

HARRY PARTCH: PHILOSOPHIC MUSIC MAN

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This is an English translation of an introductory lecture originally titled 'Avant, avec et après Harry Partch' presented on January 29, 2024 on the occasion of a viewing of the film The Dreamer That Remains in Albi, France during the 'Semaine du Son'. Images and musical examples have not been reproduced.

Good evening and welcome. My name is Thomas Nicholson, and I am a Canadian composer currently based in Berlin. For several years, my composing and performance practice as a violist has been centred around just intonation, and it's a great pleasure to be back at GMEA during this year's *Semaine du Son*, dedicated to just intonation and the infinite possibilities of finely tuned sounds.

Tonight, we have the opportunity to watch a wonderful film about the American composer and theorist of music in just intonation Harry Partch, who was also a prolific builder of instruments. But before that, over the next hour, I hope to provide some context for his remarkable life, work, and influence, as well as provide some details that will hopefully enhance your experience of the film. For much of the biographical information, I am deeply indebted to Bob Gilmore's research and excellent book about Partch, which I recommend to anyone looking to gain an intimate insight into Partch's life and work.

The term *just intonation* describes a special practice of playing in tune, that is, in harmony. It was understood and theorized about by various ancient cultures. The intervals between tones, especially the most concordant ones, correspond to simple ratios of whole numbers. In antiquity, these ratios were related to the length of strings. The tone produced by a string half the length of another produces a musical octave, and two strings in the numerical proportion of 3:2 – for example, two strings with lengths 15 cm and 10 cm respectively – create the musical ratio of a perfect fifth.

Later, with a more advanced understanding of resonance and vibrations, the principle of just intonation was generalized to simple proportions of frequencies: vibrations per second. A useful analogy for understanding just intonation is to examine the nature and structure of resonance itself. If I analyze a natural sound like my voice, I will notice many frequencies well beyond the one I hear as the actual pitch of my voice. This collection of frequencies constitutes the *harmonic series*, in which each component of the sound, each harmonic, is a whole-number multiple of the fundamental frequency. For example, if I sing a tone with a perceived pitch – which is to say, a fundamental frequency – of 100 Hz, the second harmonic will be 200 Hz, the third harmonic 300 Hz, and so on. So, the harmonic series produces ratios of whole numbers between the harmonics: this is the essential link with just intonation. The deeper we delve into the harmonics, the more they become *microtonal*. In other words, they quickly differentiate from the twelve notes of equal temperament, both in terms of pitch as well as distinctive resonances when grouped into chords.

Tonight, I aim to explore some influences that shaped Partch's vision of just intonation, while addressing some more recent developments in composition and performance. We will also examine the links that may be established between these different perspectives. I will discuss some of his theoretical innovations and showcase some of his instruments. Finally, I hope you won't mind the brief foray

into some very simple mathematical concepts that I wish to address. These ideas are essential to illustrate the fundamental concepts of Partch's harmony, and I assure you, it won't hurt!

Harry Partch was almost born in China, where for several years from the late 1880s his parents worked as religious missionaries. However, they were forced to return to the United States due to anti-imperialist uprisings at the end of the century. Instead, he was born in 1901 in Oakland, California and spent his childhood in the Arizona desert, surrounded by the final traces of the legendary Wild West and the sound of traditional Mexican and Yaqui music. His mother even sang him Chinese melodies with their original Mandarin lyrics that she had learned during her time abroad.

At home, the young Partch was encouraged to learn music and play several instruments, including the violin, mandolin and piano. He emphasized that, from a young age, he felt a strong connection with dramatic situations. After graduating, he began studying piano at the University of Southern California in 1920 but developed a growing irritation towards formal institutions and a skepticism towards the traditional music establishment. He dropped out of his studies by 1922.

His experience of isolation at the American frontier in his youth clearly contributed to a lasting sense of isolation from the rest of American life and culture. He could find no deep connection with Western music, and his growing creative attraction to dramatic situations and, crucially, to *spoken language* led him to develop a deep dissatisfaction with the widely used equal-tempered chromatic scale. His goal was to reproduce, imitate, and harmonize spoken words with a much greater degree of accuracy and nuance, and equal temperament, limited to its clinically spaced twelve tones, was woefully inadequate. Reflecting on this stage of his life, he noted that he was seeking 'a good basis for a new and great music of the people,' both for himself and others. He claimed that this is why he decided to work intimately with dramatic speech, as words are the most common means of creative expression.

Freed from institutional constraints, Partch opted for self-education through reading, composition and experimentation. In 1923, he borrowed *On the Sensations of Tone* by the German physicist Hermann von Helmholtz from the Sacramento Public Library, translated and expanded by the British mathematician and acoustician Alexander J. Ellis. A seminal text, *On the Sensations of Tone* delves deeply into the physics and physiology of sound, addressing topics such as the physics of vibrating strings and columns of air, the nature of intonation and musical scales, and human perception of sound. Helmholtz's detailed study of acoustics and just intonation, including physical descriptions of consonance and dissonance, was a revelation. Partch stated that his 'doubts and ideas achieved some small resolution' and that he 'began to take wing.' Since whole numbers may, in principle, be combined in an infinite number of unique ways, he recognized just intonation's potential to provide a much more precise framework for expressing the small tonal nuances of dramatic speech.

By the mid-1920s, Partch began experimenting with paper coverings for the fingerboard of a cello with markings indicated at various just intonation ratios. Within a year, he composed a string quartet in just intonation using his paper coverings as well as various songs and other compositions. In 1930, while in New Orleans, he broke completely with the European musical tradition by burning, with Hollywood style, all his previous compositions in a potbelly stove. During this significant phase, Partch collaborated with a luthier in New Orleans to create

a unique viola, incorporating the neck and fingerboard of a cello. This instrument, which he eventually called the Adapted Viola, became the basis of his early compositions, using a scale of 29 tones per octave. The creation of the Adapted Viola marked the inception of a lifelong commitment to crafting his own instruments, a theme I will revisit shortly.

During the early 1930s, Partch presented his music in San Francisco, Los Angeles and New York, and gave demonstrations with his Adapted Viola. Musically, he was deeply interested in how each odd number of a ratio, and especially each prime number (namely 2, 3, 5, 7, 11, 13, and so on), seemed to present a unique quality of tone, a unique *identity*, and how combining numbers in different ways, such as multiplying 3 and 5 to give 15, seemed to generate broader families of these qualities.

In 1934 and 1935, with a grant of 1,500 dollars (approximately 30,000 euros today!) from the Carnegie Corporation of New York, Partch undertook a research trip to Europe. Though his efforts were primarily focused on studying documents at the British Museum, he also arranged meetings with figures of influence. He met the writer William Butler Yeats in Dublin to study how Yeats would modulate his voice when reciting his own texts. Yeats was sympathetic to Partch's ideas and his aesthetic of emphasizing the natural qualities of spoken words. Another significant meeting took place in London with the musicologist Kathleen Schlesinger, who had examined various ancient flutes in museums around the world and had arrived at a just-intonation-based tuning system which, she believed, connected various ancient cultures. Partch himself was very interested in exploring ancient tuning practices in his own music and took advantage of the meeting to discuss nitty-gritty theoretical details as well as make drawings and measurements of replicas of ancient Greek lyres that Schlesinger had built.

An important and somewhat mysterious figure in just intonation music at the time was Schlesinger's collaborator Elsie Hamilton, an Australian composer twenty years older than Partch. She had adopted Schlesinger's theory of ancient Greek *harmoniai*, which comprised seven justly tuned modes, each associated with one of the seven planets known in antiquity. She taught and lectured widely throughout Europe. Usually overlooked historically in favour of Partch, Hamilton deserves recognition for her practical musical contributions alongside Schlesinger's theoretical work. While there is no documentation of a meeting between Hamilton and Partch, she offers essential historical context to Partch's own musical and theoretical development. *There must have been something in the air*. The simultaneous resurgence of interest in just intonation during the early 20th century among these three figures (as well as others I haven't mentioned) hints at the inception of a musical movement that would continue to evolve in the ensuing decades, establishing the strong footing it has today.

Another significant experience was Partch's return to the United States at the height of the Great Depression. Essentially homeless, he described himself as a hobo, frequently having to rely on the hospitality of his friends. This period solidified his feeling of being an outsider both in society and in music. For the first eight months, he documented his life in a journal and often notated the intonations of the speech of the people he met. He frequently highlighted the solitary and sometimes hostile conditions he had to face, writing: 'I try to be friendly, but no one even looks at me, let alone answers me when I venture to speak...My simple "hellos" do not penetrate their dream worlds. Vacant stares say: "How dare you try to insinuate yourself into this consciousness?" I decide to insinuate myself

no more.’ Throughout his career, Partch would return time and time again to the theme of loneliness and its cold and bitter reality in his compositions.

Now, I would like to highlight just a few aspects of Partch’s harmonic innovations. At the core of his harmonic logic is the concept of a Tonality Diamond. He is often credited with its invention, although it was possibly modelled on a diagram published by Max F. Meyer around the same time. In any case, Partch mentions that the development of the Tonality Diamond was inspired by Henry Cowell’s book *New Musical Resources*, in which Cowell discusses the harmonic series as well as, crucially, the subharmonic series – a theoretical inversion of the harmonic series, as if flipped upside down.

In its definitive form, the Tonality Diamond is a complex network of just intonation relations, but for the purposes of his talk I would like to propose just one of any number of ways of understanding it. The Tonality Diamond is a conceptual representation of harmony that unifies the inherent symmetry of intervals around a tone of reference. For this *unity*, Partch opts for the tone *g*, which he tunes to 392 Hz. Intervals may be projected above or below this tone of reference, thereby generating new tones. He begins by considering the characteristic intervals of each odd number, the *identities* I mentioned earlier. He has already accounted for identity 1, which corresponds to his unity as the unison has a ratio of 1:1. For identity 3, the characteristic interval is the perfect fifth whose ratio is 3:2 with respect to *g*. This gives him the tone *d*, a perfect fifth above *g*. Inverting this interval and, at the same time, inverting this ratio gives a perfect fifth below, the tone *c* with a ratio of 2:3 (the inverse of 3:2). He moves on to identity 5, represented by the major third with the ascending ratio of 5:4 and the descending ratio of 4:5. He thereby obtains the tones *b* and *eb*. Already, two chords emerge: he calls the ascending segment, which corresponds to a classical major triad *g-b-d*, an *otonal*ity in reference to the harmonic series (overtones) and the descending segment, which corresponds to a minor triad *g-eb-c*, a *utonal*ity in reference to the subharmonic series (undertones). He graphically arranges this structure in the shape of a ‘v’ with the tone *g* at the vertex and the segments extending diagonally to the left and right. He then repeats the described procedures for each new note generated, considering each one as a local point of reference, to construct a diamond of interconnected ratios containing three otonalities and three utonalities. If all tones are grouped into the same octave and considered as a kind of scale from *g* to *g*, this Tonality Diamond proposes a somewhat diatonic structure of seven tones. However, there are some rather large gaps, particularly at the beginning and end, and, with only seven tones, there is not yet sufficient tonal variety to achieve Partch’s goal regarding the subtle harmonic treatment of spoken words. His major breakthrough came with the extension of the Tonality Diamond to include the characteristic intervals of all the first six odd numbers, that is, identities 1, 3, 5, 7, 9 and 11. This Tonality Diamond gave him access to a scale of 29 tones as well as a harmonic palette of six complete otonalities and six complete utonalities.

Since he stopped at identity 11, he qualified his system of just intonation as 11-limit. If he had stopped at 5, which only contains major and minor triads as in the first example, he would have called it a 5-limit system. And why did he choose to stop at 11? He wrote: ‘When a hungry man has a large table of aromatic and unusual dishes before him, it is unlikely that he will wander along the shore and into the woods in search of other exotic dishes. And as skeptical as he may be about the many warnings regarding his unhealthy food – such as the poison of

the love apple, the tomato, just a few generations ago – he has no desire to provoke further alarms.’

Partch’s 11-limit Tonality Diamond with 29 tones still presented some problematic gaps that troubled him. To achieve a more uniform distribution, he filled these gaps with 14 additional ratios chosen by transposing various small intervallic differences between intervals already present in the Diamond. The result was his famous 43-tone symmetrical scale of just intonation ratios, which is an extension of the 11-limit Tonality Diamond. In general, the intervals between adjacent notes are very small, offering a very rich framework for representing the subtle tonal nuances of speech. Now, with 28 otonalities and utonalities (thanks to the 14 additional ratios), a given tone may take on multiple tonal senses, meaning it may function as several different identities in various chords. It is worth noting that, at this time and even before, Kathleen Schlesinger and Elsie Hamilton were also deeply involved in exploring such identities, notably going beyond 11 to include 13. Unfortunately, the majority of Hamilton’s music is lost, and we only find references to it in Schlesinger’s writings.

Partch’s break from the norms of Western musical culture meant that he refused to compromise his convictions and his harmonic system to adapt to the mechanical, but also ideological, constraints of the orchestral instruments of his time. Instead, he decided to create his own instruments, specifically designed to meet his musical needs. In his own words, he was a ‘philosophic music man seduced into carpentry,’ and throughout his life, he crafted more than 50 one-of-a-kind instruments, just a few of which I wish to introduce tonight. Partch discusses others in the film.

I have already mentioned the Adapted Viola, which he created in 1930. The choice to graft a cello neck onto the body of a viola was born of a logistical compromise. The greater length of the cello neck provided more space between tones and more room for intonation nuances, while the viola body made the instrument more portable than a cello. He inserted 29 brad nails per octave into the fingerboard along each string at different just intonation ratios to provide physical points of reference for the tones he wanted to play. This approach was chosen rather than installing frets as on a guitar because he did not want to inhibit gliding between tones, an essential quality of his playing technique imitating speech. Moreover, several of his compositions require additional tones between the ratios indicated by the brads – for example, to achieve all the tones in his 43-tone scale, but also others outside of his scale.

As he moved from town to town after his return from Europe, Partch took some woodworking classes to hone his carpentry skills. Shortly after, in 1938, he built his first of three Kitharas, inspired by decorative illustrations of kitharas on ancient vases. Indeed, the visual beauty of his instruments was truly of paramount importance to Partch and reflects his dedication to creating a *corporeal* music. For him, corporeal music was a music of a time and place, a here and now – a music dependent on circumstances, deeply visual and dramatic. It was a response to what he considered an overwhelming bias for *abstract* music. For this reason, he constructed large instruments that had the quality of sculptures. His Kitharas have many more strings than those used in antiquity. He implemented 72 guitar strings grouped into twelve hexads, many of which correspond to the otonalities and utonalities discussed earlier. The player plucks the strings using a plectrum worn on the index finger. An interesting detail is that four groups of strings have glass rods wedged between them and the soundboard that function as movable bridges.

The player can move these rods up and down to lengthen or shorten the strings, thereby modifying their tuning.

Partch also created Adapted Guitars. His experiments with guitars began with installing custom frets and inserting pins into the neck at just intonation ratios in the spirit of his approach with the Adapted Viola. However, by the 1950s, he removed the frets and pins and started playing with a glass rod in the style of a lap steel guitar. Eventually, he opted for a design with 10 strings, which he tuned according to an 11-limit chord, and used the glass rod to glide to further chords, creating floating and ethereal lines.

Partch is widely known as a prolific builder of tuned percussion instruments. Much of his music heavily features percussion, and historically, this has been at the forefront of Partch-criticism. While many types of percussion instruments may be tuned, their clarity of pitch is typically much more subdued than, for example, that of a kithara. It may seem strange, then, for him to go to such lengths to create such an elaborate system of just intonation harmony, only to insist on applying it to percussion instruments. In other words, much of his music seems to lack the degree of sonority his theories would seem to promise. However, it is important not to forget his primary driving creative force – spoken words – and consonants, the percussive and rhythmic element of our voices, are an essential component of spoken language. It is interesting to note Partch's disdain for the excessive elongation of vowels in, for example, classical opera, which he viewed as an abstraction of something as corporeal as spoken words.

In fact, the instrument that most clearly embodies his theory of just intonation is his first percussion instrument, the Diamond Marimba, built in 1946. Wooden bars, tuned according to his Tonality Diamond, are arranged in diagonal rows to form a diamond array. As he explains, the diamond marimba is 'the theoretical Tonality Diamond brought to practical tonal life.' The Diamond Marimba is essentially both an instrument and a physical manifestation in direct expression of his tonal logic.

Partch's Marimba Eroica truly has a maximal visual and sonic impact. It consists of four spruce boards suspended above large wooden resonators and can produce tones as low as 22 Hz, well below the range of the piano. Apparently, Partch had initially envisioned a design with vertical resonators akin to organ pipes. But he quickly abandoned this idea because the player would have had to ascend a nearly 3-metre-high platform. Partch commented on the sonic power of the Marimba Eroica, whose vibrations were known to be able to shatter glass bowls 5 mm thick. He writes humorously: 'I have often dreamed of a private home with a stairway which is in reality a Marimba Erica, with the longest block at the bottom and the shortest at the top...The owner could stipulate his favorite scale, then could bounce up to bed at night hearing it and paddle down in the morning for breakfast hearing it. He would need to be athletic, since simple walking would dampen resonance. If he were very athletic, he could take two or three steps at a time and produce an arpeggio.'

The last family of instruments I'd like to talk about is his collection of micro-tonal pump organs: the Chromelodeons. Partch's first experiment with this format was an instrument he built in London during his research trip. He christened it the Ptolemy in honour of the ancient mathematician and music theorist and incorporated a custom keyboard design with circular keys. A few years later, after returning to the United States, Partch began with the transformation of an old-fashioned pump organ with a standard keyboard, which he tuned ac-

ording to his 43-tone scale. With a standard keyboard, one octave of his scale requires 43 keys, almost four octaves' worth! A particular advantage of pump organs is their multiple stops, which may be tuned in different ways. Of course, Partch implemented the standard tuning of stops in octaves, but he also tuned stops to produce different types of minor thirds or, in the case of his second Chromelodeon, complete triads with the press of a single key. An interesting feature of this second harmonium is that playing successive keys does not produce a linear scale, but the tones jump back and forth. For Partch, the sound of the Chromelodeon had a nostalgic quality, evoking memories of hearing distant steam locomotive whistles in the mountains when he was a child.

Now, to quickly finish detailing some biographical details: from 1944 to 1947, he had a productive period at the University of Wisconsin, where he lectured, formed an ensemble to play his music and organized performances. Most significantly, though, he completed writing and editing his book *Genesis of a Music*, a detailed exposition of his theories and musical aesthetics. Not surprisingly, he fell out with the institution and decided to set up a studio at the ranch of a friend, Gunnar Johansen.

In 1951, Partch moved to Oakland and primarily made money through mail-order album sales of his music. He attempted for a second time to establish an institutional relationship, this time with the University of Illinois, where he focused mainly on composing and staging music theatre works often based on themes from Greek mythology such as Dionysus and Oedipus and also collaborated on film projects with Madeline Tourtelot.

He returned to California and continued composing and developing his extensive collection of instruments through the 1960s, living on grants, occasional commissions and album sales. Philanthropist Betty Freeman commissioned his last work, *The Dreamer That Remains*, to serve as the centrepiece for a new documentary about his life, instruments and music. Shortly after the film's release, Partch died of a heart attack in 1974.

There is no question that he had an extraordinary personality, sometimes seemingly troubled. Composer Lou Harrison, one of Partch's close friends who was also a gifted composer of just intonation music, mentioned that Partch would resolve dilemmas and complex situations by conversing with himself, shouting with different voices as if dramatizing each side of an argument.

During the filming of *The Dreamer That Remains*, Partch fell deeply in love with director Stephen Pouliot, who was over 40 years younger. In the score notes, which Partch had initially subtitled 'My Love Song for Stephen,' he wrote: 'Stephen lurks behind every thought, every idea, every musical note in the work, in a wondrous way. It would be hypocritical of one to deny his presence, despite the inevitable personal hurts in the process of knowing him. I, 71 – he, 26 – an old old story.' Although Pouliot felt a deep affection for Partch as an artist, mentor and friend, he was unable to respond to Partch's desires in the same way. In response to what Partch understood as complete rejection, he placed an ice pick on Pouliot's hotel room pillow – an unsettling symbolic gesture. The loneliness he had felt ever since his hobo days during the Great Depression remained a key motif throughout his life. Nevertheless, despite the rejections, unfulfilled desires and impossible situations, his friends and companions have consistently attested that he was a devoted friend, a generous musician and a profound advocate for just intonation. Due to an injured right hand, he had to write the score notes for

The Dreamer That Remains with his left hand, adding that ‘true love is ambidextrous.’

To conclude my presentation tonight, I’d like to highlight a few ways in which Partch’s influence can be felt in the broader developments of just intonation music. Of course, one of his greatest legacies has been the significant general increase in interest around just intonation and alternative approaches to tuning. Part of the reason for this surge in interest lies in the development of specialized performance practices on all sorts of standard instruments. This may seem counterintuitive when talking about someone who, for the most part, rejected standard instruments, but Partch’s instruments are mainly large and difficult to transport, and they require idiosyncratic training to play well. I think the more significant legacy is that music in just intonation *may be played at all*. Despite widespread scepticism, even today, anyone who is *willing to listen for a moment* can learn to hear the ratios of just intonation. It is merely a question of developing new performance practices for our instruments in order to reliably reproduce these sounds – and this requires hard work, plain and simple.

In terms of compositional developments in just intonation music in the generation after Partch, I would like to briefly touch on two very different artists, each inspired by Partch in their own way. In Partch’s biography, I omitted an important protagonist. After composer Ben Johnston read *Genesis of a Music* shortly after its publication in 1949, he wrote to Partch asking if he could study just intonation under his guidance. Partch was resistant to the idea of being *the teacher*, but he offered Johnston to come work in his studio as an assistant. Johnston and his wife stayed with Partch for six months in 1950, helping to build instruments, tune them, rehearse and record pieces. Initially, Partch apparently showed little interest in discussing theoretical details and was not a particularly welcoming host. Of course, the fact that Johnston was accompanied by his wife did not help the matter, as Partch would have preferred to see Johnston as a lover. However, the relationship gradually crystallized, and Johnston was able to learn a great deal by doing. At the end of their time together, Johnston was left deeply impressed and inspired to implement and develop Partch’s ideas in his own music. In particular, he wanted to compose music in just intonation for more standard instruments that Partch had rejected and push the harmonic boundaries of Partch’s 11-limit system, to include higher numbers like 13, 17 and 19. To achieve this, Johnston created an explicit staff notation to represent any ratio of just intonation in a manner that looked visually more familiar to musicians than Partch’s idiosyncratic tablature notations. And, approaching the material from a completely personal and somewhat more classical aesthetic point of view, he responded in his way to the criticisms around a lack of sonority by making use of lush, dense chords, finding a point of culmination in his string quartets.

James Tenney, who met Partch as a student at the University of Illinois and participated in a production of Partch’s musical theatre work *The Bewitched*, represents a different stream in the continuation of Partch’s legacy, allowing the just intonation aspect of his music to arise from the experience of sound itself. He focuses much more on the phenomenon of the harmonic series and our perception of modulation, incorporating other acoustic phenomena into his compositional structures, such as sum and difference tones. This almost impersonal approach to composition, in striking contrast to Johnston’s maximalist harmonies and neo-classical aesthetic, is somewhat different from Partch’s idea of a corporeal music that is dramatic. And yet, it is also deeply tied to time and place, as in works like

Critical Band and *In a Large, Open Space*. Of course, considering numbers as one does in exploring just intonation naturally leads to algorithmic structures, and Tenney was a pioneer in this field.

Both Johnston and Tenney were prolific teachers, directly influencing an entire generation of composers working with just intonation today, including artists like Kyle Gann, Wolfgang von Schweinitz, Larry Polanski, Chiyoko Szlavnic, Marc Sabat, John Luther Adams and Catherine Lamb. And there are plenty of other composers working in their own way with just intonation, such as, of course, La Monte Young, Lou Harrison, Pauline Oliveros, Kraig Grady, Wendy Carlos, Jacques Dudon, Ellen Fullman and many, many others.

As an epilogue, I'd like to briefly outline my journey with just intonation, as the approaches presented this evening have deeply inspired me as well. I am constantly seeking new ways to develop a personal synthesis of the phenomena at the heart of just intonation. Like many, I'm drawn to resonance, sometimes forgetting the percussive aspect of sound (a characteristic so dear to Partch). However, there's something truly arresting and irresistible in the chords of just intonation, in the *sostenuto* sound. It's no wonder that many of the pieces composed by the artists I've mentioned were created for string instruments. Like many string players, I had a direct experience of the complexities of intonation from my first encounters with my viola. Conventional music education offers little insight into how to approach them and provides no explanation of the phenomena we encounter. However, as the accuracy of *tuning deliberately* increases and our listening deepens – something I and my colleagues in the Berlin-based Harmonic Space Orchestra have been methodically exploring for the past few years – it's fascinating to perceive how, with strings, the timbres of wind and brass instruments, of voices, expand and gain detail; how, together, we can create new instruments built entirely from frequencies alone. The effects caused by adding or removing timbres in a just intonation chord are inspiring, addictive and somehow impossible to predict.