AN ANALYSIS OF \textit{DU CRISTAL...`A LA FUMÉE} BY KAIJA SAARIAHO AND
\textit{AXIOM UNEARTHED}, ORIGINAL COMPOSITION

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Thesis Prepared for the Degree of

MASTER OF ARTS

UNIVERSITY OF NORTH TEXAS

May 2015

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Beginning in the 1970s, and aided by the advancement and an increased prevalence of computers, spectral music emerged as an important development in twentieth century music. Spectral composers, as exemplified by Gérard Grisey and Tristan Murail, took the harmonic spectra of sounds as the fundamental materials of composition. The resulting music placed an emphasis on texture and gradually evolving forms. The generation of composers immediately following the spectralists assimilated their techniques into distinct and varying styles. Finnish composer Kaija Saariaho uses spectral techniques to create an aesthetic that generates form and progression from a sound/noise axis. In her piece *Du cristal…à la fumée*, a number of pendulum and half-pendulum gestures build up texture and form. The accompanying original composition *Axiom Unearthed* employs similar pendulum gestures and uses spectral techniques to generate melody and harmony in an aesthetic divergent from traditional spectral pieces.
ACKNOWLEDGMENTS

In the preparation of this document and the accompanying composition, I must acknowledge Dr. Kirsten Broberg for her continuous support and guidance. Additionally, I would like to acknowledge the support of my parents John and Paula Allen, as well as Lola Milling, whose support I could never repay and to whom this document and the accompanying composition are dedicated.
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PART I

CRITICAL ANALYSIS
Introduction

Since the days of Rameau, the harmonic series as a theoretical principle has informed the craft of musical composition. By the twentieth century, composers were using the overtone series to inform more than harmonic or orchestration choices. The harmonic series – and harmonic spectra in general – were elevated to the fundamental materials of composition with the increased prevalence of computers in the 1970s. These composers blurred the lines between harmony, timbre, and texture in an aesthetic distinct from other twentieth century veins. To describe this shift in aesthetic, *l’iternéraire* member Hughes Dufourt coined the term “spectral music.” With the second generation of spectral composers, these fundamental materials were employed in such a manner that the style was stretched to embody a pluralism of aesthetics.

Finnish composer Kaija Saariaho, while decidedly influenced by the spectral movement, retains a style that places texture and melody on equal footing. Her diptych *Du cristal…à la fumée* (1989-1990) exemplifies a compositional approach marked by axes of dynamics and texture. Each parameter progresses from a point of stasis and stability to extreme tension. Although unmistakably owing much to the spectral school, these two pieces transcend traditional designations and labels.

This paper will offer an analysis of *Du cristal...à la fumée*, exploring the above-mentioned sound and texture axes, pitch content, and formal structure. A comparable analysis for my own original composition, *Axiom Unearthed*, will be discussed as a point of comparison. In order to provide context, I will define spectralism and discuss its

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history, examining briefly two prototypical spectral pieces, *Les espaces acoustiques* by Gérard Grisey and *Gondwana* by Tristan Murail. Though not considered a traditional spectral composition, Per Nørgård’s Symphony No. 3 will also be discussed because of its influence on the accompanying original composition.

Definition and History of Spectral Music

Spectral music can be defined broadly as music that employs harmonic spectra of sounds as its fundamental materials. For example, the frequencies, or partials, that make up a given timbre can be taken as the basis for the pitch content of a musical composition. Composers then choose to manipulate the frequencies in a number of ways by interconnecting the partials to that of other spectra or revealing certain partials over time. Though primarily concerned with the harmonic and melodic domain, spectral techniques often have a significant ramification on form and time. Whereas in more traditional music the discourse is the result of development and progression, spectral music possesses a propensity for slow change over time and favors the unfolding of processes over the traditional sense of development. Form, therefore, is more fluid with major sections gradually transforming from one state to another.

The advent of spectral music necessarily coincided with the rise and increased availability of the computer. The computer’s processing power made it possible to quickly record and analyze the harmonic spectra of sounds and represent them in sonographic representations. Additionally, a number of spectral techniques are transferred directly from the electroacoustic domain. One such technique takes its

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name after additive synthesis, a technique in which a complex timbre is built up using sine waves. Instrumental synthesis replaces the sine waves with acoustic instruments resulting in far more complex conglomerate timbres. Other techniques, such as frequency and ring modulation, play an important role in the music of Tristan Murail.

Though spectral music could not properly exist without the assistance of the computer, the compositional technique has much earlier roots. From the beginning of the twentieth century, composers have used the harmonic series to generate varied styles of music. Treatises by Harry Parch and Henry Cowell laid out harmonic and rhythmic systems based on the overtone series and Partch went so far as to invent his own instruments to facilitate the new systems.\(^3\) Cowell’s treatise, *New Musical Resources*, discusses a theory of deriving polyrhythms from the proportions of the harmonic series\(^4\) – a technique later duplicated in Stockhausen’s *Gruppen*.\(^5\) By the 1960s, the influence of these composers had reached the minimalist composer La Monte Young. Young “shares with much early spectral music an interest in sounds of long duration and music whose rate of change is very slow…. Together with all this, La Monte Young has shown close interest in just intonation and the harmonic series.”\(^6\)

In Europe, the work of Paul Hindemith and Olivier Messiaen was strongly informed by a similar regard for natural acoustic phenomena. The harmonic theory laid out in *The Craft of Musical Composition* is derived entirely from acoustic principles and

\(^6\) Ibid.
the treatise is cited by Gérard Grisey as an inspiration. In his own treatise, Messiaen cites natural phenomena as a basis for his harmonic language. Julian Anderson writes:

Messiaen...further employs the harmonic spectrum to justify his use of ‘added resonance’ — dissonant upper pitches added to a diatonic triad in the middle register; and also to justify his fondness for ‘inferior resonance’ — dissonant clusters of notes, often at the bottom of the piano, added to a higher diatonic triad.

Messiaen secures his place as a forerunner of spectralism with the use of his ‘chord of resonance,’ containing partials 4, 5, 6, 7, 9, 11, 12, and 15 of the harmonic series (Example 1). Messiaen’s penchant for resonance is directly related to his interest in timbre, notating not only the pitches of birdcalls, but also a set of corresponding overtones that give each its unique timbre.

Previously, Edgar Varèse explored the idea of timbre as a fundamental compositional element. In works like *Intégrales*, instrumentation and orchestration are at least as important as pitch content, an idea taken even further by Italian composer Giacinto Scelsi. “[Scelsi’s] *Four Orchestral Pieces on a Single Note* (1959) reduced pitch content so completely that the listener is forced to examine otherwise unnoticeable

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7 Ibid., 10.
8 Ibid.
10 Ibid., 11.
minutiae of sound, such as harmonics, beats and difference tones.”

Scelsi’s emphasis on the acoustic properties of sound translated directly into the spectral practice of using harmonic spectra as the basis of a composition. Scelsi’s influence on the French spectral composers extended into another facet of the French spectral aesthetic: traces of the slow, gradually evolving processes that have become a hallmark of early spectral compositions can be found in much of Scelsi’s work, most notably his Fourth String Quartet.

Julian Anderson, in his article “A Provisional History of Spectral Music,” cites several composers active at Darmstadt in the 1950s who exerted an influence on spectral music. “György Ligeti’s texture-based music – pieces such as Atmosphères (1961) and Lontano (1967) – share with Scelsi’s music (unknown to Ligeti at that time) a preoccupation with slow rates of change and dense, continuously evolving textures.” An emphasis on texture can also be found in the music of Frederich Cerha, particularly in his orchestral work Spiegel V (1962), “which involved splitting the orchestra into perpetually fluctuating masses of sounds.” In the case of both composers – as well as Scelsi – traditional formal divisions are abandoned “in favor of a single, unidirectional process.”

Among the earliest compositions to employ harmonic spectra as the nucleus of a piece are two by Stockhausen: Stimmung and Mantra. Stimmung (1968) for six voices explores a single B-flat spectrum, filtered by constantly changing phonemes. Stockhausen’s application of acoustic research in this piece directly precedes the

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11 Ibid., 12.
12 Ibid.
13 Ibid.
14 Ibid.
techniques fundamental to the spectral school. *Mantra*, written two years later and influenced by La Monte Young, further uses ring modulation to affect the timbre of the two piano parts, a technique found in the works of Tristan Murail and others.\textsuperscript{15} Beginning with Stockhausen and his contemporaries, and continuing through the present, the advancement of technology has allowed for the possibility of spectral analysis of the most complex sounds, in turn allowing for these analyses to become the basis of entire compositions.

The same year *Stimmung* was completed, Danish composer Per Nørgård created what Julian Anderson considers the first proper piece of spectral music.\textsuperscript{16} Indeed *Voyage into the Golden Screen* offers several precedents for Western music. The second movement incorporated Nørgård’s first extended use of his infinity series and first movement is almost a textbook example of spectral music. Using two natural overtone spectra – G and A-flat lowered by a quartetone (Example 2) – the movement exploits difference tones and beating as the two spectra in just intonation unfold over an extended period of time. Although it is unlikely that Nørgård knew of Scelsi’s music, this piece is strikingly similar to that of the Italian composer. While Nørgård would never come this close to pure spectralism again, the underlying processes and concepts of *Voyage* manifest themselves in much of his output, including his Third Symphony (see below).

\textsuperscript{15} Ibid., 13.
\textsuperscript{16} Ibid., 14.
Spectralism proper begins with the generation of composers immediately following those discussed above. Two groups in the early 1970s are usually associated with the origins of spectral music: France’s groupe l’Itinéraire and the composers associated with Cologne’s Feedback Studios. Of the Feedback group are a number of composers associated with Stockhausen around 1970: Johannes Fritsch, Rolf Gelhaar, Clarence Barlow, and Mesias Maiguashca. Canadian composer Claude Vivier and Hungarian Péter Eötvös have also become associated with Feedback Studios. Unlike the l’Itinéraire composers, the spectral pieces of the Feedback group retained a focus on melody, perhaps evidence of Stockhausen’s influence. For example, in Vivier’s music, we find almost exclusively homophonic textures in which the melody is harmonized with a bass and then the two parts are ring modulated against each other to achieve distinct spectra.\(^\text{17}\)

Of the groups, l’Itinéraire has perhaps become more readily associated with this style of music. Arguably the most famous members of l’Itinéraire are Gérard Grisey and Tristan Murail. Students of Messiaen, the composers are widely considered fathers of French spectral music. The two met in the early 1970s and soon formed l’Itinéraire, the

\(^{17}\) Ibid., 17.
leading new music ensemble in France at the time. The origins of French spectral music emerged, at least in part, as a reaction to the serial aesthetic that dominated contemporary music from the mid-twentieth century.

The earliest pieces to emerge from the l’Itinéraire composers include Sables for orchestra and Mémoire/Erosion for horn and ensemble by Murail, and Dérives for two orchestral groups by Grisey. In Sables and Mémoire/Erosion “the musical structure is defined by drifting between moments of pure consonance derived from the natural overtone series and passages of extreme dissonance analogous to so-called white noise.”18 Similarly, Dérives focuses on a recurring consonant E-flat spectrum upon which transformations occur. Grisey explores further the processes found in Dérives in his titanic cycle Les espaces acoustiques. Heavily influenced by electroacoustic composition, Murail spent the remainder of the decade exploring the sonic possibilities of acoustic instruments manipulated by electronics, particularly ring and frequency modulation. The culmination of his work and research during this period was the ambitious orchestral work Gondwana. In the case of both composers, this type of music has important ramifications on form and time.

In addition to these two major groups in France and Germany, there were parallel developments in other parts of Europe. During the same time, Romanian composers such as Miereanu, Radulescu, Niculescu, Stroe, Dumitrescu, and Loachimescu explored spectral techniques in a style that combined them with folk music. In Budapest, the composers associated with the Experimental Group of Hungarian Radio synthesized many trends from twentieth century music, emphasizing acoustic

properties. Other composers cited as practitioners of spectralism during this period include the English composer Jonathan Harvey and the little-known German composer Erhard Grosskopf.

By the mid-to-late 1980s the spectral movement had begun to influence a wide range of composers, resulting in numerous developments. “France has seen the emergence of the nearest thing to a ‘school’ of composers expanding and developing the research of Grisey and Murail. Pupils of theirs such as Philippe Hurel, Marc-André Dalbavie, Jean-Luc Hervé, and Joshua Fineberg have all exploited the latest technologies.” In Finland, the music of Kaija Saariaho and Magnus Lindberg exhibits spectral influences. In the case of each of these composers, the aesthetic was assimilated and appropriated into their individual styles. Even the music of Grisey and Murail shifted from the slow, dense textures of the 70s:

In their works of the late 1980s and early 90s, [Grisey and Murail] avoided the smooth processes characteristic of their earliest mature work, focusing instead on discontinuity and unpredictable forms, with a new emphasis on linear, polyphonic writing. It is perhaps no coincidence that both turned during this period to writing for the voice....

Les espaces acoustiques (Gérard Grisey), Gondwana (Tristan Murail), and Symphony No. 3 (Per Nørgård)

Between 1974 and 1985 Gérard Grisey created his Les espaces acoustiques, a massive cycle of six pieces exploring spectral techniques and aesthetics. The work, totaling more than an hour and a half of music, can be performed in its entirety or adjacent pieces can be performed independently, with the exception of epilogue, which

19 Anderson, “Provisional History,” 18.
20 Ibid., 20.
may only be performed when preceded by the entire cycle. As the work progresses from the solo viola that comprises the opening movement, instrumental forces are gradually added while the harmonic spectrum expands. “The entire cycle is based on a pattern of inhalation-exhalation-rest. The moments of rest are marked by regular, periodic patterns and a part of a harmonic spectrum on E1.”22 This rise and fall of tension manifests itself most prominently in the transitions from harmonic and inharmonic spectra, in which harmonic spectra are those closely resembling the natural overtone series. Each work is designed to elide naturally into the succeeding movement, allowing seamless transitions throughout the cycle. The only pause between movements comes at the end of Partiels when the work fades to silence.

The six movements are derived for the most part from various forms of an E1 spectrum. In the opening Prologue, the solo viola explores the upper partials of this spectrum, though the fundamental is not stated until the following movement. As the spectrum transitions slowly from harmonicity to inharmonicity, the timbre of the viola gradually transforms from the relatively pure sound of ordinario bowing to sul ponticello and eventually extreme overpressure. The resolution comes with the return to an area of harmonicity and pure timbre of natural harmonics. As the Prologue dovetails into Périodes, the fundamental E1 is finally stated and it becomes clear that both the material of Périodes and the preceding movement are derived from its spectrum (Example 3).

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22 Anderson, “Grisey, Gérard.”
Example 3: Harmonic Spectrum of Prologue and Périodes.

In similar fashion, the transition from Périodes and Partiels is seamless. Partiels opens with the very same trombone blasts that close Périodes. The spectrum used in Partiels comes from the sonogram of a trombone playing E2 at a forte dynamic. This spectrum is then orchestrated to create the beginning of the movement, a prototypical example of instrumental synthesis (Example 4). Much like the previous movements, Partiels gradually moves from the harmonic spectrum of the trombone to an invented inharmonic spectrum. Noise elements are introduced as the work progresses and by the end of the movement, the spectrum has deteriorated into white noise before fading into silence.

Example 4: A trombone E2 Spectrum.
Unlike the preceding movements, *Modulations* begins in an area of relative tension and instability. The work moves from this dissonant harmonic spectrum to that of relative consonance and back again. A dissonant spectrum can be defined as that which bears relatively few similarities to the natural overtone series. As the piece traverses a number of spectra, Grisey uses the opportunity to explore texture. Throughout the movement, we find examples of static soundmass, imitative polyphony, micropolyphony, layered soundmass, and layered micropolyphony.\(^{23}\) One primary element of transformation Grisey employs in the piece is filtering. Spectral analysis shows that brass mutes act as filters, eliminating some partials while strengthening others.\(^{24}\) For *Modulations*, Grisey uses spectra from harmon mutes, stopped horns, cup mutes, and an “imagined” mute to generate timbral transformations (Example 5).


Example 5: Harmonic spectra used in Grisey’s *Modulations*.

The penultimate piece, *Transitoires*, uses spectral analyses of five different contrabass playing techniques: *pizzicato*, *ordinario*, near the bridge, almost on the bridge, and *sul ponticello* as its source material. With its enlarged orchestral forces, the piece functions as the climax of the entire work and recalls gestural and harmonic materials from the previous movements. The references to the earlier pieces continue in *Epilogue*, which, as in *Prologue*, begins with solo viola before being joined by full orchestra and an additional four solo horns.
Tristan Murail’s most ambitious piece from this period draws heavily on the work he previously did with electronic music. The bulk of the pitch content in Gondwana is generated with frequency modulation synthesis. Developed by John Chowning, frequency modulation involves a carrier frequency being altered by a modulating frequency, resulting in a spectrum made up of summation and difference tones.\textsuperscript{25} The opening section of Gondwana is comprised of a series of sonorities generated by FM synthesis. Example 6 shows the five carrier frequencies Murail modulates with the frequency 207.65 Hz (G#3). Example 7 shows the frequencies achieved from modulating the first carrier signal. The composer then builds the opening harmonies using the summation and difference tones.

Example 6: The carrier frequencies used by Murail in Gondwana.

The resulting spectrum is relatively complex and resembles, to some extent, that of a bell. In his orchestration, Murail emphasizes the bell-like qualities by scoring the low frequencies in the brass and the higher frequencies in the woodwinds. The attack is emphasized with a variety of pitched percussion instruments and piano that quickly

\textsuperscript{25} Ibid., 30
dissipate, leaving certain higher frequencies. The resulting envelope is a close
approximation of the envelope of an actual bell.26

Example 7: Summation and difference tones achieved in Gondwana by modulating the
first carrier signal with the modulating frequency.

An important piece that uses spectral theoretical systems in an aesthetic far from
that of the French school can be found in Per Nørgård’s Third Symphony. In this work,
Nørgård links three distinct hierarchical systems representing the melodic, harmonic,
and rhythmic domains, respectively. The rhythmic system is derived from the Fibonacci
series and the melodic system is Nørgård’s hallmark infinity series.27 The harmonic

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26 Ibid., 32
27 To develop the infinity series, one begins with two notes, a single interval. This interval contains all
necessary information to generate the entire series. The interval is marked out from either initial note,
inverted melodically to generate the next two notes. The interval between the second and third notes
then determines the next two notes and so on. For more information on the infinity series see Kullberg,
system comes directly from the natural overtone series and enables the interaction of the other two systems.

In the first movement, Nørgård chooses to expose the harmonic materials independent of the melodic and rhythmic materials. The movement opens with a strong bass attack that leaves the highest of partials to swell into a quintessential spectral texture. The cascading figures in the high strings and woodwinds point unmistakably to the fundamental of G1 that is later stated during the culmination of the introduction (Example 8). The overtone series is then explicitly stated in measures 48 through 58 in glorified fortississimo trombones, so as to make the harmonic materials of this piece explicit.

Example 8: Symphony No. 3, 1st mvt., mm. 36 – 40.; piano, harp, violin.

The second movement opens in a similar fashion with a statement of the sub-harmonic series (Example 9), resulting in a decidedly minor quality throughout the piece. Though more subtle, this statement is no less explicit than that of the first movement.
In addition to providing the harmonic underpinning for the entire symphony, the overtone series also provides the means for all three hierarchical systems (melody, harmony, and rhythm) to interact as one comprehensive hierarchical structure. The partials of the harmonic series, understood as ratios, provide the necessary framework. If the octave is viewed as a ratio of 2:1, we can easily see how rhythmic (tempo) and melodic relationships interact (Example 10). With other partials, the task becomes more complicated. The relationship between partials two and three can be expressed as a 3:2 ratio. In the rhythmic domain this could easily be expressed as a polyrhythm of three against two but the melodic infinity series does not fit so nicely. Here the undulating rhythms derived from the Fibonacci series become necessary to facilitate the linking of the three series. Example 10 shows the simplest interaction of the harmonic and melodic series as a single hierarchical structure as expressed by the ratio 4:2:1.

Example 10: The interaction of the infinity series with the natural overtone series.
Analysis of Kaija Saariaho’s *Du cristal…à la fumée*

Of the generation immediately following Grisey and Murail, Kaija Saariaho stands out as one major composer that fully assimilated the spectral techniques of her predecessors while retaining her own voice and aesthetic. Her earliest works show a transition in emphasis from melody to tone color.\(^{28}\) By the 1980s, timbre and harmony became inextricably linked and functioned as the primary elements in her compositions, employing a noise/sound axis to replace the conventional dissonance/consonance parameters.\(^{29}\) Saariaho’s music is often informed by a strong recourse to extra-musical sources including nature, literature, and the visual arts. Her sources of inspiration are sharply juxtaposed with her approach to composition, which is almost always aided by a computer and marked by meticulous calculations.

Both of these factors figure importantly into Saariaho’s 1989-90 diptych *Du cristal…à la fumée*. The title, literally translated as “from crystal into smoke,” comes from the book *Entre le cristal et la fumée* by Henri Atlan. In the composer’s words, “*Du Cristal…à la fumée* is one world with two faces, both completely defined, living and independent.”\(^{30}\) The two works may be played individually or together as a unit. Saariaho’s first work for large orchestra, “*Du cristal* was commissioned jointly by the Los Angeles Philharmonic Orchestra and the Helsinki Festival, and it was first performed by the Finnish Radio Symphony Orchestra.”\(^{31}\) …à la fumée is essentially a double

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\(^{31}\) Ibid.
concerto for alto flute and cello. It comes as little surprise that the composer chose these instruments to showcase: they each have received extensive attention in her solo and chamber output. Like many of Saariaho’s works, Du cristal…à la fumée makes use of electronics, but to a lesser extent. A prominent synthesizer part is found in each movement and the soloists in …à la fumée are amplified.

The two pieces, though strikingly different on a surface level, are considered by the composer “two facets of the same image;” the same materials in diverging directions. The immediately perceivable differences in the two pieces can be understood as a direct result of their respective titles. Anderson in his program note for the diptych writes, “Crystal is a classic example of repeated order, symmetrical, tense, stable mass. Smoke, on the other hand, changes its form constantly, an unpredictable, developing state. Crystal and smoke, like order and entropy, chaos.” The following analysis will explore the relationship between the two pieces with regards to symmetry and musical content. For each piece the parameters of timbre, texture, gesture, rhythm, and pitch content will be discussed in order to understand the ways in which the composer generates progression and form.

Analysis of Du cristal

The harmonic content of Du cristal is almost entirely derived from the bell-like chord that opens the piece. During the first 64 measures of the composition, the spectrum of the opening sonority is augmented with the gradual addition of other

32 Ibid.
frequencies. Example 10 shows a reduction of the original chord and the supplementary pitches. Once these additional pitches are added, the opening harmony remains relatively static for the first 130 measures. An illusion of motion is achieved in the pitch domain by the use of microtonal inflections and the movement of instruments from one pitch to another. Glissandi in particular play an important role in the perceived motion of the harmonic material, allowing the string instruments to traverse wide intervals in the chord without compromising its overall character. The composer further varies the opening harmony by exploring and emphasizing certain pitches in the spectrum and constantly shifting the orchestration.

Example 11: Harmonic content at the opening of *Du cristal*. Black note heads indicate pitches added after the initial chord is sounded.

The stasis of *Du cristal*’s opening is replaced in the middle section with a relatively quick rate of change. These new sonorities continuously evolve and change in tandem with the texture. Several harmonies serve as markers within this section because of their location in the structure of the composition. Measure 209 is the first significant arrival point of the piece and marks a change of direction that precipitates the climax of the work, which arrives at measure 227. Nearing the end of the work we find
the harmonic material returning to that of the beginning. The original chord, with slight modifications, is restated twice, the first being at measure 315. From this point, the chord is reduced as pitches are gradually eliminated until only the E-flat trill that concludes the movement remains. Example 11 shows a harmonic reduction of Du cristal.

Example 12: Structural Harmonies in Du cristal.

The concept of “melody,” as it is traditionally defined, does not apply to Du cristal. There are moments in which melodic fragments are gradually layered to create distinctive textures. In these instances the ear perceives the fragments as part of larger micropolyphonic texture, rather than a broken melody. Example 12 illustrates such a texture. More often, however, we find a sense of line created by the interweaving of small gestures by many instruments. In this way, large sections of the piece are generated from the most basic of materials. Four independent parameters can be delineated as the fundamental materials of this piece:

1. Pitch: trills between small intervals or glissandi
2. Volume: crescendo and diminuendo
3. Rhythm: change from short to long durations

4. Timbre: change between bow pressures or between pitched and non-pitched sounds

By manipulating these four parameters the composer generates the form of the piece and creates a sense of forward motion despite the static nature of the harmony.

Example 13: *Du cristal*, mm. 223 – 225, woodwinds.

In the case of each parameter and the diptych at large, a pendulum concept is significant. Simply put, a pendulum motion involves modifying one parameter and then returning to the original state.\(^{34}\) We have already seen the pendulum motion on a large

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scale in the harmonic construction of the piece, with a departure from and a return to the original chord. Applied globally, a pendulum can be observed between *Du cristal* and *…a la fumée*, with the solo cello trill between the two movements serving as the center of the pendulum.

A pendulum motion applied to a specific sound parameter usually lasts between 1 and 4 measures. In the dynamic domain, the most typical manifestation is a crescendo from *niente* immediately followed by a *diminuendo*. Regarding timbre, changes in bow pressure are most common. A descending glissando is often balanced by an ascending glissando, and vice versa. The entire form of *Du cristal* is built up entirely of these pendulum motions. Example 13 shows a static soundmass texture in the strings constructed with timbre changes (*sul tasto* to *ordinario*) and swells in dynamics.

As for the overall form of *Du cristal*, if we take the first 64 measures as introductory material, we can divide the remainder of the piece into three large sections. Measures 65 to 131 are dominated by soundmass textures and occasional micropolyphony. Pitched metal percussion dominates the foreground and the harmonic content is derived from the opening bell sonority. Measures 131 to 237 are marked by dramatic shifts in texture and a faster rate of harmonic change. The harmonic spectrum increases in inharmonicity, growing toward the climax. Rhythm becomes the primary catalyst for motion in this section, moving gradually from the irregular rhythms of the timpani and rototoms at the beginning to the pounding ostinato of the climax. Half pendulums become prominent in this section. For example, dissonant sonorities will be attacked at *forte* and diminuendo into silence. The final section, 237 to the end, begins...
as the pounding ostinato dissolves into sustained textures, signaling a return to the first section and completing the pendulum motion.

Example 14: *Du cristal*, mm. 136 – 141, strings.
Analysis of …à la fumée

As its name might suggest, à la fumée is marked by unpredictability and a constant state of change in all the musical parameters. The piece at times even suggests outright chaos. The biggest differences between the two pieces are texture and form. Whereas Du cristal’s texture is dense and changes gradually over time, …à la fumée is characterized by much sparser textures that change quickly and dramatically. In the case of each, the textures help delineate the overall form of the piece. For Du cristal, this results in a pendulum motion: a long excursion from the opening material and back. In …à la fumée, we get a succession of disparate parts, with a notable absence of traditional formal elements.

The fundamental materials of the two pieces are the same: trills and glissandi, swells in volume, changes from pitched to un-pitched sound, and short melodic fragments. Unlike Du cristal where the pendulum motion functions as the building blocks of the composition, …à la fumée is almost entirely void of these gestures. Martha Brech, in her analysis, contends that in contrast to Du cristal, …à la fumée is filled with half-pendulums. Writing about the primary gestural materials in this piece Brech writes, “it is interesting to note that only the reflecting surface is missing to create the characteristic impression of mirroring symmetry found in Du cristal.”35 These half pendulums are manifested most clearly in the volume domain as sharp crescendos from niente or a diminuendo following a sharp attack. Examples in other parameters, though less obvious, exist as well: for instance, glissandi will reach their terminal point without returning to their pitch of origin and bowing will change from ordinario to sul tasto and

35 Ibid., 33.
remain there. In each case, these half pendulum gestures function as contrasting material to the primary lines usually found in the solo instruments. Whereas in *Du cristal* the pendulum motions typically function as dense textures in the background, the half-pendulums of *…à la fumée* usually exist in the foreground.

There are three contrasting textures in *…à la fumée* from which a number of varieties are generated. The first texture encountered is referential of *Du cristal*: static soundmass and micropolyphonic textures that are built up from small pendulum gestures. The second is a sparse texture with energetic lines found in one or both of the solo instruments. In most instances, the soloists are accompanied only by a thin texture of sustained notes. More rarely however, we see individual instruments or families of instruments joining the soloists in their material. The treatment of the two soloists is such that when they play together, the distinction between the two is blurred. The result is a kind of meta-instrument that is heard as one line (Example 14). There are, of course, instances where each soloist plays alone. In such cases, the accompanying textures discussed above apply. The final texture found in *…à la fumée* is generated when the soloist’s material is built up in the tutti orchestra into micropolyphony.

Example 15: *…à la fumée*, mm. 91 – 96, solo alto flute and solo cello.
The most dramatic difference between *Du cristal* and …*à la fumée* is not in the textures employed, but rather in the transitions between each texture. In the former, textures evolve gradually and transitions are seamless; in …*à la fumée*, some textures gradually change over time, more often new textures are introduced abruptly, frequently interrupting the previous one. The result is a sometimes jarring scission of lines and materials. It is precisely these vertical breaks in the piece that define it and distinguish it from its predecessor. Two types of vertical divisions in …*à la fumée* can be defined: the first is an abrupt shift in the total texture, beginning a new point in the structure of the piece; these occur near the beginning and end of the piece. The second type affects the trajectory of the composition less; these serve primarily as interruptions of the solo lines and occasionally act as a trigger for a new section. In addition to clarifying the structure of the piece, these sudden breaks in texture provide a sense of forward motion in their contrast to the primary material.

In terms of structure, it is difficult to perceive any sort of traditional form. The piece moves from its opening transitional material to the primary section where the soloists interact with one another and the orchestra. Aside from several episodes reminiscent of *Du cristal*, the section never changes and no real arrival point is felt. Rather than ending, the piece seems to just stop with one final scission.

…*à la fumée* opens with the solo cello playing the E-flat trill that ended *Du cristal*. The remaining celli gradually fade in and out on the same figure as the pitch content is built up. Throughout the first 33 measures the pitch content is conservative, building up to a pandiatonic set built around E-flat major. Dissonant chords exist in the brass as a means of contrast. The texture remains relatively sparse until measure 34 where the
orchestra erupts into a cacophony of micropolyphony comprised of figures that foreshadow the upcoming material in the soloists – a sort of orchestral exposition. The pitch spectrum becomes increasingly dense and dissonant throughout this section. After 43 measures of this, the texture thins and the energy dissipates. The solo instruments – at first alto flute, then cello – are now introduced. The accompaniment is sparse, consisting mostly of sustained lines in the strings. As the section progresses pitched percussion, followed by woodwinds, join the soloists in their material and build up the meta-instrument while creating a more active texture.

The first scission occurs at measure 145 in the woodwinds and functions as a simple interruption of the soloists. Several more interruptions occur during the following 22 measures, each one becoming louder and more dissonant. The final vertical break of the section, occurring at measure 167 functions as a trigger for a new section, upon which the orchestra returns to the energetic material earlier in the work. This latest round of cacophony ends abruptly – one of the only occurrences of silence in the entire diptych. The soloists emerge out of the silence. This time each is treated in turn with dialogue from the orchestra. The discourse between soloist and orchestra continues on for nearly 150 measures until measure 344, at which point the sudden interruptions in the texture return. The breaks are more violent, scored for non-pitched percussion and brass. Unlike the breaks of measure 145, these strike the listener as being more final. Each vertical cut leaves the texture thin and inert. On first listen, one wonders if each break will be the cut to end the piece. Ironically, the scission that does end the piece sounds the least definitive of all.
Measure 415 marks the return of Du cristal material and even includes complete pendulum gestures. In this way the overarching pendulum of the diptych is resolved. The total form of the diptych can be understood by way of symmetry with the trilled E-flat in the cello as the axis. The symmetry comparison is further supported by the climax of each piece: Du cristal ‘s occurs about two thirds into the piece, and …à la fumée mirrors that by climaxing at the beginning of its second third. A more overt unity is established with the reintroduction of the material from Du cristal.

Analysis of Axiom Unearthed

The characteristic techniques and aesthetics of the spectral style served as a point of departure for the accompanying original composition, Axiom Unearthed. The primary compositional technique for the piece involved spectral analysis and instrumental synthesis. The pitch content for the entire piece is derived from the spectrum of three basic sound sources: a gong played at multiple dynamics, a suspended cymbal scrape, and an E2 played on the contrabass with varying bow pressures and attacks. For the gong I created three sonographic representations corresponding to piano, mezzo piano, and forte strikes, respectively.36 Example 15 shows the most prominent partials of each notated to the nearest quartertone. For the contrabass, a spectral analysis was made of sul ponticello and ordinario bowing, as well as pizzicato, all on E2. Examples 16 and 17 show the notation of the suspended cymbal scrape and the bass sul ponticello spectra, respectively. My notation of the

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36 Sonographic representations of the sound sources in Axiom Unearthed were generated with the program Sonic Visualizer, Nokia Corporation, 2013.
analysis of the cymbal scrape shows the change of frequency over the period of several seconds. All melodic and harmonic materials are generated from these spectra.

Example 16: Approximation of the harmonic spectra of a gong played piano, mezzo piano, and forte.

Example 17: Approximation of the harmonic spectrum of a suspended cymbal scrape.
Example 18: Approximation of the harmonic spectrum of E2 played *sul ponticello* on the contrabass.

The form of the piece is generated from the progression of one spectrum to the next (Figure 1). The work opens with an exploration of the gong sonority, and gradually introduces partials from the *mezzo piano* and *forte* spectra. Three basic materials are important in this section: repeated two-note figures, dynamic swells in the brass (not unlike the half pendulums found in ...à la fumée), and sustained pitches. The three figures interact in numerous ways, serving as the building blocks for various textures in the piece and acting as unifying motives throughout. Example 18 demonstrates the interaction of the three elements. The climax of the opening section coincides with the most dissonant incarnation played *tutti*, immediately dissolving into a more harmonic spectrum.
The second section, beginning at measure 77, is characterized by the use of multiple spectra, all relatively harmonic. The background material is derived from the bass ordinario spectrum, resulting in a warm E major sonority, while the foreground material alternates between that of the suspended cymbal and the bass pizzicato. The bass pizzicato spectrum is shown in example 19 along with an inversion of the uppermost partials in the spectrum. The texture throughout this section is sparse in comparison to the beginning. Solo lines are accompanied by sustained notes in the strings and clarinets. Example 20 shows the primary thematic material of this section, derived entirely from these spectra, as played by the English horn. The melody is exchanged from English horn to solo strings before the maestoso statement in the tutti strings. The material from the opening briefly returns, acting as a transition to the third major section.

Figure 1: Formal analysis of *Axiom Unearthed*

Example 20: Approximation of the harmonic spectrum of bass *pizzicato* E2 and its inversion.
The pitch content of the third section comes from the *sul ponticello* E and its inversion. Foreground in the brass and basses is an outgrowth of the repeated-note figure of the opening: as the pitch content gradually becomes more dissonant the running figures in the woodwinds evolve into a frenetic micropolyphonic texture. The climax of the work comes at measure 226 when the brass in cluster harmonies alternates with violent outbursts in the woodwinds and strings. A *fortissimo* tam-tam strike marks a sudden return to the gong spectrum that opened the work. As the texture once again dissolves, only the harmonic partials remain. The coda, measures 306 to 345, further modify the gong spectrum until only the brilliant E major sonority of the last few measures is left.

**Conclusion**

Although influenced by the French spectral composers and the music of Kaija Saariaho, *Axiom Unearthed* is differentiated from those composers in the way it uses its original sound sources and the overall aesthetic of the piece. While the resulting sound world is strikingly dissimilar to that of “traditional” spectral pieces, *Axiom Unearthed* contains a number of important similarities.

The most important relationship between *Axiom Unearthed* and *Du cristal…à la fumée* – as well as other spectral pieces – is that pitch content is derived from harmonic spectra. In its use of the instrumental resynthesis of various sounds, *Axiom Unearthed*
employs perhaps the most important spectral technique. The difference between Axiom Unearthed and the pieces discussed in this paper is that the former relies on spectra only insofar as to generate pitch and form. Whereas in traditional spectral pieces the exploration of harmonic spectra comprises the primary discourse of the piece, Axiom Unearthed uses spectra as one parameter in service of the greater structure of the piece. In Axiom Unearthed, spectral analyses are used to generate melody and harmony in much the same way as a tone row or pitch class set; in this way the piece progresses more traditionally in terms of themes.

The presence of conventional melody in Axiom Unearthed may constitute the primary difference between it and early spectral pieces. Even Du cristal…à la fumée is largely void of melody, save for the motivic ideas that generate the primary material in …à la fumée. If Axiom Unearthed primarily uses spectral techniques as a means of generating harmony and melody, Du cristal…à la fumée employs the same techniques to achieve color and a conglomerate timbre within the orchestra. This difference accounts for the fact that Saariaho freely employs microtones in her diptych while Axiom Unearthed uses them only sparingly.

Despite these differences, several important similarities between Axiom and the diptych can be identified. The various textures throughout Axiom Unearthed are largely influenced by spectral composers and Saariaho in particular. Both Du cristal…à la fumée and Axiom place emphasis on micropolyphonic and soundmass textures. Furthermore, each work demonstrates a propensity for slow transition over time. The idea of gradual transformation of texture and timbre in Du cristal is one shared by Axiom Unearthed. The half pendulum motives that make up …à la fumée are nearly
ubiquitous in Axiom in the form of dynamic swells. In regards to harmonic spectra, Du cristal...à la fumée and Axiom Unearthed each unveil their respective harmonic materials gradually, introducing individual partials over a relatively long period of time.

Even with these similarities accounted for, Axiom Unearthed stands out as a unique entry among spectral, with clear influences in the domains of pitch and texture but ultimately a product of many varied influences. It is a testament to the flexibility of spectral techniques that the aesthetics can vary so greatly from the earliest spectral composers of the 1970s to the subsequent generation of Kaija Saariaho and beyond. That Axiom Unearthed can employ some of the fundamental tenets of the style at the service of a more traditional idiom is further confirmation of this fact.
Appendix

Spectrograms of Source Materials in *Axiom Unearthed*
Gong played *piano*

Gong played *mezzo piano*
Gong played *forte*

Suspended cymbal scrape
Bass E2 played *ordinario*

Bass E2 played *pizzicato*
Bass E2 played *sul ponticello*
Bibliography


PART II

AXIOM UNEARTHED
John Clay Allen

Axiom Unearthed

for orchestra
Instrumentation

1 Piccolo
2 Flutes
2 Oboes
1 English Horn in F
2 Clarinets in B-flat
1 Bass Clarinet in B-flat
2 Bassoons
1 Contrabassoon

4 Horns in F
3 Trumpets in B-flat
2 Trombones
1 Bass Trombone
1 Tuba

Timpani
Percussion 1
   (Suspended Cymbal, Bell Tree, Tam-tam)
Percussion 2
   (Bass Drum, Tam-tam)
Percussion 3
   (Glockenspiel, Marimba)

Harp

Strings
Performance Notes

Strings

- S.P. \textit{sul ponticello}
- S.T. \textit{sul tasto}
- Ord. \textit{Ordinario}

Gradually change from one playing technique to another.

Gradually add bow pressure until tone is replaced with noise.

Percussion

- Suspended Cymbal Scrape
- Bowed Tam-tam
Tempo I ($\varphi = 126$)

Eng. Hn.
B. Tbn.
Tbn. 2
Tbn. 1
Vln. II
Tpt. 3
Tpt. 2
Bsn. 2
Bsn. 1
Timp.
Cbsn.
B. Cl.
Hn. 4
Hn. 3
Hn. 2
Hn. 1
Tpt. 1
Vln. I
Ob. 2
Ob. 1
Cl. 2
Picc.
B. Cl.
Tba.
Fl. 2
Fl. 1
Vla.
Cb.
Vc.
Slightly slower \( \dot{=\text{}} 108 \)