Harmonic Constellations

1. *The Spaceship* (descending)
2. *The Romantic Constellation* (trapezoid)
3. *The Magic Constellation* (ascending)
4. *The Romantic Constellation* (descending)
5. *The Harmonic Opening Constellations* (ascending and descending)
6. *The Spaceship* (ascending)
7. *The Cross: The Harmonic Opening Constellation* (ascending) and *The Magic Constellation* (descending)

Harmonic Constellations (2016) was commissioned and composed for violinist/electronics specialist Mari Kimura and is scored for violin with 13 pre-recorded violin tracks and sine tones. The complete work is comprised of nine constellations of complex just intonation harmonies that gradually shift and evolve over time. The frequency relationships between each tone are perfectly tuned in whole number proportions. In turn these same proportions determine the durations and envelopes (attack, sustain, and decay) of each tone, as well as structural elements of the work. I am calling the concept "Integrated Proportionality."

Works using the technique known as total serialism are among the first to create interrelationships between pitch, rhythm, dynamics and structure; however, the aesthetic approach of *Harmonic Constellations* is completely different, and since the pitch relationships of total serialism are generally in equal tempered tuning, the interrelationships are based on correlations with sets of pitches rather than the frequencies of the notes themselves. Since all the pitches used in equal temperament are multiples of the 12th square root of two, the resulting intervals, except the octave (2:1), do not create whole number proportions. As a result all of the frequency relationships in equal temperament produce irrational numbers with non-periodic waveforms.

All of the tones in *Harmonic Constellations* are tuned in extended just intonation (with the vibrations between every note tuned in whole number proportions). This creates an invisible geometric formation of periodic composite waveforms which can be experienced as a sonic hologram in which the listener can move, or slightly shift the position of their head, to hear different tones in every part of the room. In this way the listener becomes an interactive participant, and unless headphones are used, the work will never be heard the same way twice.

The rhythmic pulsations heard in the work are the result of interference patterns perceived by the brain as acoustical beats. When we hear two sounds of slightly different frequencies, an acoustical beat is perceived as a periodic variation in volume whose rate is the difference of the two frequencies. Because each constellation includes between seven and thirty tones, and the

constellations overlap with each other, the acoustical beats continually shift and evolve over time.

Harmonic Constellations was composed entirely using math and text based computer programming. The data was then organized into spreadsheets to create a more traditional score with the just intonation ratios and exact frequency specified in Hertz above each note. All of the tones were divided between the violins and sine tones to create a complex and integrated timbre. The work is inspired by the harmonic language of La Monte Young's *The Well-Tuned Piano*, and all of the frequencies, durations and envelopes are generated from multiples of the prime numbers two, three and seven.

Michael Harrison