

## ***Light Variations***

**By Jamie Hancock**

The photograph of this enchanting Vanšu Bridge in Riga, Latvia, the dramatic lighting of the sky and its reflection on water, along with Albert Einstein's Special Relativity  $E=MC^2$  (as opposed to General Relativity), inspires this piece. The themes are: visible light and chiaroscuro; varying degrees of weight and density; that equations are like balancing weighing scales, if you alter one side, like Energy, the other side, Mass, needs to change as well, but the speed of Light is a constant and absolute; Einstein's Special Relativity gives rise to the idea of private universes, that is the formula remains consistent, but there is a variant in each individual's state and lastly, Special Relativity is symmetrical. Whatever adjustments one person needs to make to distances and times in their private universe to find out what those distances and times are for another's private universe, that other person would have to make the same adjustments to their distances and times to find out what they are for the first person.

The work is made up of:

- 'Variation 1' for MIDI piano, electronics, samples and birdsong
- 'Variation 2' for cello, piano, electronics, samples and birdsong

These variations are notated in Sibelius and rendered in Ableton Live.

I am indebted to Edward Hickton & Stewart Keach for their enlightening book, *Einstein's Relativity: Private Universes* and Finn Peters for his inspiration, mentorship and encouragement.

The commentary below focusses on 'Variation 1'.

Messiaen's Third Mode of Limited Transposition does much to inform the note choices, harmonic direction and sound world of this piece. This is elaborated on in detail below. An additional layer to this work is birdsong recorded in the Cotswolds using a rifle microphone and processed through software for spatialisation called Spat or Spatialisateur in French, developed by the Institute for Research and Coordination in Acoustics/Music (IRCAM). This audio is also treated with the *SoundHack* freeware plugin '+matrix' to increase the gain and the plugin is implemented in Ableton Live. This use of birdsong ties into the Messiaen flavour that permeates the composition (Messiaen took much of his inspiration from birdsong). It is also a nod to Apex Twin's 'aisatsana [102]' from his album *Syro*. Throughout, 'Variation 1' is coloured by electronic treatment of notes and samples. This composition is not intended to be performed live with a pianist. It is entirely for machine; a laptop through which MIDI piano is programmed. At points the piano is perhaps faster than realistically possible for a performer, which suggests the impossibility of travelling faster than the speed of light. The *Studies for Player Piano* by Conlon Nancarrow are an influence.

The composition is explained in terms of material, form and structure. The same points will be viewed from these different perspectives. There are overlaps and grey areas.

### **Material**

The material in a composition is the notes, for example, motifs, but this definition may also be extended to include editing of samples and electronic treatment.

To signal the Big Bang Section A opening, there is a note by note thickening of sound into a cluster, punctuated by these notes in a forte staccatissimo chord. This happens three times. The sustain pedal (MIDI piano sound) is held just for the initial sounding of the forte staccatissimo chord on the first occasion, then it is held until half way through the second bar on the second occasion and finally on the third occasion it is held just for one bar through the note by note thickening of sound into a cluster, but also on this third occasion there is electronic treatment of the forte staccatissimo chord using Nobuyasu Sakonda's *Granular 2.5* patch implemented in the graphical programming environment Max/MSP. This processing is recorded and the sample

edited in Ableton Live. Ableton Live's 'Reverb-Studio Reverb(True Stereo)' effect is used here. Each chord is made up of different notes from transposition 1, mode 1, in Messiaen's Third Mode of Limited Transposition. Each chord consists of five notes, three of them different, two repeated. The first three are fifths apart and the last two are fourths apart. So for example, chord 1 is made up of C G D G C. After chord 1, subsequent chords start a major third higher than the last.

After these three chords have sounded there unfolds an extension to the Big Bang Section A opening made up of cut, edited, spliced and manipulated samples. As well as using the electronically treated chord through Nobuyasu Sakonda's *Granular 2.5* patch described above as a sample, a sample from NASA's 'Song of Earth' from the album *Symphonies of the Planets* is used at the opening too. There is also a 'New Light' sample, which comes from the London Community Gospel Choir recorded using binaural microphones. The *SoundHack* freeware plugin '++phasor' implemented in Ableton Live is used at this section too. Then in the Big Bang Section A, there is a sample created through recording audio using the *Moog Ladder Filter* gen~ Max/MSP patch by Peter McCulloch and then processing this audio further using the *Granular Synthesiser v4.0 2011* Max/MSP patch by Nobuyasu Sakonda, followed by a sample created through recording audio only using the *Moog Ladder Filter* gen~ Max/MSP patch by Peter McCulloch. After this, there enters a recording made using an ultra sonic detector (Bat Box) and this recording has been edited in Ableton. This recording has a sound reminiscent of that made by a cooling sparkler and in *Light Variations* it signifies the cooling of the earth's crust after the Big Bang. The use of this sound has also been inspired by Iannis Xenakis' piece 'Concret PH'. To close, is a sample processed using the *GMEM Microsound Universe (GMU)* external bufGranul~ object in Max/MSP - a sound that conjures the idea of steam and water on earth.

The mathematics in Einstein's Special Relativity influences the generation of material in this piece to varying degrees, loosely in places to more stringently in others. Mass-Energy equivalence means that anything having Mass has an equivalent amount of Energy and vice versa. You can view Energy and Mass as a ratio. They directly relate to one another according to the Special Relativity formula.

$$M = E/C^2 \text{ and } E = MC^2$$

The relationship between these fundamental properties is drawn on in the musical material through dynamics and articulation for Energy, the density of notes for Mass and motivic development for the speed of Light. For example, from bars 10 to half way through bar 30 the dynamic increases from p to mf. Starting at bar 20 and ending at bar 41 an accent is placed on every dotted crotchet note in the treble that is a harmonic addition to the melody. From bars 10 up to and including 41 the density of notes also increases tying in with the idea of Mass-Energy equivalence. The recurring figure from bars 10 up to and including 41 is representative of the constancy of the speed of Light. The music here is punctuated rhythmically using audio samples from the opening. The short samples are taken from the audio processed using Nobuyasu Sakonda's *Granular 2.5* Max/MSP patch and are additionally treated using Ableton Live's 'Reverb-Studio Reverb(True Stereo)' effect along with the *SoundHack* freeware plugin '++phasor' implemented in Ableton Live. The rhythm of the phrases from bars 10 up to and including 41 takes some inspiration from the piece 'Moonlight with Strings' from the album *In Memory of Thunder* by José Neto. The related section from bars 42 up to and including 64 maintains the mf dynamic, use of accents and fuller texture. The final note in the treble of bar 63 is treated with the *SoundHack* freeware plugin, '++delay' implemented in Ableton Live. Added to this is Ableton Live's Auto Pan 'Around The Head' panning effect with a triangular low-frequency oscillation (LFO) waveform.

The idea of private universes is explored through two musical characters. Each character has their own *idée fixe* - a term coined by Hector Berlioz in relation to his *Symphonie Fantastique*. The *idée fixe* for character 1 comes in the treble and is first introduced at bar 65, while the *idée fixe* for character 2 comes in the bass and is first introduced at bar 67. At bar 70 they are both played together, character 2 finishing after the spread chord bass notes at bar 72, with character 1 completing the spread chord in the treble and completing its *idée fixe* with the enclosure at bar 73. Then both *idée fixes* are heard a major third higher and again a major third above that. This is using notes from transposition 1 of Messiaen's Third Mode of Limited Transposition. From bar 82

transposition 2 informs the note choices. The *idée fixe* for character 1 (expressed in the treble) is extended further for five bars now, while the *idée fixe* for character 2 (expressed in the bass) still lasts for just two and a half bars. Again the *idée fixes* rise a major third on each repetition. There are discordant moments before resolution and then more suspense, which with a gradual increase in the duration of the *idée fixe* for character 1 all suggests the incremental changes when an increasing speed for character 1 causes time to both dilate and shift and distances to shrink. As speed and movement over distance is greater for character 1, the differences between the two private universes become more significant. The two private universes illustrated are in flux. An influence here is Peter Maxwell Davies' garbled Victorian hymn played on an out of tune piano in 'The Mocking of Christ' as part of his *Versalii Icones* - a musical style he considered 'almost the ultimate blasphemy'. This sound Davies draws on inspires the electronic treatment - using the *SoundHack* freeware plugin, '++decimate' implemented in Ableton Live - of the final note in each *idée fixe* statement representing character 1 (taking place in the treble) from bars 82-96, where transposition 2 is employed. Specifically this occurs at bars 86, 91 and 96. Throughout this section featuring the two characters' *idée fixes*, the enclosure feature and then final note treated with the *SoundHack* freeware plugin '++decimate' for the *idée fixe* for character 1 is treated with an incrementally increasing amount of panning to the right channel and an incrementally increasing amount of 'Reverb-Studio Reverb(True Stereo)' with each statement building on the last so far as these parameters are concerned and by a proportionate amount, which contributes to the embodiment of character 1 becoming more distant.

Private universes may be in flux, but ultimately Special Relativity is symmetrical. This symmetry is indicated by the rhythmic similarity of the *idée fixes* and that character 2 is based around loose inversion - using the notes of transposition 1 of Messiaen's Third Mode of Limited Transposition and from bar 82 the notes of transposition 2 of Messiaen's Third Mode of Limited Transposition - of the first two bars of character 1. This also brings to mind the idea of reflection.

The patterning from bar 97 draws on the axis of symmetry, the repeated set of intervals between notes, in the modes of Messiaen's Third Mode of Limited Transposition. Here, notes from transposition 3 are used. For example, D, F#, F $\natural$ , E and F#, Bb, A, G#. The intervals repeat every four notes. This is emphasised with the articulation being a slur over groups of four notes and a staccato dot over the fourth note. This material is later retrograded starting from bar 104, which also ties into the idea of symmetry and suggests reflection too, albeit there is rhythmic variation here - the rhythmic patterning is inspired by the introductory piano accompaniment in the dance music track 'Back & Forth' by MK, Jonas Blue and Becky Hill - along with a restatement of transposition 4 of Messiaen's Third Mode of Limited Transposition. Through the exploration of transpositions 3 and 4 here, there is clear definition of the three modes within each transposition. This is explained further, later on in the commentary.

For the final note in the treble and final notes in the bass of bar 122 and through bar 123 the *SoundHack* freeware plugin, '++pitchdelay' implemented in Ableton Live is used. Also at bar 123 the birdsong pauses before resuming at bar 124 where earlier material resurfaces, but in an altered state. Again, at the return of Equivalence Section B1, short samples punctuate the piano line here, but this time they are taken from longer audio heard nearer the end, which is the final piano note, processed using Nobuyasu Sakonda's *Granular 2.5* patch in Max/MSP and additionally treated using Ableton Live's 'Reverb-Studio Reverb(True Stereo)' effect along with the *SoundHack* freeware plugin '++phasor' implemented in Ableton Live. As at nearer the beginning, the final treble note of the returning Equivalence Section B2 is treated with the *SoundHack* freeware plugin, '++delay' implemented in Ableton Live and again added to this is Ableton Live's Auto Pan 'Around The Head' panning effect with a triangular LFO waveform. This return of the electronic sound occurs at bar 153.

To end, from bar 155, the music is reminiscent of the Big Bang opening. As in the beginning there is a note by note thickening of sound into a cluster, but this time it separates out and becomes sparse again. There is use of the sustain pedal (MIDI sound) as each chord builds, but the pedal is taken off for the second bar of each chord as notes are individually taken away. After each chord there is the addition of a motif in the treble, which adds to the reflective mood and for which some inspiration is drawn from 'In a Silent Way' composed by Joe Zawinul and featuring on the album titled *In a Silent Way*, which was directed by Miles Davis. Also reminiscent of the beginning, is that

the final note in the piano is treated using Nobuyasu Sakonda's *Granular 2.5* patch implemented in the graphical programming environment Max/MSP. This processing is recorded and the sample edited in Ableton Live. Again, Ableton Live's 'Reverb-Studio Reverb(True Stereo)' effect and added to that the *SoundHack* freeware plugin '++phasor' implemented in Ableton Live are both used here. The ending is reminiscent of the start in that there is cutting, editing, splicing and manipulating of three samples - the final piano note treated using Nobuyasu Sakonda's *Granular 2.5* patch implemented in the graphical programming environment Max/MSP, a sample from NASA's 'Song of Earth' from the album *Symphonies of the Planets* and the 'New Light' sample. Then there is the sound of the clap of a bird's wings to finish.

## Form

The form is the overall shape of a composition.

In this composition there is a balance and symmetry in the form just as equations are like balancing weighing scales and Special Relativity is symmetrical. Each section is given a title and the form of this piece can be viewed as: Big Bang Section A, Equivalence Section B1, Equivalence Section B2, Relativity Section C1, Relativity Section C2, Equivalence Section B1, Equivalence Section B2, Big Bang Section A. Equivalence Section B2 and Relativity Section C2 are subsections relating to Equivalence Section B1 and Relativity Section C1 respectively.

'Das Rheingold' forming part of *Der Ring Des Nibelungen* by Richard Wagner is an influence. Wagner is recorded as saying the 'Prelude' to 'Das Rheingold' 'should throughout create the impression of a phenomenon of nature developing quite of its own accord ...' 'Light Variations: Variation 1' opens with the Big Bang Section A, bars 1 up to and including 7 followed by cutting, editing, splicing and manipulation of samples, before birdsong enters. There is a connection between birdsong entering, the dawn chorus and the dawn of time. It has been a source of encouragement that other composers have been preoccupied with similar themes to those that feature in *Light Variations*, which is rich with many influences. Other works and composers to mention here are *Sudden Light* by Mark Bowden - a piece concerned with mathematics, light and the universe, having taken its inspiration from Marcus du Sautoy's book *The Music of the Primes* in which du Sautoy describes prime numbers as being like 'jewels studded throughout the vast expanse of the universe' - and 'Spiegel im Spiegel' by Arvo Pärt, who in writing this piece, which translates as 'Mirror(s) in the Mirror', was concerned with the reflection of light.

After this there comes Equivalence Section B1, bars 10 up to and including 41, and Equivalence Section B2, bars 42 up to and including bar 64, in which the relationship between Energy, Mass and the speed of Light is explored musically through interplay between the following parameters: dynamics and articulation for Energy; density of notes for Mass and melody for the speed of Light.

Everyone's private universe is different. At Relativity Section C1, bars 65 up to and including 96, character 1 and character 2 are introduced, each illustrated by their own *idée fixe*. Both are woven together in a fugue. Here there is dissonance resolving to consonance, before more suspense and also balance and symmetry - through rhythmic similarity and diatonic inversion - which different private universes have in terms of Special Relativity. At Relativity Section C2, bars 97 up to and including 123, continuing the idea of symmetry in this section is an exploration of the axis of symmetry in the modes of Messiaen's Third Mode of Limited Transposition as well as the use of retrogression. Relating to symmetry is the idea of reflection - another characteristic outcome of the behaviour of light.

Then there is a resurfacing of Equivalence Section B1, bars 124 up to and including 138, and Equivalence Section B2, bars 139 up to and including 154. This return is not entirely the same as the previous musical statement, though there is a strong similarity. The interplay between musical parameters that represent the fundamental properties of  $E=MC^2$  still remains.

To finish there is a return of the Big Bang Section A, bars 155 up to and including 169 so far as notation is concerned. Beyond this and bringing the piece to a close is the cutting, editing, splicing and manipulation of samples alongside birdsong. At this return of the Big Bang Section A,

the music is not the same as, but reminiscent of the Big Bang Section A opening at the start of this piece. The Big Bang explains the evolution of the universe. Light is a fundamental property of the universe and the absolute speed limit and a link between the fundamental properties, Energy and Mass. The ending of this piece does not sound entirely resolved, which is consistent with the idea of perpetual motion. The earth is spinning on its axis and orbiting the sun, the galaxy is spinning and the universe is expanding. Being stationary or moving is relative, not absolute. Nothing is really stationary.

## Structure

The structure of a composition is the musical cohesion, how it fits together, like the chemical structure of a molecule.

At Equivalence Section B1, bars 10 up to and including 41 and Equivalence Section B2, bars 42 up to and including 64, different musical parameters are designated for Energy, Mass and the speed of Light. Energy is represented by dynamics and articulation and Mass is represented through the density of notes and harmony. Energy and Mass increase and decrease together. The continuous melody in the upper register is analogous to how the speed of Light remains constant and absolute. At points Energy and Mass join in rhythmically with the speed of Light melody.

The note choices, harmony and sound world are informed by Messiaen's Third Mode of Limited Transposition, which has four transpositions and three modes within each transposition. That there are three modes within each transposition is appropriate because there are three parameters in Einstein's Special Relativity formula.

After the Big Bang Section A opening, transposition 1 is explored further at Equivalence Section B1, from bars 10 up to and including 41. Within this transposition, mode 1, which starts on C enters at bar 10 with the melody in the treble clef. Mode 2 starts on D punctuated by the D in the bass clef at bar 15 and mode 3 starts at half way through bar 20 on Eb punctuated by the Eb in the bass clef and the Ab as a fourth above in the treble clef. The opening melody line is elaborated on; when heard for the second time it is extended by a dotted crotchet and for the third time extended by a dotted crotchet again, in keeping with the introduction of modes 2 and 3. Transposition 2 comes in at bar 42 on Db initiating mode 1. This is the start of Equivalence Section B2. Modes 2 and 3 of this transposition are hinted at by the semiquaver run at bar 45. Transposition 3 comes in at bar 46 on D initiating mode 1. Modes 2 and 3 of this transposition are hinted at by the semiquaver run at bar 49. Transposition 4 comes in at bar 50 on Eb initiating mode 1 of this transposition and the semiquaver run at bar 53 emphasises this mode. The semiquaver run at bar 57 is suggestive of mode 2 of transposition 4 and the semiquaver run at bar 63 is suggestive of mode 3 of this transposition.

As relativity is symmetrical, the piece draws on the axis of symmetry in Messiaen's Third Mode of Limited Transposition. Relativity Section C2, with the pattern starting at bar 97, highlights this. Here mode 1 of transposition 3 is used. Mode 2 of transposition 3 is presented through this pattern in semiquavers, from bars 101 up to and including 102, and mode 3 of transposition 3 is presented through the same pattern in demisemiquavers - bar 103. Starting at bar 104 the pattern is retrograded, there is rhythmic variation and the note choices are informed by mode 1 of transposition 4 from bars 104 up to and including 114. Mode 2 of transposition 4 is presented through this pattern in semiquavers, from bars 115 up to and including part way through bar 120 and mode 3 of transposition 4 is presented through the same pattern in demisemiquavers from bars 120 up to and including 122.

Broadly speaking there is a restating of Equivalence Section B1 and Equivalence Section B2 from bars 124 up to and including 154. Here marks a variation in the musical landscape. The music is more concise, crystallised and chordal. This simplicity takes on a more spiritual dimension and the work of John Tavener is an inspiration.

To a large extent, the harmony of this piece is also built on perfect fifths in the bass and perfect fourths in the treble. Notes are stacked on each other according to whether a particular transposition - derived from Messiaen's Third Mode of Limited Transposition - being explored will allow for that; there are only so many notes available. Throughout the composition this is done to

varying degrees. For example, Equivalence Section B1, on its first statement, increases in density of notes, while Relativity Section C2 starts off with a thicker texture and thins out, before the retrogression where texture is initially fuller and then thins again.

The atonality of the harsher and more experimental sounds mirrors the amorality of nature and the universe.