

The Strange and the Beautiful:

Images of the Aurora Borealis

by

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We acknowledge and respect the Ləkʷəŋən (Songhees and Xʷsepsəm/Esquimalt) Peoples on whose territory the university stands, and the Ləkʷəŋən and W̱SÁNEĆ Peoples whose historical relationships with the land continue to this day.

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1. Introduction

Sometimes, on the most magical of nights, there are ribbons of light in the sky. Flickering, undulating, fading in and out as though controlled by some supernatural force far above the stars. Colours so bright against the ink-black night you'd think they had to be painted on the dome of the sky, stretching from horizon to horizon. This glow, dawn-like over the Earth, like the sun has been torn apart and its essence spread into all the colours of the rainbow as far as the eye can see. Standing there in a cool spring night, staring at the colours dance around and above the nearby mountains, you think, *I'm going to write a piece about this.*

The result came a year and a half after that night. My work, *Images of the Aurora Borealis*, is a concerto for flute and orchestra that explores beauty, open form, parametric variation and consistency, sonification and musical representation of visual data, timbral colours, and extended techniques for the flute. It was premiered by the University of Victoria Symphony Orchestra at the Farquhar Auditorium with conductor Ajtony Csaba and soloist Connie Goetz on November 28, 2025. The composition and performance were financially supported by a master's level Canada Graduate Scholarship from the Social Sciences and Humanities Research Council of Canada (SSHRC).

The musical techniques and concepts explored in this work are abundant. *Images of the Aurora Borealis* utilizes an open form as described and developed by Umberto Eco¹ and featured in music by composers such as Karlheinz Stockhausen.² Each of its short

¹ Eco, *The Open Work*.

² Stockhausen, *Klavierstück XI*.

movements is inspired by one corresponding image. The methods through which the movements derive from the images have certain consistencies and in other ways are constantly varied. Expanding on my research from previous years, the solo flute utilizes extended techniques as its integral musical material. The orchestra's material complements, follows, is followed by, and ignores the solo flute in various movements. All of these musical features were chosen to support the central conceptual themes of the work.

In this paper, I will provide an in-depth overview of the composition, from the deepest contextual layers of inspiration and intention to a detailed analysis of excerpted music. I will begin by discussing the preliminary stages of composition, showing background and the fundamental ideas behind the work. Then, I will examine how one night's aurora objectively and subjectively influenced the music on conceptual, structural, and superficial levels. A detailed analysis of a few selections from the score will close the body of the paper.

2. Beauty

The program notes for the piece are as follows:

Three themes are critical to *Images of the Aurora Borealis* at varying explicit and metaphorical levels. The most obvious is the visual metaphor of the northern lights, from which all harmonies and timbres in the work are derived. The ephemeral phenomenon gives the piece its fragmentary, fluid form, the effect of which is emphasized by the accompanying photographs taken by the composer in May of 2024. The second main idea is the extended techniques that permeate the solo flute part with

airy, percussive, and unusual sounds, as well as decorating the orchestra with subtle and overt colour shifts. Finally, at the deepest level, the piece is about disability: the perception, by others or by oneself, of being different, or strange, or weird. Written and premiered by disabled female musicians, the work is a celebration of what can be accomplished by those traditionally perceived as less-than. These three main concepts—disability, extended techniques, and the aurora borealis—are joined by one common, central thread. All of them may be strange, but they can also be remarkably beautiful.

‘Beautiful’ is a challenging word. Inherently subjective, large-scale beauty is not something one can simply manufacture. Merriam-Webster defines beauty as “the quality or group of qualities in a person or thing that gives pleasure to the senses or the mind.”³ Art is often in pursuit of such pleasure, so if one medium or combination of colours or musical texture was objectively most beautiful, would we not, on average, use that one technique above all others? Even things and experiences that the vast majority of people would likely agree give pleasure—for example, chocolate, sunshine, intimacy—can be disliked or hated by some, and vice versa. Less popular pleasurable experiences create even more dissent. The universality of subjectivity is responsible for the existence of genres, stylistic movements, and the wide variety of art media today and throughout history. Some artists have proposed definitions for beauty, such as Helmut Lachenmann in his essay “The Beautiful in Music

³ *Merriam-Webster Dictionary*, “beauty,” accessed January 21, 2026, <https://www.merriam-webster.com/dictionary/beauty>.

Today,” but the opinion of one man is never representative of that of all others, no matter how compelling he may be. Within certain aesthetics—genres, artistic movements, and specific places in specific time periods—there do tend to be certain standards for beauty. These, however, differ vastly between different groups of people across different points in history, and to a lesser extent between individuals within the groups. For example, despite my brother and I being raised in the same place, at the same time, we prefer different subgenres of music. Therefore, as a worldwide agreement of what is beautiful does not exist, it is fundamentally impossible to create universal beauty. Attempting such a feat is overconfident at best and arrogantly obdurate at worst. Trying to create something beautiful is not, however, futile, so long as the creator aims primarily to create something that is beautiful for *them*. Even if no one else agrees with the artist’s assessment of their art as beautiful, they have at least created something that fulfills their own creative impulse. Therefore, while it is impossible to manufacture something that is beautiful on a worldwide scale, creating beauty for yourself is not only possible, but deeply gratifying.

As summarized in the program notes, *Images of the Aurora Borealis* is supported by three conceptual themes. The northern lights, flute extended techniques, and disability play very different roles in the composition but have similarities in how they may be conceived of. All three may be considered both strange and beautiful. Strangeness, for the purposes of this paper, may be summarized as that which is unexpected and/or misunderstood.⁴ Of the three proceeding supporting concepts, some may typically be thought of as more strange and

⁴ “Different from what is usual, ordinary, or expected;” also, “not before known, heard, or seen.” From *Merriam-Webster Dictionary*, “strange,” accessed January 21, 2026, <https://www.merriam-webster.com/dictionary/strange>.

less beautiful than others. By connecting them with this work, I suggest that all three crucial themes are equally beautiful, which is, explicitly, not in opposition to their peculiarity or abnormality.

2.1. The Northern Lights

The first conceptual theme is another example of something that many people agree is beautiful: the aurora borealis. Even if some people don't enjoy the typical colours of the northern lights, they likely appreciate the phenomenon for its rarity and natural serenity. Many people also, however, do not understand how the aurora works. They might know that it occurs as a result of solar activity interacting with the Earth's magnetic field, and even how different colours result from different molecules being excited to different energy levels, but understanding the complete physical causes of the aurora requires a significant level of preliminary knowledge as well as at minimum a basic comprehension of solar, atmospheric, and particle physics and their respective terminologies.⁵ If the northern lights are generally misunderstood, therefore, it is reasonable to consider the aurora borealis strange.⁶

As an inspiration for the work, the northern lights are responsible for essentially all of the compositional choices I made during the writing process. The phenomenon and its photographic artefacts form the backbone of the form, instrumentation, harmonies, and small-scale details of the piece, all of which will be examined later in this paper. The northern lights even inspired my use of the second theme: extended techniques.

⁵ NOAA, "Aurora Tutorial."

⁶ The specific experience that inspired the piece was the northern lights. The aurora borealis is what is mentioned throughout the paper, but all discussions of the phenomenon may also be applied to the southern lights, or aurora australis.

2.2. Extended Techniques

The second main theme, flute extended techniques, is the most musically obvious. The term ‘extended techniques’ refers to anything played on an instrument outside of what is typically considered standard. Already, the inherent abnormality of these techniques makes them strange. Some modern music proponents dislike the term for exactly that reason. Implying that they are outside the norm imposes value and implies that they should only be used in special circumstances, when in actuality, these techniques offer some of the richest and most diverse timbral opportunities. As timbre is one of the most prevalent and foregrounded musical features of *Images of the Aurora Borealis*, using extended techniques expands my colour palette beyond what is achievable with standard methods of performance. For example, many flute extended techniques have an airy and indistinct timbre; these can be useful for capturing faint, pale shades in the aurora. Elaboration on the importance of timbre in the work and further examples of its multitudinous possibilities will be provided in later sections. By utilizing the bountiful timbres provided by flute extended techniques to represent the colours and shapes of the northern lights, I connect these techniques to the aurora borealis both musically and conceptually and demonstrate that the sounds that many people might consider strange can also be beautiful.

2.3. Disability

The third conceptual theme of the work, and the one that is at once the most important and the least connected to the music itself, is that of disability. The piece does not overtly reference this third compositional consideration, and musical decisions were not made with the goal of representing, sonifying, or accommodating the quality of being

disabled. Its thematic presence is contextual rather than referential (unlike those of the northern lights and extended techniques), connected to the work only through its connection to me as the disabled composer. The music could have been written without the acknowledgement and integration of disability. This acknowledgement, however, and the association of disability with the aurora and the extended techniques, has important personal and social benefits, giving the music reason to exist beyond those creative motivations that encouraged the first two themes.

Disabled people—literally, those who are less able than the average in some area of life—often face significant prejudices. Ostracism and misunderstanding are two of the more minor challenges disabled people face from others, both of which align with my working definition of strangeness. More damaging opinions people may hold include the ideas that disability makes someone undeserving, insufficient or dysfunctional. These harmful views can be not only external, but internal as well. When a person convinces themselves that such things are irrefutable fact, the resulting feelings of worthlessness and self-loathing can be almost impossible to escape from. After all, what is a diagnosis of disability but an expert examining you and concluding that you are *fundamentally broken*?

Composing *Images of the Aurora Borealis* with explicit acknowledgment of disability as an important contextual element is an act of rebellion against those negative claims made by outer voices and my inner demons. By doing so, I not only claim that my differences are okay, but also that they may even be beautiful. This is acceptance, honouring, defiance. It is a first attempt to heal something that has been broken inside me since I was fifteen years old. Disability does not make a concrete appearance in the music, nor the score, nor the various processes and methods I used to compose it. But it is engrained in the work by the quality of

being engrained in me, and acknowledging my disability—attempting to accept it, even—is the first critical step toward self-appreciation.

The wider benefit to naming disability as the third beautiful theme of the composition is the potential for increased representation. In an attempt to honour and give opportunity to someone like me (a disabled female musician), my soloist for the piece’s premiere, Connie Goetz, was exactly that. Without connecting disability to the work’s other conceptual themes and being subsequently supported by the SSHRC, I would not have been able to hire Connie. Drawing a connection of acceptance and beauty from the northern lights to disability allows me to celebrate the remarkable capabilities of those of us seen as less able than others.

3. Auroral Influences

On May 10, 2024, I was fortunate enough to witness a spectacular northern lights display in the Canadian Rockies. That forty-five-minute experience inspired my master’s graduating composition. I knew as I watched the spectacle that I would write a piece about it, but I had no idea that the resulting work would be so significant and important. Honouring my original inspiration as thoroughly as possible, from form to timbre to instrumentation to harmony, the aurora shaped and defined essentially every aspect of the piece.

3.1. Open Form

Because the human eye needs light to see much colour, the vibrancy of the dim aurora is picked up more accurately by a camera than by our cone cells. Due to this, and to attempt to capture the wonder of the moment, I took twenty-five photos during the geomagnetic

show.⁷ At some point, I accidentally duplicated one of the photos, which slightly altered its hues; I did not notice the mistake until partway through the compositional process. For the remainder of this paper, I will be referring to twenty-six photos and twenty-six short corresponding movements, which are arbitrarily labelled A-Z following the chronological order of the photos.

My first concept for the work was to represent the entire remarkable experience in music through a direct parametric translation. This would have involved studying the movement of the aurora, the shifting of brightness, and the blending of colours over time. At the time of witnessing the spectacle, however, I did not know what I would want to write, so I took pictures instead of video. When I started composing, instead of trying to evoke one long consistent event from a series of fragments, I decided to work with each photo separately. This allowed me to represent the shapes, colours, and movement in a myriad of different ways. By using the images themselves as the base material, I was able to fulfill my goal of variety as well as my original, exciting concept of sonifying the aurora itself.

The collection of photos represents the full experience. Unlike words in a poem or chapters in a novel, however, each picture is a complete and individual piece. Its place in the set is inconsequential and does not assign the image its validity. Accordingly, each movement in *Images of the Aurora Borealis* is complete and independent of the others. Another critical aspect of the photo collection is their ambiguous arrangement. The photos have chronology, but as there is no narrative or internal sequence within an event such as the northern lights, their order is irrelevant. Again, the composition follows this characteristic. As order does not

⁷ These can be seen in the background of the cover of my score and in Appendix 2.

matter, the twenty-six movements inspired by the photos may be freely reordered, omitted, or repeated at the discretion of the performers. This structure acts as a catalogue, or as a gallery, perhaps, whose rooms the performers may guide the listeners through in any order and miss or return to at will.

The only exceptions to the free restructuring of the piece are the two boundary movements. The introduction and conclusion must be placed on either temporal end of the work. Representing the night sky before the aurora with bass drones and sparkling glockenspiel and plucked piano or harp, these two movements will be discussed in detail in Section 5.1.

This type of structure, first described and discussed in depth by Umberto Eco, is called open form.⁸ Versions have existed since the Classical period with pieces such as Mozart's *Musikalisches Würfelspiel* ("Musical Dice Game"), in which hobbyist musicians roll dice to assemble a short composition from a set of precomposed measures.⁹ Modernist examples include Karlheinz Stockhausen's *Klavierstück XI*¹⁰ and Pierre Boulez's Third Piano Sonata.¹¹ Establishing some of the consequences of works with open form, Eco says:

Every performance *explains* the composition but does not *exhaust* it. Every performance makes the work an actuality, but is itself only complementary to all possible other performances of the work. In short, we can say that every performance offers us a complete and satisfying version of the work, but at the same

⁸ Eco, *The Open Work*.

⁹ Mozart, *Musikalisches Würfelspiel*.

¹⁰ Chang, "Klavierstück XI."

¹¹ Harbinson, "Performer Indeterminacy."

time makes it incomplete for us, because it cannot simultaneously give all the other artistic solutions which the work may admit.¹²

He also states, "... the auditor is required to do some of this organizing and structuring of the musical discourse. He collaborates with the composer in *making* the composition."¹³ These two quotes summarize the two most important aspects of open form for *Images of the Aurora Borealis*: that each organization of movements is valid and complete, and that putting together such an organization is a collaborative process.

Composing each movement with different methods and encouraging free performer customization has both aesthetic and practical benefits. On one hand, it creates variety, demonstrates the ethereal intangibility of the aurora borealis, and implicates others' aesthetic preferences as a feature of the composition. Just as no two northern lights displays are the same, and as the lights never make exactly the same shapes in the sky, no one's viewing of the phenomenon is identical to anybody else's. Encouraging performer choice ensures that likewise, no two performances by different ensembles will be alike; different audiences viewing different concerts will hear a different piece, just as they would see a different aurora. With approximately $2.96e28$ possible versions of the work without repeating movements, and truly infinite possibilities if movements are repeated, the chances of two ensembles randomly choosing the exact same organization are essentially zero. On the other hand, the open form allows the piece to be approachable for ensembles of different instrumental forces and technical abilities. The imposition of external aesthetics on my work

¹² Eco, *The Open Work*, 15.

¹³ Eco, *The Open Work*, 12.

does not compromise my compositional authority; it rather heightens the existing relationship between the composer as instructor and the performer as interpreter by giving the performer an additional layer of choice.

3.2. The Concerto Format and Timbre

The two main instrumental entities within a concerto—the solo and the large ensemble—are both derived from the northern lights in *Images of the Aurora Borealis*. With the solo flute’s range of extended techniques, the symphony orchestra’s infinite timbral possibilities, and the structureless genre of the concerto, the large-ensemble-soloistic format was an ideal choice for my composition.

The concerto genre has a rich history. Originating in the late 17th century, new concerti have been consistently composed for the last 300 years, from Arcangelo Corelli and Antonio Vivaldi to Julia Wolfe and Arvo Pärt. In the era of modernism and radicalism, the concerto lost its typical structural attributes, but it maintains an unironic presence in the oeuvres of 20th- and 21st-century composers, not for its ritornello or sonata formal tendencies but for its widely appealing format. Large ensembles and virtuoso performers continue to exist, and combining them continues to offer unique structural and timbral possibilities. Modern concerti are often defined by no more than the combination of ensemble and soloist(s), if as much as that.¹⁴

In the case of *Images of the Aurora Borealis*, the choice of both instrumental elements is more timbral than structural. The modern symphony orchestra has a greater variety of

¹⁴ Hutchings et al., “Concerto.”

instruments than any other standard contemporary ensemble. It can therefore portray the most colours. In contemporary language about music, timbre may be considered to be the musical equivalent to colour. Many of the words people use in descriptions of timbre derive from the sense of sight—bright, dark, or shimmering, to name a few.¹⁵ These particularly align with specific colour qualities, such as shade or hue. Colours themselves can also be metaphors for timbres, though, such as the purple and yellow used by Trevor Wye to explain tone colour in one of his pedagogical flute books.¹⁶ Extending my orchestral palette with a few select techniques for the orchestra (such as string harmonics, bowed percussion, brass mutes, and flutter-tonguing) allows for even more possible colours and the expression of the delicate differences between them. In the compositional process, each timbral hue was designed with the utmost care to suit the attributes of the section of the corresponding image associated with it. As an example, a pale greenish-grey in image S was orchestrated with flutter-tongued piccolo, flute, and bass flute; sul ponticello violins, violas, and cellos; one of each stopped horn and muted trumpet; ordinario oboe, bassoon, and clarinet; and double bass harmonics. Manipulating the instruments of the orchestra to lighten and weaken their timbres along with standard orchestration tactics of observing instrument registers and proximities mirrors the pale, apprehensive shade of grey-green this specific orchestration represents.

The solo flute, featuring a full library of extended techniques, is layered on top of the colourful orchestra. No fewer than twenty distinct techniques for the solo flute are utilized

¹⁵ Wallmark and Kendall, "Describing Sound," 18–21.

¹⁶ Wye, *Tone*, 10–12.

throughout the work.¹⁷ Amplified so that they can be heard above the orchestra, these sounds are a rainbow of their own. The catalogue of options is quadrupled by the inclusion of four total flute varieties (piccolo, C, alto, and bass) across different movements, each of which have their own timbral characteristics and aesthetic tendencies and benefits. Almost all the extended techniques may be performed on all four flute types with differing results. From air sounds to pizzicato to singing while playing, the flutes have an intimacy to their palette of extended techniques unlike that of any other wind instrument. The graceful airiness of many of these playing methods matches the ethereal delicacy of the aurora borealis. These sounds are often so subtle that they would never be heard over the orchestra, so artificial amplification is utilized to intensify the soloist's performance. By sparingly applying and positioning such amplification, I ensure that making the extended techniques louder does not compromise their soft auroral identities.

Choosing flute as the solo instrument has a few other benefits. As common of a format as the concerto is, and as popular as extended techniques have become in the 20th and 21st centuries, many concerti by contemporary composers only include extended techniques as timbral decoration rather than as fundamental material. These include (in increasing order of extended techniques) Anže Rozman's *Phoenix*, Haukur Tómasson's *Flute Concerto No. 2*, Kaija Saariaho's *L'aile du songe*, and Brian Ferneyhough's *Carceri d'invenzione II*. The necessity of amplification makes a work prioritizing flute extended techniques challenging, but *Images of the Aurora Borealis* confronts that challenge. The piece is a continuation of my research into flute techniques and their aesthetic and narrative possibilities, an

¹⁷ For a categorized complete list, refer to Appendix 1. For performance and notation information, refer to the performance instructions in the frontmatter of the score.

intensification of concepts featured in the aforementioned recent concerti, and a constant timbral reflection of the images of the aurora borealis.

3.3. Consistencies and Inconsistencies

In order to create a balance between large-scale coherence and maintained audience interest, certain musical features of the work remain constant while others are different in almost every movement. This stems from the idea that there is an infinite number of ways to represent a visual stimulus in music. Consistent parameters and materials include harmonic language, tempo, and lack of metrical pulse. Inconsistent features include instrumentation, texture, and solo flute type. Every potential parameter may be sorted into one of these two categories. A materially fragmentary structure is not very representative of the fluid, constant aurora, but it does reflect my series of discrete photos. Choosing this structural representation also offered potential for a more concrete and defensible mapping of the images, aligning with my original conception for the work.

Some of the intentionally varied elements are highly conceptual. This can go so far as to include the compositional method on a spectrum from systematic to intuitive composition, the conceptual or literal representation of the corresponding photo, and the level of strictness with regard to following the imposed consistencies. These constants, on the other hand, are straightforward. They consist of three main categories. These are the careful use of timbre; the lack of perceived metre, which is accomplished by notes starting on weak beats or fractions of beats, the use of drones, very frequent obscured attacks through the use of niente, explicit directives to performers, and a clock-based tempo; and the system of harmonic generation, whose rules, including application and pitch set, are unchangingly

imposed on every movement. All three categories were chosen as the consistent parameters for their strong aesthetic connections to the aurora.

As previously discussed, a wide variety of musical colours from orchestral combinations, ranges, techniques, and flute varieties and extended techniques are made possible with the concerto format and utilized throughout *Images of the Aurora Borealis*. The types of timbres used in different movements are highly inconsistent, making up one of the most crucial methods of variation in the work. The intentional utilization of timbre, however, is present in every movement.

The avoidance of perceived metre in the work reflects both the temporal movement of the live aurora and the spatial forms of the photographed sky. The northern lights dance to no human system of metre. Their only apparent time limit is the sunrise, which merely obscures the lights from view rather than halting their show. Likewise, there is no constant structure to their colours. The edges of patches of colour are soft, blending into adjacent shades or the night sky with inconstant rapidity, and the flickering lines have undefined edges. All of these visual tendencies inspire the lack of palpable metre.

While the northern lights have no restrictions for time and no system that they follow, the composition had to. To limit the focus on metrical pulse while maintaining practicality for large ensemble performance, I chose the simplest organization I could: 4/4 time, quarter note = 60 bpm. Only two movements break from this pattern, and both instances are to facilitate easier notation and performance of triplets.¹⁸ The other temporal limitation of the

¹⁸ Movement T is in 3/4 so that triplets do not cross the barline (metre changes would draw undesirable attention). Movement Z has metric modulations to avoid the writing of constant septuplets and metre changes around both tempo changes to maintain the correct number of beats on either side.

written piece is length. An aurora may continue for an extended period of time, or, with inconsistent strength, indefinitely. To keep the project reasonable, I decided to write enough music to last about as long as my viewing of the northern lights did. The goal of 40–50 minutes of music was divided across the photos that I took, with each photo therefore being allotted approximately 60–120 seconds (90 on average). This division was an arbitrary but necessary way to limit the amount of music that I would commit to writing. Importantly, the piece need not last only fifty minutes; with the open form, the musical representation of the aurora may very well copy the entire length of a multi-day geomagnetic storm and its resulting colourful phenomenon.

With no large-scale form to speak of, internal consistencies within the work are crucial to create a coherent piece of music. The balance of variety and constancy was one of the most important considerations for my compositional process. While the aforementioned two categories of consistency contribute to a coherent aesthetic, the third, the harmonies of the work, offer an underlying structure that gives the entire work a systematic foundation and inextricably ties every movement together.

4. Data Sonification

Data visualization refers to representing information through graphs, charts, and other visual displays. Data sonification is its auditory equivalent, using sound to depict information over time. When applied to music, its goal tends to be focused less on data transmission and more on deriving musical material from an external source, the process of which may or may not be overt, consistent, and/or reversible in the final composition. The data sonification in *Images of the Aurora Borealis* is critical as a cohesive parameter between

the movements and is present in every note of the work, but it is not reversible; the data could not be deduced from the music. While this unidirectional derivation is less true to proper data sonification, encoding the information in the music was not a critical concept for this work, and the unspecific nature of my system does not detract from its consistency, aesthetic potential, nor overall value to the piece.

The pertinent data comes from arguably the most striking feature of the aurora borealis: its colours. To create a set of musical pitches from a colour in an image required several steps. The included figures demonstrate the process with image C as an example.



Figure 1: Image C

The number of actual colours in each image, analyzed pixel-by-pixel, would be overwhelming, especially given twenty-six images to dissect. Instead, I studied the images and approximated the colour fields: the contiguous areas which contain similar colours, defined by relatively rapid gradients into adjacent colour fields. C has six. Figure 2 suggests

the boundaries of C's colour fields, but in actuality, there are no hard edges to the colour fields in any of the pictures.



Figure 2: Outlined colour fields in image C

Next, I generated an average colour by taking a sample from four points in each field. I attempted to capture an accurate depiction of the colour by choosing points in notable, substantial sections within the field as well as by choosing opposing shades within the same field. These four colours were evenly combined to create one average per field.¹⁹ This resulted in 3–7 colours for each image. Going through the process for every photo resulted in a total of 128 different colours for the entire composition.

¹⁹ This process was done by hand. The result is therefore imperfect regarding the averages and colour field approximations. However, it is also more accurate to my personal viewing of the aurora, which is ultimately the original inspiration for the composition.



Figure 3: Image C with analyzed average colours

As discussed in Section 3.2, colour can often be instinctively analogous to timbre. Unlike many other musical parameters, timbre has very little temporal dimension, and its resistance to objective description aligns well with the subjectivity of colour, which can only be described with any specificity through comparisons.²⁰ Despite their resistance to verbal capture, very subtle differences between colours and timbres are sensorially distinguishable. There are just as many timbres as there are colours. As previously discussed, I captured the shades in the images through instruments in the orchestra, but this was a subjective technique rather than an analytical one—an additional layer to the representation of colour, not the foundation. To create the mapping that would give a consistent framework to the

²⁰ Wallmark and Kendall, “Describing Sound.”

composition, I wanted to find an objective system whose results were invariable but which also left room for substantial creativity and interpretation.

To convert the colours into workable, numerical data, I examined their composition. Colours in RGB format have three parameters—red, green, and blue—which each have a value from 0–255. This three-part combination, unique to each colour that can possibly be displayed in this common digital format, may be expressed using a six-digit number called a hexadecimal code (see Figure 4). The number of necessary digits to describe each shade is limited to six by using base 16, in which the numbers 10–15 are represented by letters A–F. I therefore had sixteen unique numbers to universally convert into usable musical data. There were multiple musical parameters I could have applied this data to, but the one I settled on felt comparable to how the RGB colours combine variables to create one composite shade: harmony.

I assigned each of the six digits in each hex code to a pitch. Choosing the correlation involved several challenges. With sixteen unique digits and twelve chromatic notes, I would have to either designate register or include microtones in order to ensure every number corresponded to a unique note, which would be required if I wanted to be able to derive the hex codes back from the harmonies. This, however, seemed unnecessary; the function of my data sonification was, after all, art. I rejected the idea of register assignment to allow for complete freedom in orchestrating the harmonies, and I rejected the idea of microtones to keep the work from being prohibitively challenging for the orchestra (though microtones do appear, particularly in the part of the solo flute, as extended techniques for timbral shading). I therefore had twelve possible unique pitches to choose from.

A	8B5AA0	876170	709C66	25223C		
B	1B132C	6B925F	938487	7D4B5B	88489C	1F1B2E
C	171428	7BB466	A1566F	939088	A14A9F	814095
D	5B954E	9C5573	64347D	090811	B855A6	948E87
E	030509	3A5944	673C5A	827A71	B3ABC4	
F	364F44	715679	8A839C	8EA195	40614E	
G	6A8C6D	98959C	714F75	8D59C4	2C374A	496E62
H	BAB5D6	5B3E64	7D76A7	4A5B5A		
I	587566	817884	91679C	564376	1E182C	
J	819D58	395247	8C7889	AC777B		
K	596463	594A72	AA79A3	465E5E		
L	A46692	648063	855A98			
M	3E5E4E	554C61	A78082	5C6753	182221	
N	291D31	874E54	6A785A	884F7E		
O	2B1F39	2C2533	7A4C52	71496A	7B866B	
P	97C666	250C32	86394F	331536	201726	
Q	66705C	A2B970	6F3758	8F515E	3D2D42	271037 361D36
R	1B0F27	3C1D35	A563AF	979499		
S	130721	521D2F	81907B	69486F	863D5D	6E7358
T	41444E	080512	707865	8C4669	602B66	
U	524D49	8F907E	7A406C	AE4078	481434	CB5A8E
V	52195F	894070	724350	757B65	81806F	
W	915EA0	737F63	59816B	0E151B		
X	211C34	7B9861	79A786	88487C	69564B	
Y	493263	904F7A	91A476	344740		
Z	1B1625	636E64	84B37D	6A3664	9E79AC	

Figure 4: All hex codes, organized by movement and including corresponding colours

To connect the hex codes to notes, I had to assign a specific pitch class to each digit in base 16. Because six of these values are represented by the letters A–F, I allowed those to correspond to their equivalent pitches. This left the numbers 0–9 to be mapped. Initially, I experimented with a ten-note chromatic set and a different diatonic scale for four different categories of colour (purple, pink, green, and grey). Ultimately, I moved away from both; the former seemed too dissonant for my preference, and the latter’s organization of the colours flattened their individual nuances. I decided to represent the colours’ affects through orchestration and timbre instead. With colour aesthetic designated to a non-systematic parameter, I returned turned to the plan of using one system to map all colours to pitch (Figure 5). In this, the diatonic set of A Aeolian is listed for digits 0–6, and then the notes A, C and G are repeated for 7–9. Because the hexadecimal digits A–F were already converted directly into musical pitches, G was the only note not already represented twice, and A and C were chosen to be the two notes with three instances each to encourage an ambiguous sense of tonality. This system, applied to all 128 hexadecimal colour codes, resulted in the harmonies shown in Figure 6.²¹

I also restricted the chord inversion of each harmony. Almost all of the colour-derived harmonies included repeated notes. In order to reflect the importance of certain notes over others within each harmony, I designated the most common note in each harmony as the bass. In a tie, notes from the A–F set would win, and if there was still a tie, I would choose which bass to write. I could have imposed further restrictions, such as pri-

0	A
1	B
2	C
3	D
4	E
5	F
6	G
7	A
8	C
9	G

Figure 5: Diatonic pitch mapping system

²¹ The capital letters in the chords refer to the notes which were drawn directly from the hex code letters.

A	cBfAAa	cagbaa	aagCgg	cfccdC		
B	bBbdcC	gBgcfF	gdceca	aDeBfB	ccecgC	bFbBcE
C	babecc	aBBegg	AbfggF	gdgacc	AbeAgF	cbeagf
D	fBgfeE	gCffad	gedeaD	agacbb	BcffAg	gecEca
E	adafag	dAfgee	gadCfA	ccaAcb	BdABCe	
F	dgeFee	abfgag	cAc dgC	cEAbgf	eagbeE	
G	gAcCgD	gcgfgC	abeFaf	cDfgCe	cCdaeA	eggEgc
H	BABfDg	fBdEge	aDagAa	eAfBfA		
I	fcaf gg	cbacce	gbgagC	fgecag	bEbccC	
J	cbgDfc	dgfcea	cCaccg	ACaaaB		
K	fggedd	fgeAac	AAagAd	egfEfE		
L	Aegggc	gecagd	cffAgc			
M	dEfEeE	ffeCgb	Aacacc	fCgafd	bccccb	
N	cgbDdb	caeEfe	gAacfA	cceFaE		
O	cBbFdg	cCcfdd	aAeCfc	abeggA	aBcggB	
P	gaCggg	cfaCdc	cgdgeF	ddbfgd	cabacg	
Q	ggaafC	AcBgaa	fFdafc	cFfbfE	dDcDec	cabada dgbDdg
R	bBaFca	dCbDdf	AfgdAF	gagegg		
S	bdaacb	fc bDcF	cbgaaB	ggecgF	cgdDfD	gEadfc
T	ebeeeE	acafbc	aaacgf	cCeggg	gacBgg	
U	fceDeg	cFgaaE	aAeagC	AEeaaC	ecbede	CBfAcE
V	fc b g f F	cgeaaa	acedfa	afaBgf	cbcagF	
W	gbfEAa	adaFgd	fgcbgB	aEbfbB		
X	cbbCde	aBgcbg	agAacg	ccecaC	ggfgeB	
Y	egdcgd	gaeFaA	gbAeag	deaeaa		
Z	bBbgcf	gdgEge	ceBdaD	gAdgge	gEagAC	

Figure 6: All harmonies, organized by movement and including corresponding colours

oritizing the second-most common note in each harmony or following the order of pitches, but for the sake of compositional freedom and artistry, I left all other decisions free to be made as needed for each harmony's appearance(s) in the work.

To adhere to the modular structure of the work, each harmony is used only in the movement corresponding to the photo it is derived from, and, inversely, each movement uses only the pitches within its harmonies. The presence of every note in each harmony within every given movement is an uncompromising feature of the work, even as the temporal, spatial, and timbral applications of the harmonies differ from movement to movement. The following section illuminates a few of these approaches.

5. Analysis of Selected Movements

5.1. Introduction and Conclusion

Two movements in the work are not associated with images, but these, too, follow the colour sonification system. The introduction and conclusion of the piece, designated as the first and last movements played, respectively, evoke the night sky before and after the aurora. They are both dominated by a drone in the depths of the orchestra's range. While the timbre undergoes gradual shifts, the pitch never strays from A1 or A2. Even the cello's glissando to and from B $\flat$ acts only to complexify the timbre, not as harmony. *Senza vibrato* markings keep the note still. This drone, representing the eternity of space, takes its pitch from the colour black, hex code #000000. The inverse of the drone comes in the musical representation of stars. High, sparse, and brilliant, these Fs on glockenspiel and pizzicato piano or harp punctuate the inky darkness of the double basses and low winds. Similar to the drone, these

aural stars draw their pitch from the colour white, hex code #FFFFFF, and complete the binary image of the night sky.

With an indeterminate structure for the inner movements of the work, the conclusion needed a strong formal connection to the introduction in order to signal the end of the piece. A direct repetition could have worked but for the fact that internal movements are permitted to be repeated, so recurring material may be present anywhere throughout the work. Rather than repeat the introduction, therefore, the conclusion mirrors it. The palindrome offers a kind of return of material that is not found within or between any other movements and cannot be created through ordering and repeating image-based movements under my set guidelines. The reflection of the introduction represents the night sky after the aurora has faded away: the same as it has always been, but also, somehow, perceptibly different thanks to the magic we have just witnessed. In addition, the palindrome hearkens back to my previous large-ensemble work, *Fairy Squall*, drawing a throughline of reflective forms across my compositional practice.

Both musical elements of the introduction and conclusion—the night sky’s drone and the stars’ pointillism—come up throughout the inner movements. Although we focus on the strange, beautiful colours of the aurora, the night sky is ubiquitous before, after, behind, and around the shimmering shades. The recurrence of its two textural motifs within many of movements A–Z demonstrates this omnipresence, as well as offering the work a material consistency that may be easier to notice and grasp for an audience than the parametric constancies discussed in Section 3.3. The necessity of these frequent deep drones rationalizes my division of the double basses into two sections. 21 out of the 26 inner movements start or end with a low, static drone representing the void, and 14 include a

pointillistic texture depicting the stars. While these two features are somewhat less pervasive than those timbral, metrical, and harmonic ones discussed previously, their salience brings them to the forefront of perceptible links between the movements.

5.2. Movement B

One movement that exemplifies the use of these two material elements is B. The movement begins with a drone in bass clarinet, contrabassoon, bowed marimba, and solo double bass, representing the deep violet in the upper corners of the photo. Simultaneously, to imitate the stars that decorate the dark sky and peek through the aurora's curtains, the soloist performs key clicks on piccolo. These are blended with a multifunctional set of harmonies, a systematic and mathematical structure, and colourful orchestration. All of the various features of movement B contribute to the ways in which it is unique, the quality of which combines with B's more straightforward characteristics to connect it to and simultaneously distinguish it from all the other movements.

Several features of the photo associated with movement B lend themselves to systematization. One of these is the designated harmonies. The ordering shown in Figure 7 is almost entirely derived from the photo, following the layers of colour from top to bottom. Two aspects of this progression immediately stand out. Firstly, the number of notes in the chords is symmetrical, increasing to two five-note chords in the centre and decreasing one

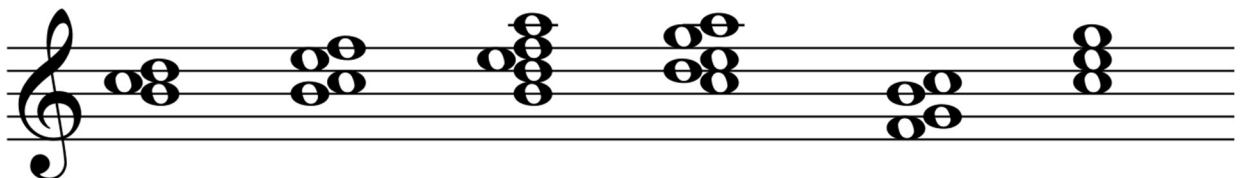


Figure 7: Harmonic progression for movement B

note at a time to trichords on either end. Secondly, the harmonies themselves seem to imply a resolution from dissonance to consonance under the theoretical bounds of functional harmony. The starting cluster leads to a pair of minor seconds, which then move to two ambiguous seventh-type chords with added notes. The penultimate harmony reads as a dominant seventh in C major with an added fourth, and the final chord is a root-position C major triad. The only harmony that was shifted from its original photographic position is that important C major harmony (corresponding to the purple layer) to strengthen the dissonance-to-consonance progression which was already present in the other five chords. When placing the final harmony, I also considered Krzysztof Penderecki's *Polymorphia* as a potential formal inspiration thanks to its comparable extreme dissonance followed by a C major conclusion, although my movement did end up straying away from the idea of sudden resolution.



Figure 8: Image B

These six harmonies were evenly spaced across the 24-measure movement, and an additional process was applied to them. The extra systematic layer was derived from the lines of varying colour intensity in the photo. Along with the horizontal colour fields, there is an apparent vertical sectioning of alternating more and less saturation that is consistent across all four of the auroral colours, stretching from the sky to the silhouette of the trees (see Figure 8). For movement B, I did not want to change the orchestration within each colour. Instead, I represented these sharp changes in brightness with dynamics.

In order to be accurate with the positions of the volume changes—taking away compositional choice would give the result a more natural rhythm—I measured the actual colour shifts in the image. This data was then converted to sum to 24 (measures), and the numbers were approximated to musically appropriate fractions (in this case, eighths).²² Figure 9, a working document for the composition of the movement, shows the decimals and their resulting fractional equivalents. Sections of lightness result in a *mp* dynamic, while darker sections are represented by *pp*. These changes are sudden, following the relatively stark shifts in intensity in the image and offering aesthetic variance from the slow transitions and avoidance of rhythm in many other movements. Combining the two predetermined systems results in the compositional plan shown in Figure 10. The changes in volume are supported by the addition of instruments during the louder moments of the movement.

²² This process was used in several movements, but the set of fractions that the decimals were converted to changed depending on the intended complexity and focus on rhythm in each movement. For example, while B only uses eighths of measures, P, the cadenza, uses fractions with denominators divisible by 2, 3, 5, and 7, all the way down to 1/24 of a measure.



Figure 9: Image B with measurements and analyzed colours

Figure 10: Consolidated compositional plan for B

A more intuitive compositional element of B is the orchestration. Like in many other movements, I orchestrated the harmonies to reflect the colours. There are a few tendencies

that come up often (but not always) in the movements that focus on orchestral colour. B is not one of the exceptions. Dark colours, usually drawn from patches of night sky or the aurora immediately bordering it, tend to be represented by low drones, as discussed in the previous section. Pale shades tending toward grey are given inharmonic timbres, such as air noise, flutter-tonguing, and string tremolos with *molto sul ponticello* in movement B, mm. 13–16.

Shades of pink and purple are often warmed with brass instruments, including horns in mm. 9–11 and a solo trombone in mm. 21–24. Double reeds are difficult instruments to use for this work because of their inability to transition smoothly from air to pitch and vice versa, but I do tend to utilize oboe on bright shades of green, mm. 16–20 in movement B. The listed orchestrational tendencies crop up across the work, but they are present with enough variation to keep them from becoming stale. Rather, their subtle familiarity and recontextualization supports the formation of an implicit mapping of colour to timbre in my own personal aesthetic view—an opposing yet similar concept to the mapping of colour to harmony, which is a critical driving force behind the composition.

The greatest challenge in the composition of movement B was keeping the focus on the intensity shifts rather than the harmony changes, which, following the photo, are comparatively gradual. A switch in harmony and orchestration, however, tends to be much more noticeable than a change created mostly by dynamic level. I therefore had to be cautious with the rate of my orchestration changes, bringing in instruments with crescendi from niente before the moment where the harmony was to switch (see, for example, horns in m. 12). This crossfading had the added benefit of reducing the sense of a perfect authentic cadence in the final change of harmony, which in the first draft of the movement seemed cliché.

The final significant feature of the movement is found in the solo line. Another parameter within the piece that is intentionally varied between movements is the relationship between the solo flute and orchestra. B is one of the movements which has two separate layers, so disjunct, in this case, to be separable. The flutist, playing piccolo here, is solely responsible for the representation of the stars. The notes they play follow the

orchestra's harmonic progression, but the similarities end there. The solo piccolo is given proportional notation within the grid of the barlines. Its dynamics and articulations serve musicality of its own line rather than to align with what the orchestra is playing. The soloist's material, star-like, consists entirely of key clicks. On piccolo, these have minimal resonance; the resulting inharmonicity follows my preference for giving whiteish colours a minimum of pitch. With proper amplification, the subtlety of these key clicks will not be lost behind the orchestra. The soloist's line, distinct and unique, the only one in the composition to exclusively feature key clicks, is a contrasting complement to the material given to the orchestra.

B's unique combination of features—intensity systematization, sharp dynamic contrasts, quasi-functional resolution, simultaneous unified harmonies, intuitive colourful orchestration, separate layers of soloist and orchestra, and narrow focus on one extended flute technique for the soloist—demonstrate just one of over two dozen ways of representing the aurora borealis through music. The latter two are also found in an intuitively composed movement: H.

5.3. Movement H

H is written for alto flute and strings, and it is the most poetic of all the movements—literally.

Its text is as follows:

Beauty.

Fluttering lights mar the night sky, brightening the sleeping
world, blotting out the stars.

Shapes form and fade, kaleidoscopic, mosaic feathers and
prismatic wings, flickering, ungraspable.

Unearthly hues of peacock and flamingo obstruct constellations
above.

The Milky Way is concealed by thick sheets of light, shifting and
shuddering.

This unusual phenomenon that disturbs the northern sky:
the aurora is abnormal; therefore, it is ugly.

This poem, which I wrote for movement H, states the opposite of the theme of the work. Of the three representative concepts linked by strangeness and beauty, the aurora borealis is by far the easiest to call beautiful. In this poem, I use negative language to describe it, calling it disturbing and abnormal, culminating with the explicit contradiction of the beauty that the entire piece is about. In its negativity, the text represents the feelings that people may carry about the other two conceptual themes of the work—extended techniques and disability—and, by linking them instead to the broadly appreciated aurora, attempts to render such feelings absurd. Given the established connection between the three fundamental concepts of the work, the denial of beauty in this poem is intended to disquiet the listener and to disrupt their preconceived opinions.

Along with the negative descriptions of the aurora, the poem is also dense with words related to birds. This intentional metaphoric connection is thanks to the associated photo for the movement (see Figure 11). The bird-like shape in the very centre of the image inspired the textural and poetic components of this movement.

The bird itself is represented by the solo flute. Following my decision to primarily represent white or near-white colours with inharmonic timbres, the flute's primary extended technique for the movement is whispering across the flute. The soloist reads out the text, which is again notated with proportional notation between the barlines. Keeping the flute in

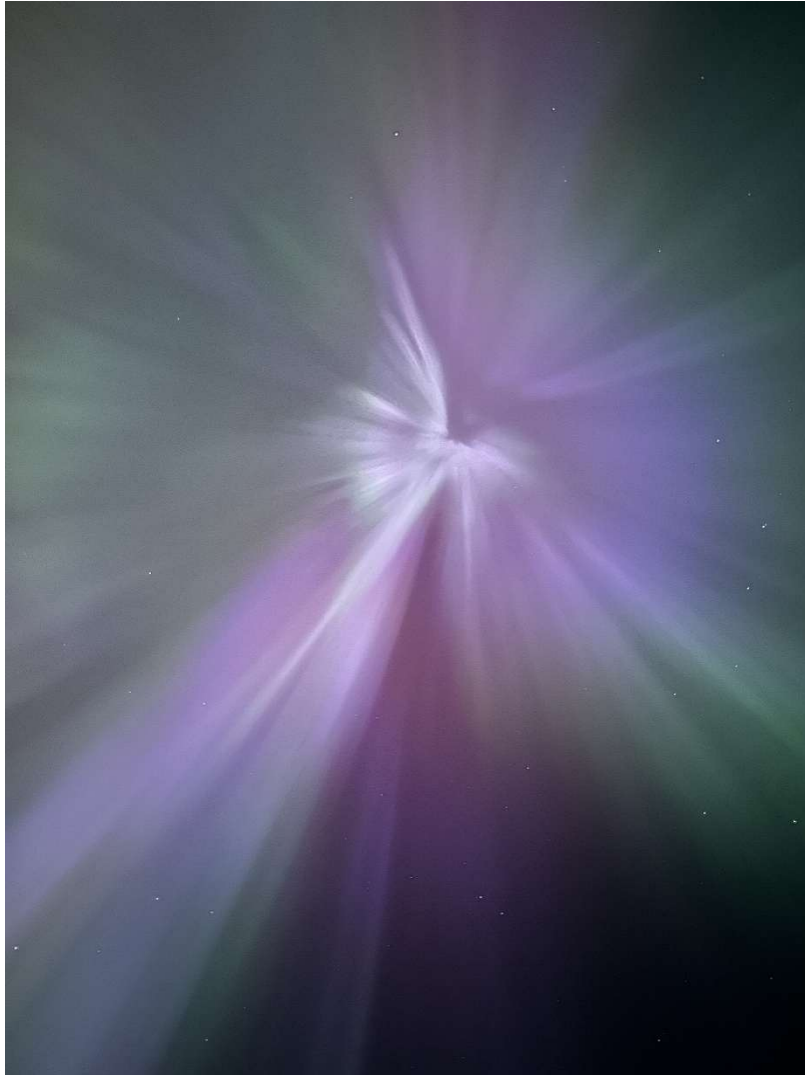


Figure 11: Image H

playing position, they finger the pitches according to their designated harmony, BDFGA. Whispering across the embouchure hole of the flute creates an inconsistent blend of pitch (which matches the fingered note), air, and near-silence. Different fingerings tend to resonate different consonants and vowels in different ways, and this physical tendency influenced the notes I chose to set with each syllable. Also decorating the text are trills, creating a fluttery effect, and key clicks, which mimic and accent certain syllables and in one moment (m. 17)

clarify the inversion of the flute's single harmony by resonating the bass note an octave lower.²³

Unlike in movement B, in H, the harmonies are assigned to each instrument and therefore distinguished by timbre and voice rather than time. No instrument ever plays more than one specific harmony. The remaining three harmonies are divided between the strings: the violins take the woody green on the outskirts of the image (ABEF), the violas are responsible for the faint purple bottom-left and right of the bird (ADG), and the low strings take the deep pink bounding the section of black (EFGBD), which in this movement is not accounted for. The strings' texture, dynamics, and form represent the bird metaphor on three different levels.

Reflecting the striking wings in the photo, H attempts to sonically represent wingbeats. The textural level does so on the smallest scale. All of the strings throughout the movement, whenever they are present, play a tremolo between an ordinary note and a harmonic. For the upper strings and violoncelli, this is between a regular pitch and its fourth-partial artificial harmonic two octaves higher; the double basses have natural harmonics with two different pitch classes in their tremolo. The rapid alternation of notes multiple octaves apart and with very different timbral characteristics results in a unique susurrant reminiscent of the fluttering of a hummingbird's wingbeats.

On a larger level, the strings' dynamics also suggest fluctuation. Each set of strings assigned a single harmony follows the same dynamic swells. All of the upper strings are in

²³ When the flute's embouchure hole is covered, extended techniques performed will resonate a major seventh lower than the fingered pitch. To reach B₂, the flutist fingers B_{b3} and blocks the embouchure hole with their lips before performing the key clicks. The size of the alto flute and the nature of that particular fingering lend themselves to a particularly strong pitched response.

two- or three-part divisi, so this consistency partially reunites them. Between the three groups, however, the dynamics are never the same. Swells of varying lengths and intensities peak at different times out of the base *ppp* dynamic level. Sometimes, like in m. 17, swells alternate between two different groups, and on other occasions, they cascade down the register, one group after another, as in m. 22. These swells, whether in association with others or acting as independent foreground accents, can be as short as a beat (m. 11) or as long as two bars (mm. 9–10). Less persistent than the tremolo fluttering but more rapid than the third symbolic layer, these pulsing dynamics, too, represent the flapping of wings.

Finally, the presence and silence of certain string groups suggests a natural oscillatory fluidity. Unlike with the tremolos and dynamics, the parts within each group of strings are layered to promote gradual, smooth transitions into and out of silence. The interaction of the resulting areas of noise and silence creates a flowing, breath-like registral contour that is drawn into the score itself (see Figure 12). This flow of instrumental presence could depict the path a small bird takes through the air, or the great wingbeats of some luminous feathered being: the alternating absence and increase of air pressure above and below its flapping wings.

Figure 12: Excerpt from movement H showing registral contour of silence and sound

5.4. Movement G

Another movement that deals with the visual positioning of elements in the score is G. Inspired by the unique shapes and flow of the colours in its image, G is second in systematic complexity only to P, the flute cadenza (see Appendix 2 for a brief summary of P's mathematical compositional scheme). Unlike the one-dimensional system of movement B, which only applies its mapping to the temporal axis, movement G applies its photo to the score using both planar photographic dimensions.

The goal of G was to represent the physical photo on the score. To do so first required a grid (see Figure 13). This sectioning divides the image into twenty horizontal segments, corresponding directly to the twenty measures of the movement, and twenty-five vertical segments, corresponding to the non-percussion/keyboard instruments of the orchestra (the solo flute is also excluded). Not every rectangle is identical in height; in order to account for

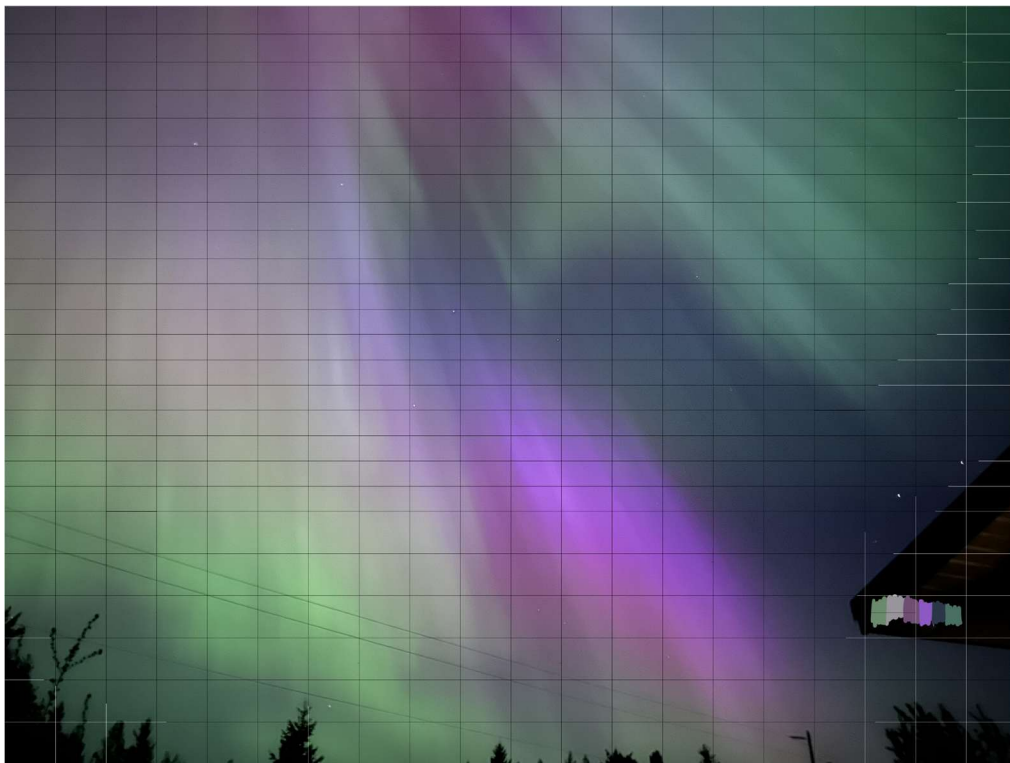


Figure 13: Image G with grid overlay

the higher number of brass and woodwind parts, each of the three included instrumental sections is given one third of the vertical space of the photo, and each third is divided by the number of parts within each section. This results in the system shown in Figure 14.²⁴

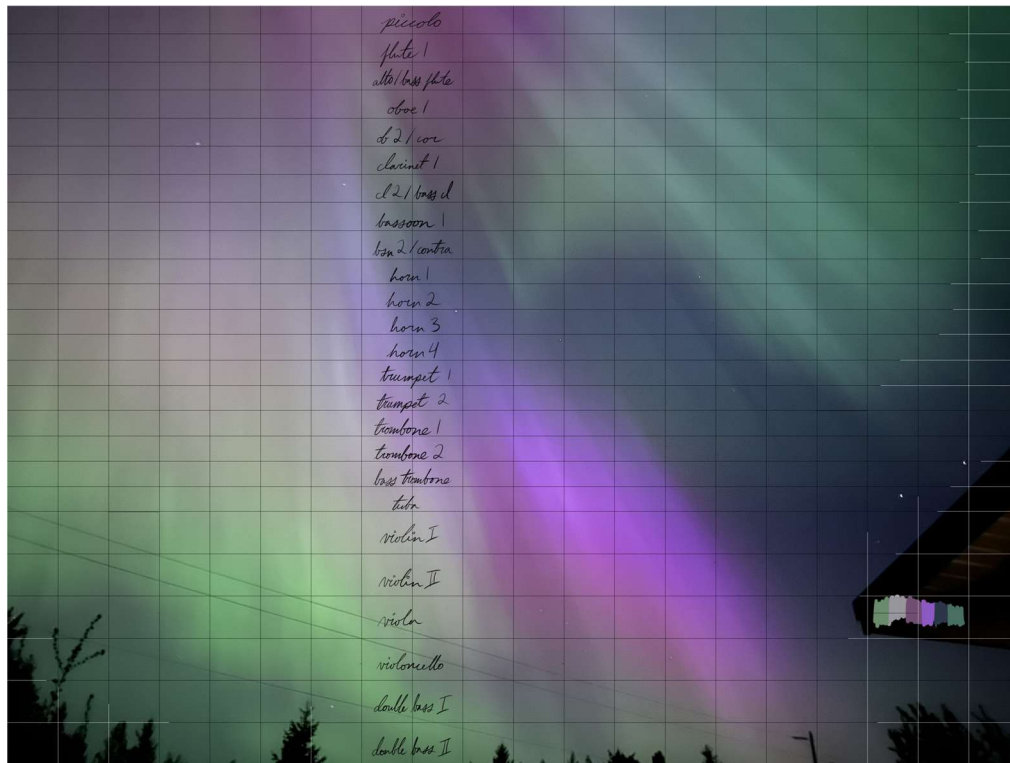


Figure 14: Image G with grid overlay and instrument plan

The next step in the compositional process was to map out the colours and their associated harmonies within the given grid. As the six shades are averages, not every section of the photo perfectly matches one of them. Rather than choose the closest option for every single pixel, I decided to allow the movement (and the performers) to rest in places where

²⁴ When writing the movement, the piccolo part was the top line of the score. The score and music have been corrected to represent the proper order of instruments, but Figures 16 and 17, as the documents I used to compose the movement, still reflect the earlier score order.

the photo's colour did not closely match one of the six options. Shaping the edges of the colours to the grid resulted in Figure 15.

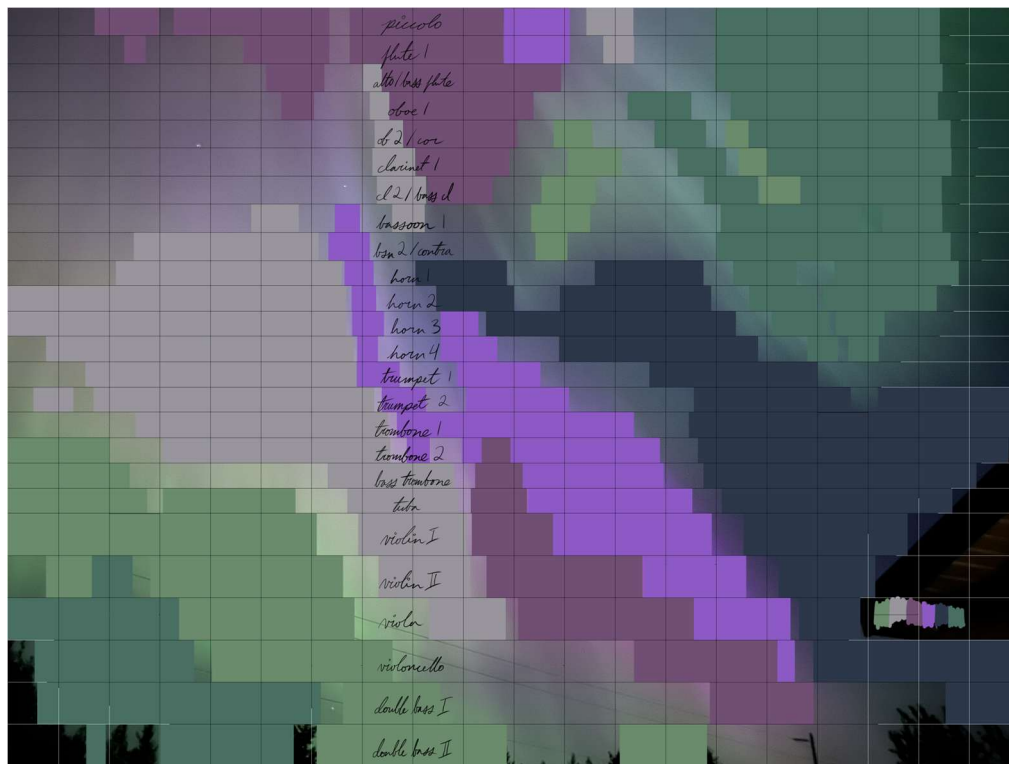


Figure 15: Image G with grid coloured for compositional plan

Assigning the colours to specific instruments severely inhibited my orchestrational flexibility. Given that the intent of the movement was accurate, proportional, and evocative representation of the photograph, this instrument designation posed a challenge. The general patterns I had formed of light greys being inharmonic and vibrant pinks using brass, along with other tendencies discussed in Section 5.2, were rendered unworkable by the strict assignment of certain colours to certain instruments. The system resulted, for example, in the pale grey being assigned to horns 2 and 3 at the start of the work and the four-note harmony derived from dark pink needing to be covered by just flute 1 and piccolo for its first appearance. Additionally, with the same colours appearing across the vertical space, I was unable to reliably associate any given shade with a certain instrumental timbre as I was

inclined to for other movements. The solution was the deliberate and constant control of timbre and texture. By forming connections across instrumental groups through the use of extended techniques, metaphorical language, and textural or contour-based motifs, I was able to generate familiarity between vastly different instruments and create the continual sound-colour associations I wanted. These associations are listed in Figure 16.

Colour	Harmony	Association
Pale Grey	GCF	Trills blended with air sounds and airy timbres
Light Green	CDGA	GADC motif and tremolos; thin, unclear timbres (see Figure 17)
Dark Green	GCE	Long tones: murky, distant, faint to rich, dark
Dark Pink	FABE	One-octave melodic arch (see Figure 18)
Bright Pink	CDEFG	Rich timbres, usually ordinario, long tones
Dark Blue-Grey	ACDE	Still drones

Figure 16: Colour-sound associations for movement G

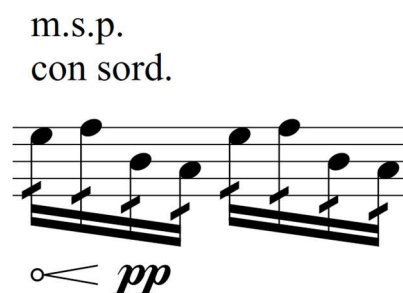


Figure 17: Excerpt of light green motif
from movement G (bass clef)

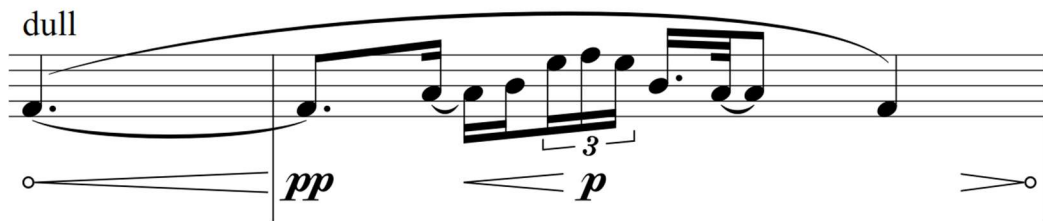


Figure 18: Dark pink melodic arch excerpt from movement G (treble clef)

Variability, deviation, and ambiguity within and between the musical colour associations account for fluctuations in the colours in the photo. As an example, the patch of light green in mm. 11–12 is realized by cor anglais, the clarinets, and the bassoons. Clarinet 1 plays the established sixteenth-note motif, flutter-tonguing to emulate the strings’ tremolo and to disrupt its timbre, and bassoon 2 plays a supporting role with a “pale, soft” timbre. The other three instruments do not strongly imply the light green shade they are meant to be evoking. This is thanks to the true colour at this point in the photo, rather than the approximation I assigned to it. In actuality, the shade lies somewhere between light grey and green. Supporting this connection are cor anglais and bass clarinet, which play trills—not far from the assigned light green tremolos, but closer to pale grey. The final instrument, bassoon 1, highlights this shade’s particular sage ambiguity with a new, unique technique: a multiphonic. At once following the light green’s tendency toward unclear timbres and also offering something new, this performative deviation combines with the material played by the other four aforementioned woodwinds to demonstrate the wide variety of colours not accounted for by the default averages and the subtle timbral confluences that can be used to imitate them.

With a rigorous compositional system, necessarily intense timbral innovation, and complex resulting texture, G is one of the most unique movements of the work. It is not free from the consistencies that tie the composition together, however. Not only do the tempo,

lack of perceived metre and harmonies follow the pre-assigned pattern, the space and star textural motifs are also present, embedded in G's material. The former finds itself where the darkest shades are present in the deepest instruments; the latter is sprinkled across the orchestra using percussive techniques in measures corresponding to the points of light in the associated image. Even in a systematically extreme movement, constant auroral inspiration, uniqueness and familiarity, and personal voice all remain crucial musical features.

6. Conclusion

First conceived of on one beautiful night almost two years ago, *Images of the Aurora Borealis* uses its auroral catalyst as inspiration for every aspect of the composition. It inspired the open form of the work through its lasting impression in discrete photographs. It provided the images that I used for critical objective data as well as subjective inspiration. Its characteristics allowed me to connect it to two other important and relevant conceptual themes, which in turn gave the piece crucial relevance, individuality, and added complexity. The northern lights do far more than title the work; they guided my hand through every stage of composing it.

At its heart, *Images of the Aurora Borealis* is a piece about beauty. It neither claims to achieve universal, unanimous appeal nor that such a thing even exists; rather, it nears true, subjective beauty by fulfilling what I, its composer, deem personally beautiful. The piece captures, in my own view, the ethereal beauty of the northern lights through the medium of orchestral sound. The aesthetic preferences of others never guarantee their concordance with my opinion of what is or is not beautiful, but this agreement is fundamentally extraneous. *Images of the Aurora Borealis* is beautiful because I think it is.

In this, the composition also confirms the beauty of its three interconnected themes. The aurora borealis, flute extended techniques, and disability are all phenomena which may be seen as strange. *Images of the Aurora Borealis*, with its systematization, inharmonic timbres, and open form, may be viewed the same way. Like its namesake, though, it is indeed beautiful. The other conceptual themes follow the same conclusion. The composition, the aurora, the extended techniques, and the disabled are all a little strange, yes. But—in an act of self-compassion and defiance against my own darkest feelings—they are also individually, imperfectly, truly, remarkably beautiful.

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Appendix 1: List of Utilized Flute Extended Techniques

Sustained Techniques

ordinario
tremolo
flutter-tongue
harmonics
multiphonics
microtones
bisbigliando
embouchure glissandi
bamboo tones
extended high/low register

Air Sounds

air sounds
air sounds with covered embouchure hole
air sounds with flutter-tongue
half air
whistle tones
jet whistles

Percussive Techniques

key clicks
key clicks with ordinario
pizzicato

Vocal Techniques

whispering
singing and playing

For detailed information on how each of these techniques is performed and notated, please refer to my performance instructions in the frontmatter of the score.

Appendix 2: Concise Analysis of All Movements

The following appendix lists characteristics of every interior movement according to the following format. The purpose of this succinct list is for direct comparison of the unique and similar features of various movements.

Movement Title

Length

Harmonies (bass listed first; multiple possible bass notes are enclosed in brackets)

Instrumentation (doubling woodwind and percussion players are generally referred to by one instrument)

Solo Flute Type and Techniques

Summary

A

25 measures

ABCF	ABCG	GAC	CDF
------	------	-----	-----

Orchestra *without piccolo, violas, piano, double reeds*

Bass: harmonics, air sounds (regular and covered)

After a low drone opening, the orchestra pulses with alternating soft harmonies and inharmonicity created through air sounds and *sul tasto*, representing the vertical lines in the photo. Meanwhile, the solo flute derives its rhythms and whispered syllables from the precise positions of the same light, medium and dark bands.



B

24 measures

BCD	FGBC	CDEGA	BDEFA	CEG	BCEF
-----	------	-------	-------	-----	------

Orchestra *without piano*

Piccolo: key clicks

The exact positions of the vertical lines give the orchestra its rhythm; lighter sections are given an abruptly louder dynamic. The harmonies follow the horizontal stripes and move steadily from tonal dissonance to consonance. Stars are added with solo piccolo key clicks.



C

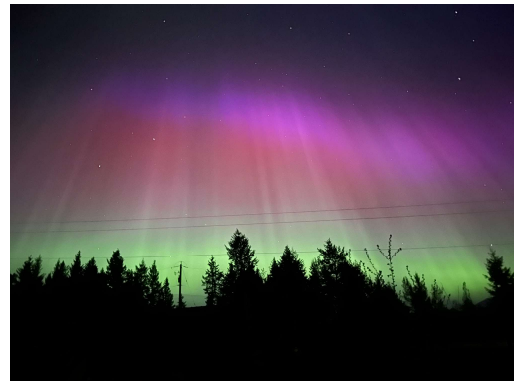
18 measures

(BC)EA	BEGA	FGAB	(CG)DA	ABEFG	(EFGABC)
--------	------	------	--------	-------	----------

Orchestra *without cor anglais, contrabassoon, percussion*
1, piano

No Solo Flute

The subtle angle of the photo's lines implies a meeting point somewhere above the upper margin of the image. C travels up the picture with the idea of increasing (but unachieved) unification designated to rhythm, which grows closer to metrical consonance and unison over the course of the movement. Harmonies shift slowly; dynamic peaks emphasize the temporal centre of each.



D

21 measures

EFGB	FGACD	DEGA	(AB)CG	FGABC	EGAC
------	-------	------	--------	-------	------

Chamber with *flute 1, alto flute, bassoon 1, horn 1, trombone 1, one solo of each string instrument*

C: ordinario, microtones, half air

Emphasizing the colour gradients in its photo, D uses solo instruments to facilitate smooth, consistent glissandi between the notes in its chords and precise control of timbre. Woodwinds suggest lighter shades with air sounds in the background.



E

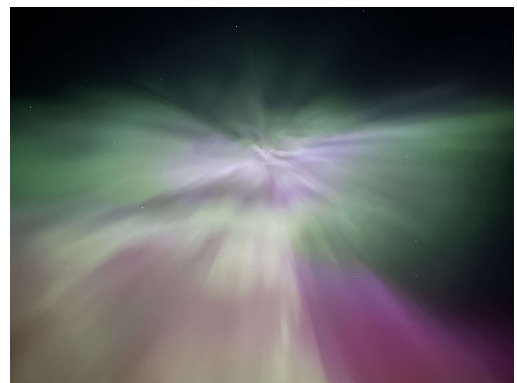
27 measures

ADFG	EFGAD	ACDFG	CAB	BCDEA
------	-------	-------	-----	-------

Woodwinds and Strings *without alto flute, violins; with glockenspiel*

C: flutter-tongue, harmonics, air (regular and covered), embouchure glissandi, ordinario, combinations thereof

E separates the image into the night sky, oppressive at the top of the photo, and the colours beneath. While the low strings maintain the same deep drone, the other instruments follow the order of colours from left to right in two layers, starting first with green and second with greyish yellow. Flute flutter-tonguing provides sonic texture representing the visual variety. Strong rhythmic entrances in woodwinds offer an intense contrast from other movements.



F

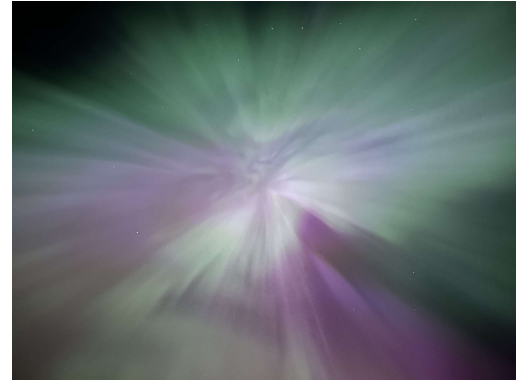
18 measures

EFGD (GA)BF CDGA (EA)BCGF EGAB

Orchestra *without timpani*

C: ordinario, embouchure glissandi, extended high register, microtones

The orchestra is given all three shades of green, which are played simultaneously and divided by register. Each register/chord group travels slowly downward through the notes of its harmony toward E, a coincidental common tone. The solo flute's microtonal glissandi move in the opposite direction and incorporate the notes of the other two colours. The *f* at the end of the orchestra's gradual crescendo and the flute's final E7 act as the bright, intense centre of the photo while also contrasting the quiet of other movements.



G

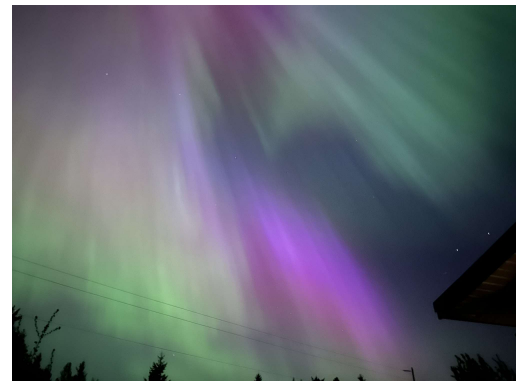
20 measures

CDGA GCF FABE CDEFG (AC)DE GCE

Woodwinds, Brass, and Strings *without piano*

No Solo Flute

Using a grid over the image, the score for G attempts to visually match the photo. Instruments play the harmonies associated with the colours they are designated according to score order and measure. The texture is dense and complex; certain instrumental layers are naturally covered by others.



H

24 measures

BDFGA

EFGBD

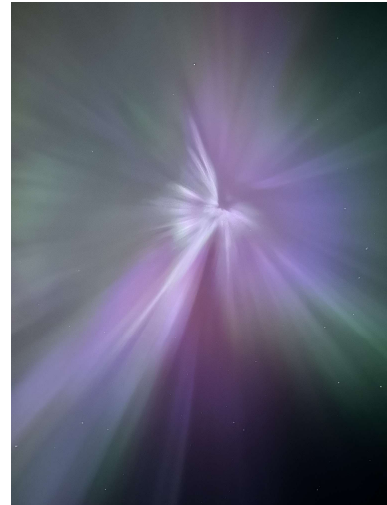
ADG

ABEF

Strings *in divisi*

Alto: whispering, key clicks

Each group of strings, assigned to one of the three darker colours, plays one tremolo between an ordinary note and a harmonic for the entire movement, creating a fluttering sound that fades in and out and swells in oscillation between the groups. The soloist whispers a poem over their instrument with the pitches assigned to the pale, bird-like shape in the centre of the image.



I

21 measures

(FG)AC

CEAB

GABC

GACEF

CEB

Woodwinds, Brass, and Percussion *without percussion 2, piano*

No Solo Flute

The wind instruments play descending glissandi with air sounds on the pitches of the various harmonies in the melody. Bowed cymbal in water and superball on timpani with glissandi provide a timbral foreground. Accidentals throughout the movement work to ensure the resulting air sound has the correct pitch inclination; the necessity of adjustment varies by instrument.



J

22 measures

CDFGB

(CDEFGA)

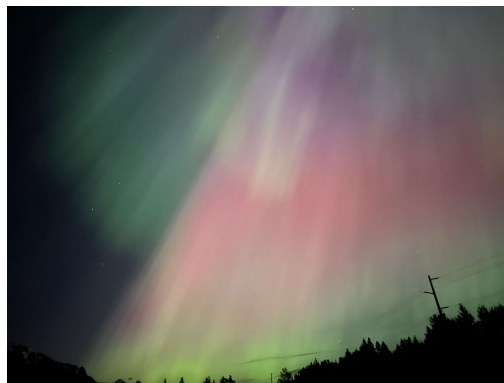
CGA

ABC

Woodwinds *with marimba*

No Solo Flute

The unusual salmon pink of J's image results in a movement ripe with rich, pure timbres. Fragments of melody in all the woodwinds carry motivic associations to the colours from which their pitches are derived. This movement was composed intuitively.



K

19 measures

GDEF

ACEFG

ADG

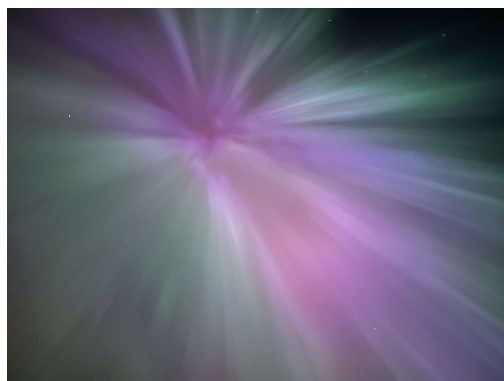
EFG

Woodwinds, Percussion, and Strings *without piano*

C: jet whistles, whistle tones

The four harmonies are placed in temporal succession.

Each is orchestrated to capture the aesthetic of its associated colour with timbre as well as with the assigned pitches, and each includes a climax, accomplished through gradual dynamic swells and intensified orchestration. Each apex is strengthened and shaped by a lengthened jet whistle in the solo flute. The large-scale form resulting from these multiple climaxes of different dynamic peaks follows the same cusp-like contour.



L

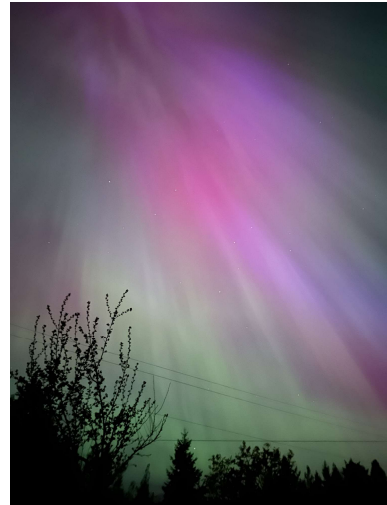
25 measures

GACE GACDE (CF)GA

Woodwinds and Strings *without double basses; with trumpets, vibraphone*

Piccolo: flutter-tongue, air sounds (covered), embouchure glissandi, ordinario, key clicks with ordinario, combinations thereof

Each of the groups of orchestral instruments playing in L do not drastically change their material. The resulting timbral layers fade in and out, under and on top of each other for an impression of masking. The piccolo features a more distinctive and varied musical line, but it, too, participates in the effect of layering.



M

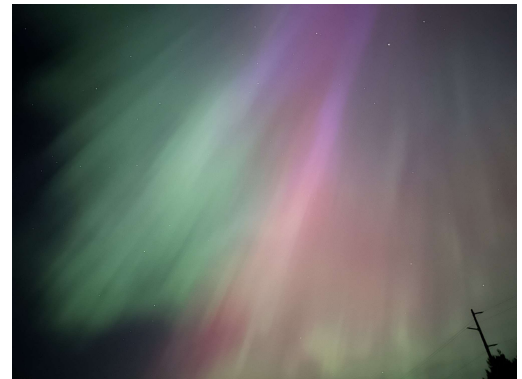
20 measures

EFD FGBCE AC FGACD CB

Chamber *with flute 1, piccolo, bass flute*

Alto: ordinario, bamboo tones, multiphonics, embouchure glissandi, pizzicato, bisbigliando

Shrinking the timbral palette to what is possible with only the four common flute types, M makes deliberate use of bamboo tones, vibrato, air sounds, and register to create vivid timbral orchestrations of the colours with only a flute quartet.



N

19 measures

DGBC EFAC ACFG EFAC

Orchestra *without percussion 2, piano*

C: ordinario, microtones, embouchure glissandi, flutter-tongue

N incorporates a sense of tension and release as each harmony transitions into the next using dissonance and consonance, which in this case are present as microtonality and 12-tet, respectively. Colourful orchestration is featured.



O

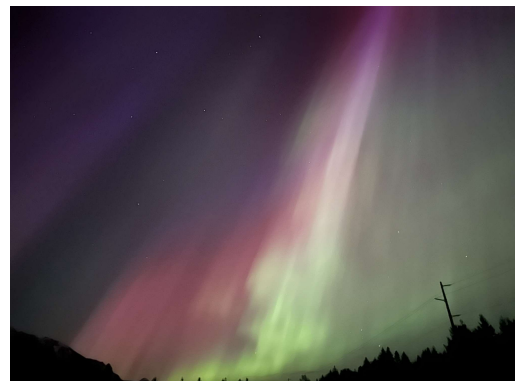
21 measures

BCDFG CDF (AC)EF ABEG BCGA

Percussion *with piano*

Bass: ordinario, extended low register

Percussion techniques are layered with the orchestra in many other movements; in O, they are isolated. The timbres of bowed marimba and vibraphone, superbass on timpani, and half-muted piano are combined with bass flute in all three of its distinct registers.



P

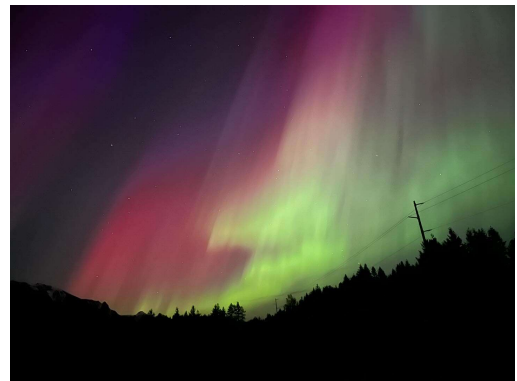
83 measures of changing metre (26 converted)

GAC	CDFA	GCDEF	DFGB	(AC)BG
-----	------	-------	------	--------

Solo Flute Cadenza

C: all techniques

The cadenza takes the flute techniques present in all other movements and compresses them to fit into one. This mathematical process entailed determining which flute technique prevailed in every measure of the work to find how long each lasted for, dividing these lengths by 22.3413, rounding the decimals to the nearest fraction with a musically reasonable denominator (divisible by 2, 3, 5, or 7, up to 24), and adjusting the direction of certain rounded fractions to result in exactly 26 bars. The outcome required irrational time signatures to retain its precision with notational clarity.



Q

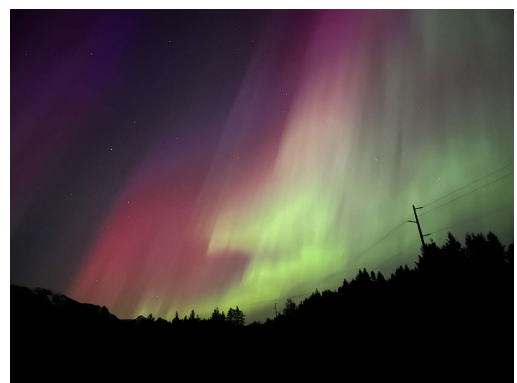
26 measures

(GA)CF	ABCG	FACD	FBCE	DEC	ABCD	DGB
--------	------	------	------	-----	------	-----

Orchestra

No Solo Flute

Where the other movements take the numeric values of the hex codes and convert them into pitch, Q also derives rhythm from this data. Each set of note lengths is assigned pitches from its harmony. The texture is monophonic.



R

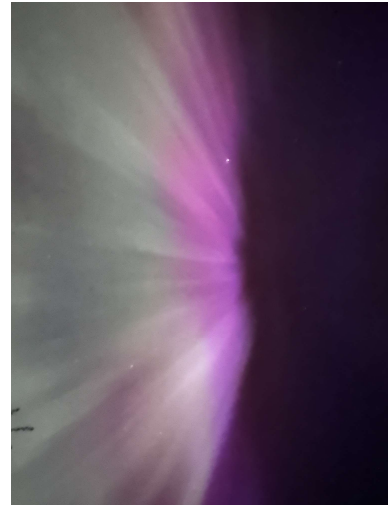
21 measures

BCFA DFBC ADFG GAE

Orchestra *without alto flute, trumpets, tenor trombones*

Bass: harmonics, flutter-tongue, embouchure glissandi, combinations thereof

R is divided into two halves with contrasting textures, timbres, and registers. The first uses high strings, piano, and woodwinds with rapid note changes for a rough texture. The second is comprised of drones in bassoons, low brass, and low strings, which are static but for necessary alternation in winds for breathing purposes. Bowed mallet percussion offers a smooth backdrop throughout.



S

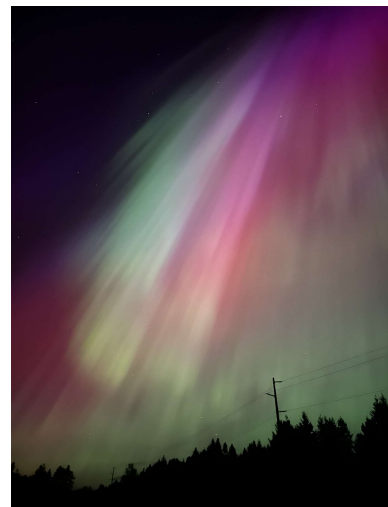
20 measures

(AB)CD FBCD BCGA GCEF DFGC EFGACD

Orchestra *without piano*

Alto: pizzicato, ordinario, flutter-tongue, air sounds (regular and covered), combinations thereof

The intense sense of direction in this photo encourages a linear form in its associated movement. Each orchestrated harmony is progressively assigned more instruments until a full *ff* tutti is reached shortly before the final bar. The solo flute alternates between ordinario, blending with the orchestra, and extended techniques, offering inharmonic and percussive sounds.



T

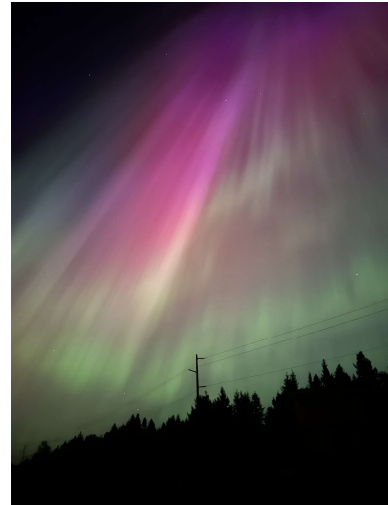
35 measures of 3/4 (26.25 in 4/4)

EB (AC)BF ACFG GCE GABC

Orchestra *without piccolo, bass clarinet, bassoons, horns*
2–4, trumpets, tuba, timpani, piano, violins

C: singing and playing, embouchure glissandi, quasi jet whistle

T explores singing while playing for the solo flute. The other instruments, a few from each section, offer soft harmonic background, pitch for the sung elements, and echoes of the soloist's melodies.



U

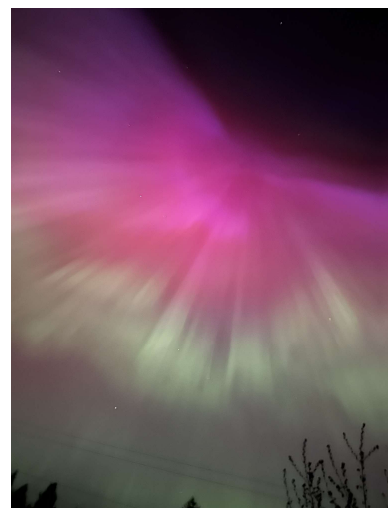
27 measures

EFGCD ACEFG ACEG ACE EBCD ECFAB

Woodwinds, Brass, and Strings *without horns, piano*

Piccolo: whistle tones, ordinario

U is bookended by long notes in the orchestra and whistle tones in the solo piccolo. In the middle, all instruments gradually ascend to a climax which quickly fades once it has been reached.



V

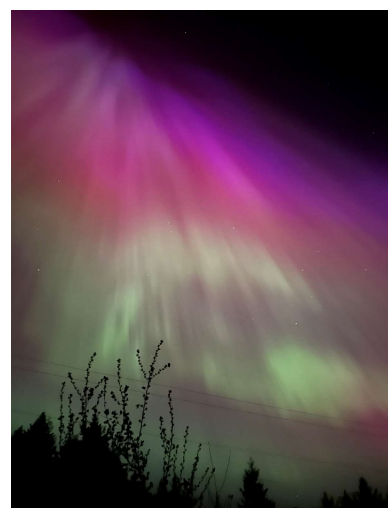
19 measures

FGBC ACEG ACDEF (FA)GB CFGAB

Brass and Strings *with piano*

No Solo Flute

The brass and strings in V act as two separate entities, each having their own pattern of swells which may or may not cover the other. Registral extremes and glissandi help to reinforce the strings.



W

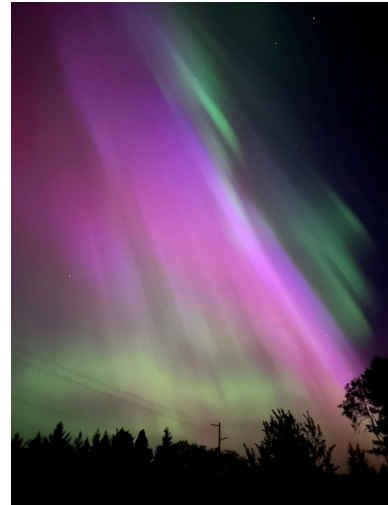
25 measures

ABEFG	(AD)FG	BCFG	BEFA
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Brass

No Solo Flute

Each brass section is assigned one of the four chords and an associated motivic pattern or melodic direction which they play throughout the movement in canon-like interaction against each other.



X

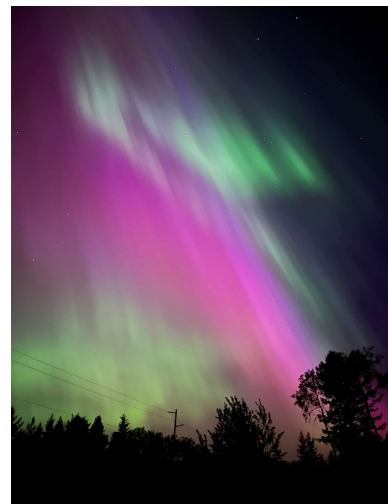
22 measures + eighth-note anacrusis

CDEB	BCGA	ACG	CEA	GBEF
------	------	-----	-----	------

Woodwinds and Strings *with piano, suspended cymbal; without cor anglais, bass clarinet, bassoons, violoncelli, double basses*

C: ordinario, harmonics

The striking colours in the image for X are represented through ordinario solo flute and piano, which alternate and converse with ascending grace note runs. In contrast to this layer, the woodwinds and strings fade in and out with trills and tremolos for a textural background to the flute's melody.



Y

22 measures

(DG)EC AEFG ABEG EAD

Orchestra *without alto flute, double reeds, timpani, piano*

Piccolo: ordinario, bamboo tones, key clicks with ordinario

Y's four distinct sections crossfade into each other. A fluttery pale green texture fades into rich pink tones, decorated by light green in the piccolo to represent the layering of those two colours in the photo. This is followed by a brief purple chord, and the movement concludes with deep rumbling in low strings and brass, decorated by more layered solo piccolo.



Z

29 measures with tempo change (22.5 converted)

BCFG GDE DEABC GADE ACEG

Flutes and Strings *without alto flute, double basses*
or Solo Flute Cadenza

C: ordinario; cadenza version requires circular breathing

Movement Z starts and ends with the darkest shades in the top left and bottom right corners of the photos, respectively, and uses the adjacent colours to transition into and out of the bright green middle section. This middle section is comprised of constant quick alternating notes that form a compound melody within and between the three flutes. The cadenza version does not trade off the melody sections with the orchestral flutes.

