleagues were astonished by the impact their work on the Johnston had on classical repertoire: chords shimmered; intonation fell into place with ease.

Conclusion

Johnston told me that he considers his method of notating just intonation. He is overly humble. After all, but for his remarkable music, this notation would not exist. The 10 string quartets themselves—ranging from his more abstract early microtonal serial works (the second and third quartets) to those that draw from the warm traditions of everyday musical life (4, 5, and 10 include "Amazing Grace," "Lonesome Valley" and "Danny Boy" respectively)—this music encapsulates the alienation and heritage, challenges and resources of mid- to late-20th Century life.

One of the lessons we learn over and over again is that no matter how skilled, there are always new worlds to explore in music. Johnston's use of extended just intonation opens an entirely new universe; one that is tightly coiled inside the world we inhabit. The result is profound. At times, the harmonic textures offer warm, rounded, ringing solidities. At others, a listener is bathed in a nebulous tone cloud, especially when the harmonies venture into the realm of the "undertone" series (the inversion of the overtone series). Because Johnston's harmonic language is derived from the pitches that are already nestled inside one another, no matter how strange the textures may initially seem, with experience the relationships come to sound right.

He is a thoughtful, witty and charming southern gentleman. Through the years each of us has developed a unique friendship with him, making this project deeply personal for all involved. Alas, he is in poor health. Watching him grow more and more frail over the years has lent a sense of urgency to our work. Having his guidance and approval in unraveling these masterpieces has been invaluable.

Ultimately, his quest has been spiritual in nature. His work is an attempt to infuse meaning into life through the composition and practice of music. "There are two approaches to life, and one is linear and melodic—the hero's journey," he said. "But there is another one—the vertical, harmonic way that is concerned with perfect relationships. I have grown to find this a much richer experience. It is the same in music. I don't mean to say that I am a better person than others, and therefore this is better music. But I do believe that working with this music has the potential to make me a better person. This is true for anybody who deals with it. If it is used right, it has that sort of potential. It's not just a question of what the composer has put down on paper and how accurately it is realized. It's a matter of finding meaning, and what actions this meaning might invoke."

Endnotes

1. Although not a household name even among musicians, Johnston's music is increasingly performed. His book *Maximum Clarity and Other Writings on Music* (USA: University of Illinois Press. 2007) won an ASCAP Deems Taylor award. His music has been the focus of numerous Ph.D. dissertations.
2. Letter from Ben Johnston to The Lynde and Harry Bradley Foundation, Board of Directors, April 27, 2011. (In fact, we were simply realizing sounds that had long lived in Ben's imagination.)
3. See White's *Modern Piano Tuning and Allied Arts*. New York: Edward Lyman Bill, Inc. (1917).
4. A comma is the discrepancy between two examples of the 'same' note (ignoring octave displacement), when it is approached in different ways, using pure (or just tuned) intervals.

Links

Interview with Ben Johnston: https://www.youtube.com/watch?v=slXIOTTYpHY
Kepler Quartet http://www.keplerquartet.com
New World Records: http://www.newworldrecords.org
CD #1 http://www.newworldrecords.org/album.cgi?rm=view&album_id=15254
CD #2 http://www.newworldrecords.org/album.cgi?rm=view&album_id=87338
Smith Publications: http://www.smith-publications.com/index.html
Contact via the web, attn.: Silvia Smith sylvias@smith-publications.com

Violinist Sharan Leventhal has toured four continents as a soloist, chamber musician, and teacher. A champion of contemporary music, her more than 150 premieres include composers ranging from Gunther Schuller to Fred Hersch. Grants include awards from Chamber Music America, NEA, Fromm Foundation, and Aaron Copland Fund for Music Recording. Leventhal has appeared as soloist with the Boston Pops Esplanade Orchestra; the Toledo, Milwaukee, and Albany symphonies; and the Wisconsin and Cleveland chamber orchestras, among others. She is a founding member of the Gramercy Trio and Kepler Quartet, and was a founding member of Marimolin. She can be heard on the New World, Catalyst/BMG, Newport Classic, GM Recordings, Northeastern, Naxos and Parma labels. Leventhal teaches at The Boston Conservatory, and has served on the faculties of Brandeis University, Michigan State University, the Berklee College of Music, Interlochen Arts Camp, and the Asian Youth Orchestra. She currently serves as president of MA-ASTA and is founder Play On, Inc.. Her blog is Just Tuning In. Leventhal earned her B.M. at Boston University, and her M.M. at Yale.