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Liminal aesthetics : perspectives on harmony and timbre in the music of Olivier Messiaen, Tristan Murail, and Kaija Saariaho.

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LIMINAL AESTHETICS: PERSPECTIVES ON HARMONY AND TIMBRE IN THE MUSIC OF OLIVIER MESSIAEN, TRISTAN MURAIL, AND KAIJA SAARIAHO

By

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It has not always been an easy road, but I know I have never travelled alone…

ABSTRACT

LIMINAL AESTHETICS: PERSPECTIVES ON HARMONY AND TIMBRE IN THE MUSIC OF OLIVIER MESSIAEN, TRISTAN MURAIL, AND KAIJA SAARIAHO

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April 12, 2019

Harmony and timbre have traditionally been viewed as separate parameters by music scholars and treated as such by composers. Once timbre had been understood scientifically, however, as arising from a fundamental frequency and its overtones sounding at different amplitudes, it became desirable to replicate this structure in music. The composers associated with spectral music, a movement which first emerged in Paris in the 1970s, have enthusiastically explored this closer relationship between harmony and timbre, blurring the distinctions that once existed between these concepts. This thesis examines this new liminal relationship between harmony and timbre, asking how their closer unity has affected the aesthetic decisions made by composers in and around the spectral movement. The thesis takes a perspective which is historical and contextual, tracing this aesthetic shift through representative texts and scores by Olivier Messiaen, Tristan Murail, and Kaija Saariaho.

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INTRODUCTION

Harmony and timbre have traditionally been viewed as separate concepts by music scholars and treated as such by composers. *Grove Music Online* defines harmony as "the combining of notes simultaneously, to produce chords, and successively, to produce chord progressions."[1] This, albeit traditional, definition characterizes well the dual existence of harmony in tonal music—its vertical actualization through the combination of pitches and its horizontal function as a conveyor of motion. These roles persist in much post-tonal music, though vertical harmonies are often isolated from their horizontal contexts and motion migrates from the chordal to the intervallic plane. A lengthy discussion of concepts, development, and practice fills-out the *Grove* article on harmony, speaking to its importance as the foundation of Western art music. By contrast, *Grove* offers only a brief paragraph on timbre, and its definition is merely descriptive at that. It refers to timbre as "the tonal quality of a sound" and then mentions that a clarinet and oboe sound different due to their distinctive timbres.[2] Little effort is made to explain *why* these instruments sound different, though the article at least offers that "the perception of timbre is a synthesis of several factors."[3] Timbre has always been the more

[1] Richard Cohn et al., "Harmony," *Grove Music Online*. *Oxford Music Online* (Oxford, UK: Oxford University Press), accessed October 10, 2017, https://doi-org.echo.louisville.edu/10.1093/gmo/9781561592630.article.50818.
[2] Murray Campbell, "Timbre (i)," *Grove Music Online. Oxford Music Online* (Oxford, UK: Oxford University Press), accessed October 10, 2017, https://doi-org.echo. louisville.edu/10.1093/gmo/9781561592630.article.2797.
[3] Campbell, "Timbre (i)."

elusive of the two concepts, and, indeed, it has played a lesser role in tonal and much post-tonal music. In these repertoires, timbre has often been limited to instrumentation and the ability to create contrasts between different instruments and instrumental groups. Several authors have even described its traditional role as purely decorative.[4] Furthermore, an instrument is often assigned its part, not for how it sounds, but for its practical ability to play the assigned part.

Since the second half of the twentieth century, new concert music has made a greater attempt to explore timbre and derive structural meaning from its properties. It is an effort which can be traced at least as far back as Claude Debussy and Arnold Schoenberg, composers who, at the turn of the twentieth century, both expressed interest in working with sound itself and not merely its realization as music. They broke with the expectations of functional tonality in their pursuit of sound, though it became Schoenberg's predicament that neither traditional notation nor the available sonic technologies allowed him to enter into sound in the way he might have wanted. In his theoretical text, *Harmonielehre*, Schoenberg explained, "In a musical sound, three characteristics are recognized: its pitch, color, and volume. Up to now it has been measured in only one of the three dimensions in which it operates, in the one we call 'pitch.'"[5] The harmonic approach of tonal music has foreground pitch, but Schoenberg indicated that timbre—his "color"—could also become of utmost importance. For a time,

[4] Robert Hasegawa, "Timbre as Harmony—Harmony as Timbre," in *The Oxford Handbook on Timbre*, ed. Emily Dolan and Alexander Rehding (Oxford University Press, forthcoming), 20; Vincent P. Benitez, "Aspects of Harmony in Messiaen's Later Music: An Examination of the Chords of Transposed Inversions on the Same Bass Note," *Journal of Musicological Research* 23 (2004): 201-03. Hasegawa uses the word "decorative" whereas Benitez's discussion of added pitch material, which had not possessed harmonic function, gaining timbral function in Messiaen's music suggests that timbre can attain more than a merely decorative function.

[5] Arnold Schoenberg, *Theory of Harmony*, trans. Roy E. Carter (Berkeley and Los Angeles: University of California Press, 1978), 421.

he experimented with *Klangfarbenmelodie*, the expression of melody through timbre, but ultimately he was left unable to explore timbre fully. Instead, he retreated to the realm of pitch and outlined twelve-tone serialism, the method which has often been credited as his major innovation. Joshua Fineberg, however, from what he admits is a biased position, has commented that Schoenberg's work after 1923 "became less about searching and more about elaborating a system."[6] In the years immediately following World War II, European and American composers alike, fascinated by the apparent asceticism of serialism, especially in Anton Webern's interpretation, continued down this path, ignoring acoustic reality and perception.

Nevertheless, the development of technologies that would allow composers and researchers alike to better understand sound and timbre was well underway in the post-war years. These technologies, at first the property of the electronic music studios, have shown timbre to arise quite naturally from a basic frequency and the relative strengths of its overtones. Timbre, then, can be modeled as a spectrum, consisting of many partials. Every partial has three essential components: a frequency, our pitch in music; an amplitude, describing its volume; and a rank, or its placement in the series of partials. The first partial, which typically corresponds to the notated pitch of a sound, is called the fundamental while the other partials which accompany this fundamental are considered its overtones. The relative amplitudes of these partials then determine an instrument's timbre. Additionally, some spectra possess harmonicity, or correspondence to the harmonic series, while others do not: these instead possess inharmonicity or are described as inharmonic. Timbre, now understood as the alignment of these sonic constituents,

[6] Joshua Fineberg, "What's in a Name?," in *Spectral World Musics: Proceedings of the Istanbul Spectral Music Conference*, ed. Robert Reigle and Paul Whitehead (Istanbul: Pan Yayıncılık, 2008), 31.

takes on a striking similarity to harmony, when understood vertically as the alignment of constituent pitches. It is a similarity which has suggested to many composers a new correspondence between harmony and timbre. Indeed, some composers have questioned the entire distinction between these concepts.

This thesis investigates the blurred distinction—what we call liminality—between harmony and timbre which has arisen in the second half of the twentieth century. Liminality, a term borrowed from psychology, refers to thresholds, boundaries which are transgressed or never seem to have existed in the first place. It explores compositional aesthetics which have foregrounded this liminality, especially the liminality which has arisen between harmony and timbre. In the process, it proposes several interpretations of liminality, from radical expansion to disorienting ambiguity to vivid tension between its constituents. Liminality has become one of the primary aesthetic concerns for a group of French composers, commonly known as the spectralists, who came into artistic maturity in Paris in the 1970s. Among the first spectralists were such figures as Tristan Murail, Gérard Grisey, Hugues Dufourt, and Michaël Lévinas, though the pursuit of liminality has not been limited to this group. Olivier Messiaen, an important mentor to most of these composers, can be seen as a forerunner, while the Finnish composer, Kaija Saariaho, who settled in Paris in the 1980s and familiarized herself with their aesthetic positions, has been one successor.

Specifically, this thesis investigates the liminal aesthetics of Messiaen, Murail, and Saariaho looking to their writings and a representative composition from each in exploring their stances and application of harmony and timbre in this revised setting. Few scholars have adequately considered the aesthetic views voiced in these composers'

writings. Most of the scholarly literature has only explicated the technical side of this music or, conversely, analyzed it without much consideration of the aesthetic vision these composers have set forth in their own writings. My thesis attempts to fill this gap, by returning to the two primary sources available to me—the composers' own writings and their scores. Secondary sources will, therefore, mainly provide context to my examination as the approach itself will mostly be my own. Ultimately, I shall investigate precisely what the term "liminality" means within the aesthetics of these three composers, especially in their interpretation and treatment of harmony and timbre.

Gérard Grisey was first to propose the term "liminal" as an appropriate descriptor for the music that would instead be dubbed "spectral," as Liam Cagney explores in some depth in his recent article entitled, "*Vers une écriture liminale*: Serialism, Spectralism, and *Écriture* in the Transitional Music of Gérard Grisey." Cagney, indeed, has located the original letter of July 1980, written to Dufourt as Grisey was preparing to lecture at the Darmstadt summer courses, in which Grisey suggested "liminal" as a descriptor for their movement. Their foremost concern, he argued, was the crossing of thresholds, the breakdown of serialist parametrization, and not the structuring of complex harmony-timbres modeled after acoustic spectra as the descriptor, "spectral," which Dufourt had suggested the year before, would imply.[7] Though this structuring of complex harmony-timbres was and has remained an important concern for the spectralists and others, it represents only one way in which these composers have attempted to emphasize liminality in their music.

[7] Liam Cagney, "*Vers une écriture liminale*: Serialism, Spectralism, and *Écriture* in the Transitional Music of Gérard Grisey," in *The Routledge Research Companion to Modernism in Music*, ed. Björn Heile and Charles Wilson (New York: Routledge, 2019), 400.

Cagney, though he has composed a brilliant article placing the emergence of Grisey's aesthetic within the context of French serialism in the late 1960s and early 1970s, has not fully explored the implications the term "liminal" brings to the shared aesthetic of Grisey and his colleagues. That, instead, becomes my contribution to the scholarly literature, though I have chosen Tristan Murail as my representative of the spectralist stance. Jonathan Goldman had taken a similar approach to Cagney in his article, "Boulez and the Spectralists between Descartes and Rameau: Who Said What about Whom?," whereby he frames the emergence of the spectral movement by detailing the written debate between Pierre Boulez—then the dominant figure in French music—and the younger spectralists as well as the ensuing schism between their camps.[8] If Cagney's accomplishment, however, has been to connect Grisey to Boulez through their aesthetic convergences, then Goldman's achievement has been to demonstrate their initial divide as a consequence of the strong personalities involved and the ensuing generational conflict. Indeed, these two articles complement each other nicely.

The articles by Cagney and Goldman are, with several others indicative of a new phase in the study of spectral music and surrounding aesthetics. For the first time, these articles—all of which have been published within approximately the last ten years—have sought to explore the historical and aesthetic context of spectral music and then apply this context to their musical analyses. My thesis, with its own particular direction, is simply the next in this series. Eric Drott has contributed two articles to this emerging literature, including "Spectralism, Politics, and the Post-Industrial Imagination" and "Saariaho, Timbre, and Tonality." The former article, which perhaps launched this recent phase of

[8] Jonathan Goldman, "Boulez and the Spectralists between Descartes and Rameau: Who Said What about Whom?," *Perspectives of New Music* 48, no. 2 (Summer 2010): 208-09.

scholarship, situates early spectral music by paying careful attention to the rhetoric the spectralists used to describe their music and offset it from the serial establishment as well as the lineage of these terms in French politics of the late 1960s and early 1970s. Drott's latter article draws on Saariaho's writings to formulate the relationship of her music to traditional tonality. His texts have dealt directly with primary source writings, often including those currently available only in French, helping to clarify and contextualize the views expressed by the composers themselves. I might add that this close consideration has been part of my own inspiration in returning to the composers' writings. All three of the composers whose works I examine have made as much effort to write music as to explain their aesthetic aims in written words. The attention they have given to explicating their stances is somewhat unusual, generally speaking, but was also the practice of Schoenberg and Boulez—two inestimable figures in this same lineage.

If Drott's contribution has been primarily contextual, then Robert Hasegawa has offered a more technical approach in an article like his forthcoming, "Timbre as Harmony—Harmony as Timbre," which in its first form was presented as a keynote at "Fostering New Music and Its Audiences: The Grawemeyer Award for Music Composition 30th Anniversary Conference" hosted by the University of Louisville from March 6-7, 2015. This article explores the scientific means of how harmony crosses into timbre and vice versa, locating their liminality in the music of such composers as Jean-Claude Risset, Edgard Varèse, James Tenney, and Elliott Carter. Hasegawa had, as a graduate student, participated in the important English translations of Murail's lectures which appeared in *Contemporary Music Review* in 2005 and introduced a new generation to spectral music. Joshua Fineberg, who had likewise made significant contributions to

CMR's first exploration of spectral music in the year 2000, has written another more accessible and concise overview of the early history of spectral music entitled, "What's in a Name?," given as a keynote lecture at the Istanbul Spectral Music Conference. His has become an important narrative around this music, one which explores the broad influences which abounded at its inception and the aesthetic aims of its innovators, all in a very accessible language to the non-expert. This is a narrative to which the aforementioned scholars and myself have sought to add details.

These are several of the scholars whose approaches I have found most insightful in my study of spectral music. My thesis also examines the music of Olivier Messiaen, a composer whose aesthetic has been well-explored in many regards but somewhat insufficiently in its connection to that of the spectralists. Beginning in the 1960s, his music became more concerned than ever with timbre, color, and his own synesthesia, and, concurrently, he also mentored the emergent spectralists—his second generation of students after a first generation of Boulez, Karlheinz Stockhausen, and Iannis Xenakis. Pianist and scholar, Marilyn Nonken, has taken the lead in relating Messiaen's late music to this second group of pupils in her chapter, "Messiaen and the Spectralists." Here, she has written that, "By this point, harmony and timbre had ceased to exist for Messiaen as separate perceptual elements. He had come to recognize them as contingent parts of a single, multidimensional whole: a harmonic-timbral complex."[9] This is a fused conception which we shall see reinforced by Murail. Nonken's main focus, however, is on the relationship of Murail to Messiaen during the younger man's student years—not their liminal aesthetics in a broader context. This introduces a connection worth exploring

[9] Marilyn Nonken, "Messiaen and the Spectralists," in *Messiaen Perspectives 2: Techniques, Influence, Reception*, ed. Christopher Dingle and Robert Fallon (Farnham, UK: Ashgate, 2013), 229.

further and one which I take up in this thesis. In short, I argue that, despite the vast differences between their larger aesthetics, Messiaen and Murail, nevertheless, share an essentially similar concept of the liminality between harmony and timbre. What they do with this liminality is, moreover, a question of age, not belief, for Messiaen will incorporate his fused harmony-timbres into a serial medium whereas Murail will take these same materials and construct a brand new aesthetic from them.

This thesis falls into three chapters, each dedicated to one composer, their aesthetic vision, and a composition representative of that vision. Afterwards, I conclude with some final thoughts on the correlations between these composers and their aesthetics, and I also pose questions for future research. Throughout, I paint a historical narrative of spectralism and the larger lineage around this music which connects Messiaen to Murail, and, then, both of these composers to Saariaho. Chapter One discusses Olivier Messiaen and his orchestral work, *Chronochromie*, from 1960. I begin by outlining an aesthetic context for this composition, pulling quotes from Messiaen's own writings. These are the three texts, *Technique de mon langage musical*, *Musique et couleur*, and the *Traité de rythme, de couleur, et d'ornithologie*. My examination of these is by no means exhaustive—only functional—in so far as they inform my approach to *Chronochromie*. This contextualization leads to a discussion of the musical entities which Messiaen terms, "color chords." These are pre-composed harmonies which in their precision and attention to intervallic space cross into the realm of timbre. In this way, they are liminal at the constructional level of *Chronochromie*, appearing particularly in its two *Strophes*. I also delve into the *Antistrophes* where timbre takes on the horizontal role traditionally assigned harmony as a signifier of motion.

Chapter Two centers on Tristan Murail, his orchestral composition *Gondwana* of 1980, and the two lectures he delivered at Darmstadt contemporaneously. These are the lectures, "The Revolution of Complex Sounds" and "Spectra and Sprites." They bring to my discussion an immediate context, placing the music of *Gondwana* into the atmosphere in which it was composed and received. This chapter opens, however, with a historical account of Murail's studies with Messiaen and the birth of the spectral movement, in the process transporting the reader from Messiaen's classroom, circa 1967, to the Darmstadt summer courses of 1980 and 1982. Only then do I investigate the words uttered by Murail in those powerful and provocative lectures. Through Murail's words, I describe the vision of the first spectralists while also formulating this composer's specific liminal aesthetic. From there, I apply this context to my analysis of *Gondwana*. This analysis studies how harmony transcends into timbre through the spectral chords of *Gondwana*'s opening pages; it then tracks the form of this piece through a consideration of its periodicity. My final excerpts focus on later moments in *Gondwana* where harmony and timbre again demonstrate their interrelationship. Especially in my study of Murail's aesthetic, it must be remembered that *Gondwana* and these lectures date from his first maturity and, that in the nearly forty years that have passed, his aesthetic has greatly evolved. Indeed, if I were to examine a more recent work by Murail, I suspect I would uncover tremendous changes in its aesthetic scope.

From Murail, I move to Kaija Saariaho whose orchestral work, *Du Cristal,* of 1989 is the focus of Chapter Three. Saariaho posits a different conception of liminality from either Messiaen or Murail. Hers does not concern an indistinction of harmony and timbre, but envisions multiple intersections between two separate but still interrelated

concepts. Their precise intersections become her prerogative as composer, and she often creates tension when they intersect. This is a stance likely informed by her musical upbringing in the more conservative environs of Finland—a time and place where Jean Sibelius remained the dominant figure—and her training in serial music. As her 1987 article, "Timbre and Harmony: Interpolations of Timbral Structures," makes clear, her goal, at least at that time, was to have timbre provide material for an extended tonality where progression could be driven by timbral hierarchies. I trace this vision in her *Du Cristal*, considering her work on several planes—that of the individual melodic line as well as across the entire ensemble. In due course, I provide a formal outline to this piece in the same way I had for Messiaen and Murail. Here, only, I map its tensional attributes in this attempt to show its dramatic progression from one texture to the next.

All three of these composers offer stunning aural landscapes in their music as reinforced by the intellectual depth of their own writings. This thesis, a thorough if still introductory exploration of their liminal aesthetics, considers both of these resources equally—the aural and the written. In charting their liminal aesthetics, it aims to contribute valuable insights to a growing body of scholarly research. In my Conclusion, I suggest fruitful areas where this body of research might continue to expand. Overall, then, this thesis explores a single idea, liminality, as it corresponds to two concepts, harmony and timbre, and as it characterizes three distinctive yet related aesthetics, those belonging to the composers Olivier Messiaen, Tristan Murail, and Kaija Saariaho. It explores a common lineage between these composers as it paints a narrative around them and their music. Ultimately, it is an endeavor which itself transcends easy categorization, as we come to understand multiple perspectives, their continuities, and their tensions.

CHAPTER ONE: OLIVIER MESSIAEN // *CHRONOCHROMIE*

Olivier Messiaen was a composer whose aesthetic evolved gradually over the course of his career. In other words, the preoccupations of his earliest music still concern him in his latest. The fascination with timbre and its construction through harmony is one such preoccupation. It is of primary importance in works composed as early as the 1930s, such as *L'Ascension*, and remained significant in the compositions of the 1940s, particularly the epic *Turangalîla-Symphonie*. If it vanished somewhat in the following years as Messiaen experimented with integral serialism, then the ornithological explorations of the later 1950s encouraged its return. Indeed, *Chronochromie*, composed from 1959 to 1960, marks the pinnacle of the birdsong works as well as an entry into the later phase of his career when his approach to timbre became its most refined.[10] *Chronochromie* is an orchestral work in seven movements and lasting approximately twenty minutes. It was commissioned by Heinrich Strobel of *Südwestfunk* who specifically requested that Messiaen not use either piano or *ondes Martenot* as *Turangalîla* had. It was then premiered at the Donaueschingen Festival on October 16, 1960 by Hans Rosbaud conducting the *Südwestfunk* orchestra.

This chapter examines Messiaen's approach to harmony and timbre with respect to his later aesthetic and through specific reference to *Chronochromie*. It does so through

[10] Amy Bauer, "The Impossible Charm of Messiaen's *Chronochromie*," in *Messiaen Studies*, ed. Robert Sholl (New York: Cambridge University Press, 2007), 145.

the examination of the composer's own writings as well as through score study. Ultimately, I show that Messiaen advances a liminal aesthetic through the construction of precise harmonies that transcend into the realm of timbre and through the reassignment of harmonic progression to timbral procession. The emphasis of *Chronochromie* on the shifting relationship between harmony and timbre as well as its position as the major work of the years immediately preceding Murail's studies with Messiaen make it the obvious choice for my case study. Furthermore, its instrumental forces and its length make this work comparable to the those I shall examine by Murail and Saariaho.

I. Pre-composition // Liminality at the Constructional Level

What I have said of Messiaen's compositions, I might also say of his writings on music: the preoccupations do not change, only the ideas become more nuanced. This leaves me searching through a lifetime of material to answer the aesthetic questions I have posed. Throughout his career, Messiaen produced three significant texts on his personal aesthetics. The first of these, chronologically, was his *Technique de mon langage musical*, published in 1944 and reissued in English in 1956. This text satisfied the immediate interest in the complex workings of his musical mind, although it seems spare by comparison to what would follow. The next text to appear was the series of interviews conducted by Claude Samuel and published as *Musique et couleur*. The first interviews between Messiaen and Samuel took place in the mid-1960s, just after the completion of *Chronochromie*, but the entire book was revised and additional interviews were added in the 1980s. *Musique et couleur* was then published in French in 1986 and in English translation in 1994.

The third and most substantial aesthetic text written by Messiaen was his *Traité de rythme, de couleur, et d'ornithologie*, published posthumously in seven tomes between 1994 and 2002, and only currently available in its entirety in French. Work on the *Traité* began at least as early as the 1940s and continued throughout the remainder of Messiaen's life. It was only brought to its published form through the tireless editorial work of his widow, Yvonne Loriod. All three of these texts shall figure into my exploration of Messiaen's late aesthetic as regards harmony and timbre. Each makes its own contribution, owing to the three texts' distinctive scopes. As the work of many years, though, these texts perhaps do not have the same immediacy as the source readings I have chosen for my next chapters, each written within a year or two of the scores I examine. Regardless, they provide valuable insight not found anywhere else.

Messiaen's late aesthetic stands at an interesting crossroads—a threshold in itself—between serialism and spectralism. At its surface, the music appears to maintain many of the traits associated with serialism, including its harmonic stasis, rigorous specification of parameters, calculated sonic impression, and, overall, its seeming impenetrability to the casual listener. Yet, in subtle ways, and often at a constructional level, Messiaen's music is distinguished from that of Boulez, Stockhausen, and the others who had been his students just a few years earlier. Despite certain disparities at the surface level, many of the traits which the spectralists—his second group of students—would shape into their aesthetic within a few years already lie implicit in Messiaen's late aesthetic. Messiaen opens his *Technique* by stating his goal in writing such a text. He explains:

> It is always dangerous to speak of oneself. However, several persons have vigorously either criticized or praised me, and always wrongly and for things I

> had not done. On the other hand, some students particularly eager for novelty have asked me numerous questions relative to my musical language. … In the hope that my students will return to the few ideas that I am going to develop—whether to use them better than I, or to draw something else from them, or to reject them ultimately if the future proves them unlikely to live—I draft my treatise.[11]

This quote has relevance for all three of the composers whose music I examine in this thesis. That writing about oneself and explaining one's techniques is dangerous but necessary is a conclusion at which all three composers seem to have arrived. Indeed, they write more about their own music than many composers have. In the willingness of all three of these composers to speak on themselves and their artistic visions, they have anticipated many of the misconceptions such radical redirections in musical language necessarily inspire. These composers and the scholars who have also written on their music, then, have been able to counteract many such misunderstandings.

One essential way that Messiaen's aesthetic foreshadows that of the spectralists is through his emphasis on perception. Early in *Musique et couleur*, Messiaen states, "Personally, I often speak of color, but color exists only through our eyes. Likewise, composers speak of sound, but sound exists only through our ears."[12] These words suggest a deeper truth: that through our senses we communicate with reality. Messiaen is aware of this connection between personal perception and objective reality, and uses it to his advantage when crafting his music. Unlike so many other high modernists at mid-century, he invites his listeners into his music. Elsewhere, Claude Samuel asks about the scandal the dawn chorus near the end of *Chronochromie* caused at its premiere. Messiaen

[11] Olivier Messiaen, *The Technique of My Musical Language*, trans. John Satterfield (Paris: Alphonse Leduc, 1956), 1:7.
[12] Olivier Messiaen, *Music and Color: Conversations with Claude Samuel*, trans. Thomas Glasow (Portland, OR: Amadeus Press, 1994), 32.

admits to the strains this section poses for the listener, but genially responds that those who are willing to "listen properly" can navigate even its difficulties. Asked to explain further, Messiaen states that, to "listen properly," one must "arrive at the concert with an open mind, with no animosity toward the composer; then, to love nature, knowing how to appreciate it in all its manifestations, sounds as well as colors, colors as well as perfumes, […] to allow [oneself] to realize that in this apparent disorder, a hidden order reigns."[13] He knows his music poses difficulties, but challenges his listeners to rise to the occasion. He additionally knows he has created something ornate, but not without recourse to familiar materials, onto which listeners can grasp as they enter into deeper understanding of his music. His compositions, moreover, connect their audience to his own particular vision of existence through their clearly-audible sonic signifiers—things we recognize and that Messiaen, in fact, wants us to recognize.

As abstract as Messiaen's music might sound, it is entirely descriptive. The persistent imitations of birdsong and the poetic titles of many works demonstrate his interest in recreating subjects, whether natural or otherworldly, in his music. The composer Alexander Goehr, who was a pupil of Messiaen, has described this as a kind of realism in his teacher's music—that the musical representation of an object actually *becomes* that object.[14] Though without this same transfiguration, something similar happens for Murail and other spectralists when their sonic analyses allow them to transform acoustic sounds into musical sounds. Fortuitously, Messiaen describes the

[13] Ibid., 133.
[14] Alexander Goehr, *Finding the Key: Selected Writings*, ed. Derrick Puffett (London: Faber and Faber, 1998), 49; Arnold Whittall, "Messiaen and Twentieth-Century Music," in *Messiaen Studies*, ed. Robert Sholl (New York: Cambridge University Press, 2007), 251.

ambient sounds which he recreates in his music as "complex sounds,"[15] a term which will have particular significance for Murail. Birdsong is one "complex sound" that he feels capable of accurately transcribing and notating into his music. He describes his process as a mix of tradition and technology as he sits in the woods with pencil and paper, scribbling away, but later he also listens to the recordings his wife has made for a more accurate accounting with which he can compare his hurried sketches.[16] He feels less effective capturing other natural sounds. Without success, he claims, "I've listened passionately to the waves of the sea, to mountain streams and waterfalls. […] I make no distinction between noise and sound: for me, all this always represents music."[17] Now, the informed reader might also sense Saariaho in the distance, for she too hears musical potential in noise as well as sound.

Ambient sounds such as these certainly point toward a fused conception in which musical parameters, such as harmony and timbre, are no longer as clearly divisible as they had been in the past. Still, as happens in the practice of transcribing birdsong, Messiaen's task is to realign parameters into a perceptual whole. Harmony, then, if structured precisely enough, can transcend into the realm of timbre, and this can happen apart from the recreation of ambient sounds. In the *Technique*, Messiaen writes of Debussy as an important precursor in the creation of timbre from harmonic materials: "With the advent of Claude Debussy, one spoke of appoggiaturas without resolution, of passing notes with no issue, etc. […] It is a question of foreign notes, with neither preparation nor resolution, without particular expressive accent, which tranquilly make a

[15] Messiaen, *Music and Color*, 35-36.
[16] Ibid., 36.
[17] Ibid., 35.

part of the chord, changing its color, giving it a spice, a new perfume."[18] These are chords without harmonic function, without progression, but which are, instead, designed and utilized only for their timbre. The horizontal role of harmony is negated as the vertical role is expanded to encompass a colorful mixture of pitches. Messiaen continues to list two intervals, in particular, which Debussy and other composers have frequently added to their chords: the sixth and augmented fourth. Of the sixth, he remarks, "Rameau foresaw it; Chopin, Wagner made use of it; […] Debussy and Ravel installed it definitively in the musical language."[19] The augmented fourth can also be added owing to its resonance from the chordal root.[20] Resonance will be invoked repeatedly by Messiaen in his own chordal additions; in fact, any pitch which can be located in the harmonic series becomes fair game for this composer as his conception of chords expands into the timbral realm.

Messiaen's aim in expanding chords into timbres is, not only the recreation of ambient sounds, but also in order to communicate his synesthetic perception to his listeners. Through his synesthesia, sounds and colors are interconnected: he exclaims, "When I hear music, I see in my mind complexes of colors corresponding to complexes of sounds."[21] Throughout his writings, he remarks on the colors—red, orange, yellow, green, blue, violet, or often something much more profound—that sounds carry for him. Simple harmonies, of course, evoke colors in his perception, but he also wishes to enrich these colors by enriching his harmonies. He sees close parallels between what he does with his resonant harmonies and what a painter does with complementary colors. In *Musique et couleur*, he describes what happens when a person stares at a red area placed

[18] Messiaen, *Technique*, 1:47.
[19] Ibid.
[20] Ibid.
[21] Messiaen, *Music and Color*, 62.

next to an area of white: "The red starts to glow [and] when it reaches its maximum state of illumination, you see green flashing intermittently on the white zone next to the red."[22] Resonant harmonies work in the same way, operating on the ear instead of the eye. The overtones of a fundamental pitch arise naturally, if given the chance to resonate. These resonance elements, captured from the overtones, are typically excluded from tonal chords as they skew the functional context of the chord. Now, however, this skewing is reinterpreted as harmonic enrichment through contrast. Vincent Benitez actually calls this opposition of contrasting harmonies within a single chord, "dynamic"[23]—a word which will gain special meaning for the spectralists. In divorcing the chord from its functional context and foregrounding its timbral aspects, these resonant chords transcend the distinction between harmony and timbre. For Messiaen, the synesthete, they also evoke brighter, richer perceptual colors.

This discussion of resonance and contrasting colors suggests the possibility of many new and unfamiliar chords now open to Messiaen. Apart from the "thousands of chords invented to reproduce the timbres of bird songs,"[24] Messiaen lists in *Musique et couleur* three specific types of color chords. These are what he calls the turning chords, chords of transposed inversions (on the same bass note), and chords of contracted resonance; he also mentions a totally chromatic chord. For the sake of clarity, I shall refer to these chords as TC, CTI, and CCR, respectively, following the example of other scholars.[25] Messiaen mentions nothing about these chords' constructions in *Musique et*

[22] Ibid., 61.
[23] Benitez, "Aspects of Harmony," 189.
[24] Messiaen, *Music and Color*, 64.
[25] Wai-ling Cheong, "Rediscovering Messiaen's Invented Chords," *Acta Musicologica* 75, no. 1 (2003): 87; Bauer, "The Impossible Charm," 151.

couleur, instead describing only their vivid colors: of a CTI with a root of C♯, he says "the upper range is the color of rock crystal and citrine; the lower range, of copper with gold highlights."[26] Though fantastically depictive, this account tells scholars interested in the constitution and function of these chords very little. We do get some indication, however, of the role register plays for these chords. Messiaen explains, "When I move the same chord from midrange up one octave, the same color is reproduced, shaded toward white—which is to say lighter. When I move the same chord from midrange down one octave, the same color is reproduced, toned down by black—which is to say, darker."[27] The colors yielded by octave transpositions, therefore, are related but not identical; this suggests that register greatly impacts Messiaen's harmonic thinking and demands that we interpret his color chords as sonorities, not merely harmonic entities.

Messiaen describes the constitution of the color chords much more thoroughly in his *Traité*. Here we learn that all three chord types are complex harmonies of seven or eight chordal members. Their configurations are also specific, so that certain constituent intervals always appear in the same order regardless of transposition. They can also undergo changes in form which Messiaen considers "inversions," although these tend to preserve intervallic content instead of merely inverting pitch classes as in tonal music. What is remarkably apparent is that these chords have expanded from the realm of harmony into the realm of timbre. Their size, as septachords and octachords, makes them comparable to the extended harmonies which the music of Debussy had privileged. Messiaen's chords also do not merely replicate tertian structure in their extensions: they integrate chromatic intervals throughout the range of the chords. Further, though each of

[26] Messiaen, *Music and Color*, 65.
[27] Ibid., 64.

the three chord types can be related to a dominant ninth and seem to have functioned in this capacity at one time in Messiaen's music, by *Chronochromie*, they have become devoid of harmonic function.[28] Their usage is associative, for the synesthetic color they conjure for Messiaen himself. Though we might not share Messiaen's synesthetic perspective, the intervallic relationships within these chords distinguish them from one another, granting them a certain timbre in this process. These timbres—the sound colors which Messiaen also perceived visually—become the most important features of these chords in the absence of harmonic function. Beyond all of this, the appeal of these chords to harmonic resonance relates them to sound itself—not its approximation in musical notation, but physical sound where harmony and timbre are less easily distinguished from each other. In effect, the root of each chord begins to resemble a sound's fundamental and the successive chordal members, its overtones. Though Messiaen does not model his chords after acoustic reality to the same extent that the spectralists will, his color chords in the ambiguity of their distinction between harmony and timbre foretell this later liminal aesthetic.

Figure 1.1 diagrams the nine chord forms which Messiaen gives as examples in the third tome of his *Traité*. These include two forms specific to the CCR, another three for the TC, and four for the CTI. Though I supply the same root pitches which Messiaen does, these chords can begin on any pitch and appear in any register. This means that 108 chordal realizations are possible, though Messiaen limits his usage to just 65 of these in *Chronochromie*.[29] We can better understand the constituency of these chords through careful inspection of their initial A forms. The A form of the CCR, in particular, makes a

[28] Bauer, "The Impossible Charm," 155.
[29] Ibid., 146.

good starting place, for it has the most similarities with familiar triadic chords. The following description pertains directly to the chord given in Figure 1.1, but it can, of course, be applied to any transposition of the A form of the CCR. This chord's lower four members, D4-E4-G♭4-A4, belong to a dominant ninth chord in which the seventh is excluded and the ninth is transposed down an octave; the third, it should go without saying, is spelled enharmonically. Meanwhile, the upper three members, D♭5-E♭5-G5, are added resonance elements, derived from the harmonic series which have also been removed from their original registral contexts through octave transposition. In this chord and the others, the root is given in black, the other dominant ninth material in dark gray, and resonance elements in a lighter gray. The restriction of the pitch material into an intervallic space of eighteen semitones suggests why Messiaen referred to these as chords of *contracted* resonance: all of the pitch material which, in the harmonic series would span several octaves, is here compressed into a single octave and a half of intervallic space. This is also a feature of the other color chords as their resonance elements are similarly contracted, and it will distinguish Messiaen's approach from that of Murail and other spectralists who preserve registral space when constructing their harmonies.

Before proceeding, it is worth observing that, not only are the upper three members of this chord derived from the harmonic series, but so are the lower four members. Indeed, the entire chord can be viewed as a selective interpretation of the overtones which arise when the pitch class D acts as a fundamental. Excepting register, every odd-numbered partial in the harmonic series will generate a new interval in relation to the fundamental or its transposition at the octave. In this way, partial three is a perfect fifth removed from the preceding octave transposition of the fundamental; partial five is a

major third removed; partial seven, a minor seventh; and partial nine, a major second. This process continues beyond partial nine, but sometimes begins to yield divisions which do not conform to the twelve-note tempered scale. Partial eleven yields an interval between a perfect fourth and an augmented fourth; partial thirteen, between minor and major sixth; partial fifteen, a major seventh; and partial seventeen, a minor second. This is as far as we need to go to understand how the members of Messiaen's chords relate to the harmonic series. The lower members of his CCR are the first, third, fifth, and ninth partials; contraction, then, rearranges the sequence of intervals. Above these, the upper three members of the CCR are tempered approximations of the eleventh, fifteenth, and seventeenth partials with their registral contexts removed. Though Messiaen approximates frequencies to the nearest semitone, the spectralists will more often approximate to the nearest quartertone in order to achieve greater precision. Additionally, while Messiaen relies on the harmonic series for his resonance elements, they will more typically construct their chords in ways that deviate from the harmonic series and, as a result, possess some aspect of inharmonicity.

This same mapping from the harmonic series can be used to shed light on the other two chord types—the TC and CTI. The initial A form of the TC also has dominant harmony, but, instead of lacking a seventh, lacks a ninth. Its configuration, furthermore, differs from the CCR, so that its major third and minor seventh appear in the upper part of the chord and resonance elements are interspersed throughout. These resonance elements—those in Messiaen's example chord are D4-F4-G♯4-E♭5—correspond to the eleventh, thirteenth, and fifteenth partials in a series beginning on the pitch class A where the eleventh partial is approximated to both D and E♭. Lastly, the initial form of the CTI

also begins as an altered dominant ninth chord with its major ninth transposed down an octave and its major third raised a semitone as a kind of appoggiatura without resolution. Two resonance elements—here, G4 and C5—are added to the top of the chord, suggesting their origin as upper partials; these are tempered approximations of the eleventh and fifteenth partials. While this appeal to the harmonic series sufficiently relates the added resonance elements to the chordal roots, it does little to explain the specific configurations of the chords. We can still ask, for example, why Messiaen excludes members of the dominant ninth pentachord from the final versions of his three color chords. Also, why does he intersperse resonance elements throughout the TC, and why does he, more generally, contract his chords? I suspect the answers to these questions have more to do with intuitive and intellectual decisions as well as the chords' synesthetic associations for him personally than a careful modeling of his chordal materials after physical spectra as will be the practice of Murail and his colleagues.

Also distancing Messiaen's aesthetic from that of the spectralists is how he converts the initial A forms of these chords into their other forms. This has entirely to do with set theory and serial logic. From the A form of these chords, Messiaen would seem to derive their other forms from shared or similar intervallic content. The CTI possesses the same interval-class vector, <433452>, in all four of its forms; this corresponds to the Forte label, 7-20. Though Messiaen calls these forms "inversions," the four example chords clearly do not share the same pitch class material, so that it is not a question of moving around pitch classes to yield another chord form, as in tonal theory, but preserving the intervallic collection despite alterations in pitch class materials. This interval-class vector distinguishes the CTI from both the TC and CCR, regardless of how

they might function harmonically in Messiaen's music: the distinction is intervallic and, thus, also timbral. The two forms of the CCR, contrary to the CTI, differ in set class, but share an identical interval-class vector, <444342>. In this way, the two CCRs are Z-related with the set classes, 7-Z36 and 7-Z12, respectively. The TC are further distinguished from the CTI and CCR, for whereas these maintained the same collection of interval classes between forms, the TC forms differ somewhat in their interval classes. The three forms of TCs possess the set classes, 8-5, 8-4, and 8-14, respectively, with the vectors, <654553>, <655552>, and <555562>. Though these interval collections are still quite similar, their differences would suggest that their forms are not quite as interchangeable as are the forms of the other two chord types; that, however, does not seem to be the case given their actual usage in *Chronochromie*.

That these chords can exist in any transposition, that they need be reduced to their intervallic content to understand their classification into three distinct chord types—both of these factors suggest that the intervallic relationships within these chords far outweigh the pitch materials which allow these intervals to arise. Some similarities between each of the interval-class vectors should be noted. Firstly, the vectors for the CTI and CCR are strikingly similar, no more different from each other than those of the three TC vectors. This might be summarized by saying that the CTI puts slightly more emphasis on the dominant, perfect fifth interval than the CCR which slightly favors the smaller intervals of major second and minor third. Secondly, all three chord types have rich collections of constituent interval classes which are relatively balanced with the exception of the tritone—an interval class which is minimized in every color chord configuration. The TCs, on the other hand, emphasize the perfect fourth interval in that each spelling of the

TC places a perfect fourth as the bottommost interval. Two forms, A and C, also have perfect fifths as their second interval from the root, while the other form, B, has instead an augmented fifth at this location. Though features like these are not visible in interval class-vectors, they might explain why Messiaen's three TC forms possess only closely-related vectors and not identical ones, if Messiaen sought foremost to stress these intervals and then constructed similar set classes around them.

Ultimately, the similarities in intervallic constitution between the three types of color chords are not surprising, given the derivation of all of these chords from a dominant ninth and their addition of resonance elements. Through their similar intervallic constitution, they become quite similar timbrally, for each chord possesses a rough harmonicity despite its complex chromatic structure. This is not true harmonicity, however, due to the compressed nature of Messiaen's chords: with registral space constricted, the chords do not maintain the shape of the harmonic series with its open intervals in the lower register and tighter intervals in the upper register. Yet, many of the basic intervals of the harmonic series still appear within the chords, and certainly the A forms of each chord type emphasize these harmonic intervals. In their precise and expanded harmonies, the color chords begin to take on timbral qualities, not least through the significance they assign to register and the strict order of intervals. In these ways, the chords themselves, at this constructional level, suggest the liminality that will become incredibly more nuanced under Murail and Saariaho. As we shall see in the next section, however, Messiaen's deployment of these color chords maintains the static, motionless harmonies of serial and post-serial music, against which Murail, Saariaho, and other spectralists shall rebel.

II. *Strophe I* // Expanding Harmony through Color Chords

Chronochromie occurs in seven movements which, aside from the *Introduction* and *Coda*, are named after ancient Greek poetic elements. These are the *Strophe*, *Antistrophe*, and *Épôde* which are interlaced so that the movement order is *Introduction-Strophe I-Antistrophe I-Strophe II-Antistrophe II-Épôde-Coda*. Messiaen is specific that he wishes there to be no more silence between movements than that which he has prescribed metrically at the end of each preceding movement. In this way, their role becomes more like sections than movements, for a freer pause between movements can, of course, in live performance, give musicians a chance to rest and retune their instruments. For listeners, little changes as these silences—still longer than any silence internal to the movements—provide clear dividing lines.

The silences between the movements of *Chronochromie*, furthermore, mark distinct formal divisions, and textural activity in particular differs immensely between movements. Even within movements, however, textural activity can sometimes come to a sudden halt, after which something new begins. Transitions between sections, large and small, and also between movements are, moreover, nonexistent in *Chronochromie*, though they will become essential in the works I consider by Murail and Saariaho. Instead, material is compartmentalized and readily interchangeable with any other material of similar shape and breadth. *Chronochromie*, in this way, becomes like a mosaic, pointillist painting, or even stained glass, in its edifice from smaller, separable parts. The interchangeability of its movements and sections—a serial remnant in

Messiaen's aesthetic—also occurs at the chordal level as should not be surprising given that his color chords amount to pre-composed building blocks.

Messiaen's usage of his color chords in *Chronochromie* is most readily apparent in the two *Strophes*. Specifically, the composer places them in the strings in these movements: the first violins carry the TCs; the second violins, the CTIs; and the violas and cellos, the CCRs. Dynamics persistently alternate between *mezzo-forte* at the onset of a new chord—its attack—and *pianissimo* afterwards—its sustain. Over this substructure in the strings, birdsong resounds in the winds, glockenspiel, and xylophone. The other percussion instruments—the gongs, bells, cymbals, and tam-tam—partner with the strings and match their rhythmic syncopation. Specifically, gongs are only struck when the first violins initiate a chord; the same is true with the bells for the second violins and cymbals and tam-tam for the violas and cellos. As the uniform deployment of the color chords in the strings enhances the timbral-intervallic similarities already discussed, only the registral stratification and rhythmic syncopation remain capable of distinguishing the chord types from one another. Though the partnered percussion matches the syncopated attacks in the strings, their ringing has the effect of adding a second, percussive timbre to an already dense texture which is just as capable of masking the strings as signifying them. To this listener at least, the partnered percussion seems to complicate textural activity more than clarify it. Indeed, these percussion sounds are almost as interchangeable with each other as the chords are in the strings. What emerges, then, are not discrete chords or percussive strikes, but a colorful mosaic, fairly consistent in texture, over which the birds are able to sing freely.

Amy Bauer graphs each color chord in *Strophe I* in her article, "The Impossible Charm of Messiaen's *Chronochromie*." She finds that each of the three groups play 32 chords in various forms, but without any harmonic reasoning for which form the chords take—A, B, C, or D. She reports, "Without a repeated pattern, or a perceptible teleology (beyond completion of the series), the overall scheme is dominated by harmonic stasis and rigidity."[30] This again speaks to the interchangeability of different forms of the same chord as well as their absence of harmonic functionality. In other words, as previously discussed, their usage is only for their color associations. For the most part, chordal attacks are separate from others: only at the outset of *Strophe I* do all three groups attack at once, and Bauer identifies only four other instances when two chords intersect.[31] We already know from our examination of the example chords what happens when one chord appears; it is, instead, more worthwhile to consider the intersections, as rare as these moments are. The very first sound we hear in *Strophe I* is the crash of all three string groups as well as their paired percussion. The first violins play a TC on the pitch A4 in A form, the same chord raised an octave which Messiaen had used as his example in the *Traité*. The second violins, meanwhile, play a CTI on A3 in its C form. The violas and cellos add a CCR on D♭3 in its B form.

The combined pitch collection of these three chords consists of nineteen distinct pitches, extending across approximately three and a half octaves. All twelve chromatic pitch classes are represented, so that in one sense this is a "gray" aggregate, devoid of color as all intervallic relationships are present and maximized.[32] We should, however,

[30] Bauer, "The Impossible Charm," 156.
[31] Ibid.
[32] Cheong, "Rediscovering Messiaen's Invented Chords," 101.

pay attention to register, given Messiaen's specific voicing of chords and their placement into different strata. Chords overlap, so that the CTI starts on the CCR's fourth member—A3—and the TC starts one octave above on A4, between the CTI's fourth and fifth members. This overlapping is interesting because it defies Messiaen's stratification into different registers and suggests, instead, the collective approach I have taken at this unique intersection of all three chords. It is also curious where the higher chords begin in relation to the lower one. The B form of the CCR does not, like the A form, feature a clean perfect fifth between the chordal root and another member. This essential harmonic interval which first emerges between the second and third partial is instead replaced in the B form by the two nearby inharmonic intervals of the diminished fifth and augmented fifth. Significantly, it is on the augmented fifth of the CCR that the CTI begins and, another octave above this pitch, that the TC begins. Given Messiaen's fondness for resonance, I suspect this structure is not completely coincidental and, indeed, the pitch materials of this chordal intersection do possess a greater cohesion than is immediately apparent by considering only pitch class and forgetting register.

In the previous section, I had described the A form of the CCR as a contraction of partials one, three, five, nine, eleven, fifteen, and seventeen in a harmonic series. This analysis had favored the non-contracted series as it appears in nature when these partials' corresponding intervals *first* appear in such a series. Messiaen, however, in contracting the harmonic series into chords, demonstrates he is more concerned with the intervals themselves than an exact mapping of pitch space. If we similarly abstract on the series, we realize that the sequence of intervals which Messiaen utilizes occurs naturally in the fourth octave of the harmonic series. Partials eight, nine, ten, twelve, fifteen, seventeen,

and twenty-one also correspond to the A form of the CCR, but do so in the order and amount of pitch space which appear in Messiaen's chord. For example, if we hypothetically assume a fundamental of D♭0, then our CCR in A form will consist of the pitches, D♭3-E♭3-F3-A♭3-C4-D4-F♯4. This is the CCR in A form at the base of the second and third intersections, and it includes the essential perfect fifth interval, lacking in the B form. The B form, which appears at intersections one, four, and five, can be understood through the same logic: it, instead, consists of partials eight, nine, eleven, thirteen, fifteen, seventeen, and nineteen. According to this analysis, at the first intersection, the CTI and TC join with the B form of the CCR as its upper partials to yield a nineteen-note collection which further ascends this hypothetical harmonic series. They interlock perfectly, so that their own roots—A3 and A4—become the thirteenth and twenty-fifth partials in this same series. All nineteen pitches as well as their ranks are diagrammed in Figure 1.2. The chordal root, D♭3, is in black while others members of the dominant ninth harmony are in dark gray.

Each of the five intersections in *Strophe I* can be described in this manner as the addition of upper partials, supplied by either or both a CTI and TC, to a CCR which comprises some segment of a hypothetical harmonic series. The second intersection is a thirteen-note structure, blending the A form of a CCR with the C form of a CTI and spanning from the eighth partial to the thirty-sixth. The third intersection, formed from a CCR and TC, includes fourteen pitches spanning the eighth partial to the seventy-second. The fourth, fourteen pitches from the eighth to the thirty-sixth partial. And, the fifth, fifteen from the eighth to the eighty-eighth. The intersections, in this way, are not much different from the pre-composed color chords: they are still densely-packed chromatic

pitch collections, except now register matters more than it did in the individual chords as pitch classes necessarily repeat. Still, it is fascinating that Messiaen would synchronize his chords in this way, and shows he must have been aware of the intervallic relationships that would lead to this type of interlocking. He needed no recourse to computer analysis nor a proper understanding of spectral construction, only the will to calculate these intervallic relationships and a knowledge of the harmonic series. These intersections, nevertheless, and to a greater extent than the individual chords, demonstrate how Messiaen's conception of harmony and timbre had become fused by the time of *Chronochromie*. A seven or eight-note chord may easily be related back to dominant harmony or set theory, as I have shown, but this understanding of resonance as well as the emphasis Messiaen places on register implies that he possessed at least a rudimentary understanding of how timbre emerges when a harmonic series is placed into pitch space.

Regardless of this theoretical understanding, Messiaen's contraction of chords still poses several practical difficulties in extending harmonies into timbres, for it skews acoustic reality in irreparable ways. Foremost, the shape of the harmonic series disappears: no longer do the larger, open intervals which are so essential to our perception of timbre inhabit the lower register and tighter intervals, the higher register. Contraction, in other words, while preserving the sequence of intervals, diminishes our perception of the fundamental. Instead, these pitch collections consist exclusively of smaller intervals, where one pitch and the next are rarely separated by an interval of more than a second or third. Furthermore, contraction undermines the distinction between harmonic and inharmonic intervals. Though within the second octave, an augmented fifth, for example, might be understood as a perversion of the perfect fifth between the

second and third partial, the augmented fifth arises naturally in the fourth octave at the thirteenth partial. Without the fundamental to ground the series in a particular register, an augmented fifth is no different from a perfect fifth in terms of their respective harmonicity. This makes the B form of the CCR essentially no different from its A form, even though the A form—not isolated from its registral context by contraction—is much more harmonic than the B form.

Contraction, therefore, while granting Messiaen certain compositional freedoms makes the intersections clustered masses as indistinct and interchangeable as the pre-composed color chords had been. Though they arise from a liminal understanding of harmony and timbre where register is known to contribute to the construction of enlarged harmony-timbres, they do not possess the distinctiveness of acoustic spectra. They result from and, again, reinforce Messiaen's aesthetic of stasis in their indistinction and their interchangeability. None of this, of course, is a problem for Messiaen: he has accomplished exactly what he intended. Yet, from the point of view of the spectralists, it is quickly seen as a missed opportunity. Messiaen understood the liminality of harmony and timbre, but made no effort to extend this into his aesthetic at more than a basic constructional level. Similar complaints had been leveled at Schoenberg by Boulez, when the older man seemingly refused to extend the separation of harmonic elements into other parameters, such as rhythm.[33] At the compositional level, however, liminality might still be accomplished in another way—through timbral contrast.

[33] Paul Griffiths, *Modern Music and After, Third Edition* (New York: Oxford University Press, 2010), 4-6.

III. *Antistrophe I* // Generating Motion through Timbral Contrast

The seeming refusal of Messiaen to make liminality a perceptible facet of his aesthetic might be negated if we look beyond the color chords and their intersections and toward an understanding of harmony—not vertically, but horizontally—as progression. This alternate approach will be particularly relevant when I come to the aesthetic of Kaija Saariaho in my third chapter. In the music of Messiaen, as in so much serialism and post-serialism, there is harmonic stasis: no longer does tonal tension propel harmonic activity toward release. But, in *Chronochromie* at least, large sections are colorized by distinctive combinations of instruments. These sections are identifiable by the instruments which actualize them and the textures these instruments create. Though there are no transitions between sections—one simply ends and the next begins—the contrasts between these sections maintain *our* interest and move *us* forward. These timbral contrasts substitute for harmonic motion. They, moreover, provide a different context in which timbre can trespass into the realm of harmony, not in terms of vertical construction but in terms of horizontal function.

Strophe I, our main model so far, is remarkably flat in terms of instrumental color. In saying this, I mean that: once an instrument is assigned a role, it pursues this role throughout the span of the movement. The strings and their partnered percussion provide a substructure over which the birdcalls in the winds, glockenspiel, and xylophone sing freely. This is an adequate description of the entire movement: nothing much changes. Different birds come to our attention, just as the color chords alternate in form and transposition, but, in the meantime, the birdcalls become as interchangeable as are the chords. Changes are minute and ephemeral, always easily resettling to equilibrium. If not

quite as fixed as a frozen image, then the aural impression is at least no more active than a brief venture outdoors into nature. The resulting texture is what I would call "statistical" in its flurry of animated parts. *Strophe II* is a recasting of this same event—an aural reflection for the composer who relished in symmetrical modes and rhythms. The *Strophes*, though, find their counterparts in the *Antistrophes*, and it is here that we find timbral motion as opposed to the timbral stasis of the *Strophes*. The *Antistrophes* demonstrate ready contrasts between timbral groups, especially between the driven, chorale-like woodwind textures and the more static, if still rhythmically-tight, sections dominated by the percussion and strings. Each *Antistrophe*, furthermore, follows the same pattern of alternating and eventually integrating these two types of sections, a pattern which shall be outlined in more depth momentarily. In *Antistrophe I*, this procession of timbres occurs at a length of three minutes whereas, in *Antistrophe II*, this same procession is expanded to nearly six minutes in length.

Figure 1.3 gives a formal outline of *Antistrophe I*. As we can see, this movement consists of seven large sections, with its sixth section consisting of two parts. The wind texture characterizes the first section. It is chorale-like in its block harmonies which are rhythmically-united among all participating instruments. These are three flutes, two oboes, English horn, two clarinets, bass clarinet, and three bassoons—the entire woodwind group of *Chronochromie*. Though Messiaen does not list in the score a specific birdcall with this rhythmic motive as he does elsewhere, the motive still seems indicative of birdcall: not merely through its placement in the woodwinds, but chiefly through its two-part structure of an isolated note followed by an ascending sweep. The contrasting, second section begins after a few beats of silence, but no other transition.

Here, birdsong appears in the xylophone and marimba; these instruments are later joined in this role by the glockenspiel. The bells, suspended cymbals, and string soloists, meanwhile, provide a substructure above which the birds can sing freely, establishing a statistical texture much like that in *Strophe I*. These instruments are at first utterly quiet, but later the bells increase in dynamics to participate on more equal terms with the xylophone and marimba. The bells' rise in prominence, quickly followed by the addition of the glockenspiel, marks a subtle shift in timbre, so that there is a progression from the earlier texture to another related, texture which foregrounds the bells and glockenspiel. The first, woodwind section had no such timbral shift, even if the activity itself was more rhythmically driven. Also worth noting is the number of strings playing in section two: two first violins, four second violins, four violas, four cellos, and one bass. This chamber instrumentation shall increase in successive sections where the strings participate, so that soon the full string complement sounds.

Sections three and four reiterate the essential contrast between the woodwind texture and the percussion and strings texture; aside from the incremental expansion of these sections, they are much like their forerunners. Section five is another woodwind texture. It, however, is more violent than its predecessors: contrasts in dynamics are greater—often *forte* and *fortissimo* gestures are quickly followed by a drop to *piano* or *pianissimo*—and melodic leaps are also wider. The sixth section, which is again dominated by the percussion and strings, responds to the increased insistence of the fifth. Immediately, we hear louder, more dissonant clusters in the strings and fiercer crashes in the bells, gongs, and cymbals; the xylophone and marimba, while still imitating birdsong, sound more restless and persistent. Instrumentation has also increased. Now all strings

play, though a solo group similar in constitution to the previous sections remains distinct. Several woodwinds—specifically, two flutes, one oboe, and two clarinets—have also joined, though they primarily reinforce the strings rather than adding their own chorale-like material. The percussion forces too have grown, notably through the addition of the three gongs and tam-tam. It is the tam-tam, through its *fortissimo* strike at m. 112, which brings this movement to its climax. This tense moment comes as the result of the other dissonances throughout section six, and foreshadows the dissonances yet to come. Indeed, the tam-tam continues to ring for several measures, so that—without precedent—it links this first part of section six to the second part when the brass enter. This transition justifies my division of section six into two parts, rather than the brass entrance initiating a new section, though tempo, instrumentation, and texture all change.

Section six continues with expanded instrumental forces, including full brass, full woodwinds, tam-tam, and full strings minus the basses. They collectively pound-out block chords at maximum dynamics, much like the chorale texture previously inhabited by the woodwinds except with all the dissonance of the first part of section six. The birdsong imitations of the earlier sections are conspicuously absent, however: the intricate birdsong rhythms have vanished, and the chorale texture, instead, consists of thick cluster chords. After this onslaught, section seven introduces new material—an imitative texture filled with quick, descending lines again with the feel of birdsong. Though tempo has now increased to its fastest in *Antistrophe I*, instrumentation remains much the same as in section six. The main exceptions are the return of the bells, gongs, and cymbals and the reduction of the strings. The strings now consist only of twelve of each first and second violins and four violas; the cellos have joined the basses in sitting-

out. The xylophone, marimba, and glockenspiel also remain absent as they had in the second part of section six. The introduction of new material shifts the formal weight of *Antistrophe I*. Before now, there had been an exchange of two textures—chorale and statistical—each marked by a particular instrumentation, which joined together after the tam-tam strike in section six. Section seven responds to all which proceeds, snatching the birdsong element unclaimed by the second part of section six, and integrating the previously distinct instrumental groups into a shared dialogue. In doing so, it has the effect of counterbalancing not only the second part of section six, its direct predecessor, but the first five sections and first part of six as well.

These interactions between one section and the next and also from one section to the whole define motion in *Antistrophe I*. This motion, however, is not harmonic as in tonal music, but timbral—between interacting textures and instrumental groups. The chorale texture and its wind instrumentation is set against and contrasted with the statistical texture of the percussion and strings. Their interchange eventually leads to integration and the creation of something new, namely the imitative texture of section seven. Contrast, we should notice, is between instrumentation and texture, two aspects which belong to timbre. These timbral contrasts, rather than always remaining separate and interchangeable, finally under intense pressure, meld into one another. From the simple contrast of procession, we move into the dynamism and tension of progression when the sections become integrated. All of this, nonetheless, happens on the timbral plane and not the harmonic plane which for centuries had defined motion in Western music. Timbral contrast and procession shall become of key importance for Tristan Murail while timbral progression shall become essential for Kaija Saariaho. Their

approaches to timbral motion will inevitably be more nuanced than that of Messiaen in this one section and its partner of *Chronochromie*.

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The timbral motion of *Antistrophe I* comes in stark contrast to the harmonically and timbrally static *Strophe I*. Though this earlier section was constructed from liminal materials, specifically the color chords which transcend the division of harmony and timbre, their deployment ultimately remains serial and separate. The *Antistrophes*, instead, prefigure the formal dynamism of the spectralists and, specifically, composers like Murail and Saariaho. Though their liminalities will become incredibly more nuanced, already in the aesthetic of Messiaen we encounter liminality between harmony and timbre on both the vertical and horizontal planes. Suddenly, timbre has become involved in both of the roles traditionally assigned to harmony: the vertical combination of pitches and the horizontal progression of the successive combinations. The color chords demonstrate how vertical sonorities in Messiaen's music now cross from the realm of harmony into the realm of timbre. No longer can we speak only in pitch class, as sonorities now require that we consider register and intervallic space as well as instrumentation, all elements associated with timbre. Timbre has also encroached on the horizontal role of harmony, for while harmony has become static, timbre has gained motion through the contrasts of instrumentation and texture which occur in the *Antistrophes*.

Though much will change between *Chronochromie* and the compositions I examine by Murail and Saariaho, the elements I have highlighted in the aesthetic of Messiaen already point toward these later liminal aesthetics. In addition to the revised

understanding of harmony and timbre, we should also pay close attention to such elements as resonance, dynamism, formal structure, and transition. All of these emerge out of a questioning of the relationship between harmony and timbre, and they will continue to populate our discussion of aesthetics in the works of Murail and Saariaho. Perception, communication, and the transmission of acoustic reality into musical space are also preoccupations we find in Messiaen's aesthetic which will not leave our discussion in the next two chapters. Let us then proceed, keeping in mind all of these concepts and their relationships with each other as well as the liminality of harmony and timbre which is my ultimate focus.

CHAPTER TWO: TRISTAN MURAIL // *GONDWANA*

In Chapter One, I explored the idea of harmony growing into timbre, harmonies becoming so precise in their construction as to resemble timbres, in the late compositional aesthetic of Olivier Messiaen. In *Chronochromie* and other works by this composer, harmony would seem to trespass a boundary separating it from timbre. This occurs at the constructional level through Messiaen's color chords, dominant ninth harmonies with added resonance elements derived from the harmonic series. If Messiaen, however, had been satisfied with constructing his complex harmony-timbres by ear and intellect, then Tristan Murail and the other composers who would define French spectralism at this movement's outset sought to ground their sonic experiments in science and technology. As we shall investigate in this chapter, Murail will construct an aesthetic which foregrounds sound and demands that the contemporary composer familiarize him or herself with both the principles of acoustics and the new sound technologies which have emerged from the electronic music studios.

Murail's resulting liminal aesthetic will, therefore, be concerned with acoustic spectra and the recreation of these naturally occurring sounds in music. These complex sounds will, like Messiaen's color chords but to an even greater extent, cross from the realm of harmony into the realm of timbre. Indeed, Murail will see no distinction between harmony and timbre, treating these traditionally distinct parameters as merely two polar

extremes on a continuous axis. This indistinction of harmony and timbre will comprise liminality for Murail, a stance already suggested by Messiaen but now taken to its logical next step by this talented student. Throughout my case study of Murail's orchestral work *Gondwana*, I shall demonstrate how Murail transforms sonorities from inharmonic masses into complexes exhibiting harmonicity. A new formal dynamism shall emerge, in which the processes of electronic studios are applied to instrumental composition. Directionality and procession shall replace the static textures of Messiaen and so much serial and post-serial music also without compromising a fully modern aesthetic. Ultimately, this chapter shall examine Murail's liminal aesthetic, one which embraces continuity and which establishes direction through process, by closely inspecting two of his aesthetic texts, "The Revolution of Complex Sounds" and "Spectra and Sprites," as well as his representative composition, *Gondwana*.

I. Defining Aesthetics // From "Complex Sounds" to Spectra

The aesthetic vision which resonates from the music and writings of Tristan Murail substantially differs from that which we have so far examined in regard to Olivier Messiaen. Where the one prizes stasis, the other pursues directionality; where the older man defaults to the established twelve pitch classes of the tempered scale, the younger composer draws from the full frequency continuum to discover new pitch materials; and, where Catholic mysticism and birdsong guide the former, science and the electronic studio inspire the latter. There is, however, a clear lineage which links Messiaen and Murail, for Murail was a pupil of Messiaen from 1967 to 1971. Furthermore, it is Messiaen's concept of liminality—the indistinction of harmony and timbre—which

Murail inherits and upon which he builds his own quite different aesthetic. As Marilyn Nonken makes clear, Murail had not pursued a career as a composer until hearing of Messiaen's appointment in 1966 as Professor of Composition at the Paris Conservatoire; instead, he had dedicated his university studies to economics and Arab languages, though he had learned piano and organ as a youth.[34] Murail knew that Messiaen was the only composer with whom he wished to study, for he had little interest in the trends exhibited by other contemporary composers. With his application to the Conservatoire, he submitted the piano piece, *Comme un oeil suspendu et poli par le songe…*, a work which is clearly imitative of Messiaen's aesthetic. Nonken suggests that this work already demonstrates a spectralist interest in harmony, timbre, and time, though it is far from a mature aesthetic statement.[35] Through Messiaen's guidance, these would become chief concerns for Murail and his colleagues as their spectral movement took shape.

Among these colleagues were Gérard Grisey, Hugues Dufourt, Michaël Lévinas, and Roger Tessier with whom Murail would found the *Ensemble l'Itinéraire* in 1973. Most of these young men were, like Murail, former students of Messiaen, and all shared his interest in crafting a new musical language which approached sound as it was understood through scientific advances in acoustics and perception. Their ensemble, as well as the shared aesthetic they put forth, was set in direct contrast to Boulez and his *Domaine Musical* which, for them, represented the post-serial establishment. In addition to programming the compositions of its members, *L'Itinéraire* also performed works by Messiaen, George Crumb, Salvatore Sciarrino, and Giacinto Scelsi—each of whom were intent on discovering new sounds and stood at least a little outside the serial hierarchy.

[34] Nonken, "Messiaen and the Spectralists," 232-33.
[35] Ibid., 233.

This last composer exerted particular influence on Murail and his colleagues through their residencies at the Villa Medici in Rome in the early 1970s. While Messiaen was an important mentor who helped Murail and the others develop their own aesthetics, he still insisted that they root their techniques in post-serialism.[36] Scelsi, on the other hand, taught them to conceive music as sound and allow the formal dimensions of the composition to evolve directly from the sound itself. They also gained from him an appreciation for gradual change as well as microtones. Though Scelsi's use of microtones differed from the spectralists' own, it was still through him that they broke free from the tempered scale: whereas Scelsi used microtones to distort familiar harmonies, the spectralists have typically used microtones and quartertones, in particular, to enrich harmonies, viewing them as a finer approximation of frequencies than semitones.[37]

Throughout the 1970s, the composers associated with *L'Itinéraire* continued to refine their artistic visions as they created their first major compositions. While Grisey pursued his definitive six-movement cycle, *Les Espaces acoustiques*, Murail created such works as *Mémoire/Erosion*, *Ethers*, *Treize couleurs du soleil couchant*, and *Gondwana*. French spectralism existed in its purest, most rigid, and iconoclastic form in this decade and, indeed, Paris in the 1970s might be called "the moment of spectral music." The Darmstadt summer courses and the lectures the spectralists began giving there in 1978, however, marked an opening up of their nascent movement to the larger world of contemporary music. Grisey spoke at Darmstadt in 1978, and Murail followed with

[36] Tristan Murail, "Scelsi and *L'Itinéraire*: The Exploration of Sound," trans. Robert Hasegawa, *Contemporary Music Review* 24, no. 2/3 (2005): 181-82.
[37] Ibid., 185. In this document, I use the symbol " ♮ " to mean half-sharp and " 𝅘𝅥 " to mean half-flat; in a few figures, I also use " 𝅪 " for three-quarters sharp. Though these symbols will be familiar to most readers, they are not consistently used by all composers, thus the need to explain my usage of them.

lectures in 1980 and 1982. Eric Drott has commented on the gravity these lectures gave to their movement: "These writings constituted a vital means whereby the spectralists might negotiate the transition from a relatively little-known group of young composers to that of a nationally and internationally recognized musical movement."[38] Murail's composition *Gondwana*—a work whose title references the ancient landmass as well as continental drift—was also premiered at Darmstadt on July 21, 1980 with Antoni Wit conducting the Kraków Philharmonic Orchestra. To properly understand the aesthetic context of *Gondwana,* I shall begin by examining the ideas Murail offered in his two Darmstadt lectures, the first titled, "The Revolution of Complex Sounds," and the second called, "Spectra and Sprites." These lectures are approached through their revised forms printed in *Contemporary Music Review* in 2005 with English translations by Joshua Cody and Tod Machover, respectively. Whereas the first lecture is broader, more visionary, and also more abstract, the second is more provocative and technical. Presumably, Murail's second lecture acts on the assumption of greater familiarity with spectral concepts among his audience, but also on the refinement of his own thoughts on the subject.

In "The Revolution of Complex Sounds," Murail introduces many of the ideas which he has continued to steadily develop over the course of his career. First, however, he opens with a challenge to Darmstadt orthodoxy, though here delivered more cautiously than many of the outright complaints and fiery objections for which Murail's subsequent writings have become well-known. Specifically, this challenge is that the true revolution in recent music has to do not with the serial or post-serial reevaluation of musical grammar, but with a refocusing on sound and acoustics. This second, more truly

[38] Eric Drott, "Spectralism, Politics, and the Post-Industrial Imagination," in *The Modernist Legacy: Essays on New Music*, ed. Björn Heile (Farnham, UK: Ashgate, 2009), 41.

revolutionary effort, has been led by Murail, his spectral compatriots, and certain predecessors, especially those active in electronic music. Indeed, he denounces many of the so-called modern aesthetics then prevalent at Darmstadt. He states, "By 'traditional' I include serialism, aleatoric composition, stochastic composition, etc.: techniques that continue to use antiquated grids of parameters."[39] As of 1980, most of the composers in his audience would have ascribed to one or more of these aesthetics! The important point in this dismissal, as he will go on to postulate, is that sounds themselves, neither their parameters nor the symbolic language that for centuries has described them, should be the contemporary composer's material. It is a stance that Schoenberg at mid-career might have voiced, though his technological and notational limitations would force his retreat into serialism. Grisey similarly emphasized sound as the proper material for composers, and surely Murail has always been first to acknowledge Grisey's many contributions to spectralist aesthetics.

Murail's relocation of sound as the proper material for contemporary composers depends on a clear understanding of what sound actually is. In his discussion of what sound *is*, he is also keen to point out what sound *is not*, rejecting what he considers to be two commonly-held misunderstandings about sound. As he sees it, the basic assumption of serial music has been that sound is reduceable to its parameters: that sound can be described through such qualities as its pitch, duration, dynamics, register, or timbre. The failed assumption, according to Murail, is that sound is merely a composite of these parameters and, worse, that serialists and post-serialists seek to (re-)combine these parameters arbitrarily and haphazardly. Another, equally-flawed assumption, according

[39] Tristan Murail, "The Revolution of Complex Sounds," trans. Joshua Cody, *Contemporary Music Review* 24, no. 2/3 (April/June 2005): 121.

to Murail, is that musical notation adequately and fully describes sound: more precisely, the assumption is that the notational symbol can substitute for the acoustic phenomenon. To this end, Murail quips, "Our entire musical tradition assumes a direct correspondence between the symbol and the thing [i.e. the sound]."[40] For Murail and Grisey, musical notation amounts to a visual representation of an essentially aural conception. Murail, in particular, has been intensely critical of any school of composers who positions the score as the artwork itself, often denouncing composers of the new complexity and their incomprehensibly complicated scores for this reason.[41] Grisey, for his part, occasionally endowed his scores with humorous illustrations or written encouragements, like those found in *Partiels*, merely to spur on his musicians; his purposefully ambiguous scores have also sometimes left room for multiple interpretations of notational elements. For the French spectralists, moreover, the score is neither sacred nor codified, but something which directs performers toward a desired aural result.[42]

Sound, as Murail conceptualizes it, is the intersection of many distinct forces each with its own attractors and following its own course. In Murail's words, "It is more realistic, more in keeping with physical reality and perception, to consider a sound as a field of forces, each force pursuing its own particular evolution."[43] These forces are not parameters under a different name, however. Parameters are musical descriptors applied after the fact, whereas the physical forces of which Murail speaks truly shape the sound and exist, as it were, within the sound. Although Murail does not stop to identify the

[40] Ibid., 122.
[41] Tristan Murail, "Spectra and Sprites," trans. Tod Machover, *Contemporary Music Review* 24, no. 2/3 (April/June 2005): 137. Here, Murail mocks the new complexity when he quips, "'Well, let's write a lot, as many as we can, indecipherable masses for eye and ear.'"
[42] Joshua Fineberg, "Spectral Music," *Contemporary Music Review* 19, no. 2 (2000): 3
[43] Murail, "Revolution of Complex Sounds," 122.

specific forces to which he refers, the idea is that these forces—various sonic properties—are always in motion, always mobile, so that what we humans perceive as sound is the dynamic interaction of these physical forces. Sound is, therefore, momentary, ephemeral, and never precisely replicable or reoccurring. His words are: "Sound can never be repeated exactly, but [is] variable also within its own unique lifespan."[44] Ultimately, Murail's concept of sound is scientific, if somewhat vague and mystical in its description in his first lecture. He attributes this re-conception of sound to the new analytic tools which have allowed him and his colleagues to "journey to the interior of sounds, to observe their internal structures."[45] The contemporary composer must seek this understanding of the interior of sounds, if he is to make sound his material; by replicating the internal dynamism of sounds, the spectral composer, as we shall see, will develop his equally dynamic musical forms.

So far, our discussion has been limited to two keywords of this article's title: "revolution" and "sounds." But, Murail, by this point, has already introduced his third keyword—"complex"—and this, for us, is where the concept of liminality also enters. Sounds are complex when they defy the traditional boundary between harmony and timbre or, further, when that boundary becomes meaningless. In a fervent passage, Murail states there is "an entire category of sounds with previously unimagined characteristics—sounds that fall between two categories, paradoxical sounds, unstable sounds, complex sonorities that defy the traditional classification of harmony and timbre completely, inhabiting the unclaimed territory between them."[46] Harmony and timbre, the old

[44] Ibid.
[45] Ibid.
[46] Ibid.

parameters of serial and tonal music, are useless categories when sound is reconceived as it exists in physical reality. Neither traditional composition nor traditional notation can account for these sounds, though they lie ahead uncharted as the most fruitful territory for spectral composition. They are opened up through the technological advances of analytical tools, and notation too must learn to account for them. Murail continues to describe them as "intermediate sounds, hybrids, sounds that possess new dimensions (transitions, development over time), sounds that are neither harmonic complexes nor timbres but something between the two."[47] They are mystical and wonderful; they hold incredible potential for the spectral composer willing to enter into acoustic analysis and find his materials in the real world and not the musical approximation which for centuries had remained the necessary limit of the composer's reach.

Murail attributes the discovery of these complex sounds to electronic music. From the invention of electronic instruments, such as the Theremin or *ondes Martenot*, to the tape manipulation of the analog studios and the digital synthesizers of newer studios, electronic music has introduced new sounds, often of a complex nature, into music; composers of instrumental music have, in response, sought to recreate these sounds. With some satisfaction, Murail reflects, "It is obvious that we would not have Ligeti's *Atmosphères* without the development of tape music."[48] His comment can, of course, be extended to many of the sound mass compositions of the 1960s and 1970s as well as much else. Thanks to the influence of electronic music, instrumental composers began to think in sonic masses and smooth continua as opposed to distinct notes and their resulting melodies and counterpoints; indeed, their thinking of harmonies became less about the

[47] Ibid., 124.
[48] Ibid., 123.

members and more about the whole. The aesthetic of separation posed by Boulez and carried out by he and other serial and post-serial composers was brought into question as various aesthetics favoring continuity began to take shape. Still, one challenge open to spectral music is how to enter these masses and control the direction they take, rather than presuming that the act of accumulation itself can forever yield something musically captivating.

Electronic music has hastened an aesthetic shift in instrumental music. Murail admonishes those composers—here he targets the neo-romantics—who would turn away from this challenge. He bemoans, "The unlimited promise of electroacoustic music was doubtlessly deceptive: but this is not a reason to spurn its gifts."[49] The spectralists, on the contrary, have answered this call and their work, which albeit has emphasized instrumental over continued electronic composition, may be considered a post-electronic music. Its complex sounds recreate those of electronic music; it prefers the frequency continuum and microtones to established notions of pitch; its formal designs are often modeled on electronic processes; its harmonic designs often derive from spectral analysis; and, moreover, it foregrounds sound as its essential constructive material. Joshua Fineberg, commenting on Murail and Grisey as post-electronic composers, emphasizes the tools at their disposal: "If frequency analyses had not been available to them, and if some knowledge of acoustics, psycho-acoustics, and the mathematical models they use to describe sounds were not also available, neither of them could have written anything."[50] Fineberg is correct that these technological developments, originally the property of the electronic music studios, have allowed the spectralists to assert a new,

[49] Ibid., 122.
[50] Fineberg, "What's in a Name?," 32.

post-electronic aesthetic, one which Debussy, Schoenberg, and even Messiaen could never attain.

The study of sound has shown it to consist of many continua, of which the harmony-timbre continuum is the most important for our discussion of Murail's liminal aesthetic. In "The Revolution of Complex Sounds," Murail describes liminality in tandem with these continua: "There is a general abolition of limits […] there is no precise line between pitch and noise, rhythm and frequency; harmony and sound color [i.e. timbre] are continuous phenomena."[51] What for centuries had been regarded as separate musical elements—and later for the serialists and post-serialists became distinct parameters open to recombination—have been shown through sound analysis to be merely opposite ends on continua, axes, or scales. A sound can be more harmonic or more timbral, however, these are but the polar extremes on a fluid continuum. Murail is more precise in his second lecture, "Spectra and Sprites," when he states, "One can progressively separate timbres to create the effect of a harmony and, conversely, progressively fuse harmonic relations until they create a timbral effect."[52] This is liminality as conceived by Murail: the nonexistence of boundaries between parameters, and as pertains to this thesis, between harmony and timbre specifically. This re-conception allows Murail and other spectralists to approach sound as it exists in acoustic reality, to learn from their sonic analyses and apply the complex sounds which electronic music has opened to them. This re-conception, moreover, allows them to formulate a new aesthetic of liminality more in tune with acoustic reality than past aesthetics.

[51] Murail, "Revolution of Complex Sounds," 124.
[52] Murail, "Spectra and Sprites," 138.

Beyond philosophy, it is also necessary to see these complex sounds which straddle the boundary of harmony and timbre as they exist in acoustic reality: as spectra. It is revealing that in his second, more technical lecture, "Spectra and Sprites," Murail avoids the vague term, "complex sounds," and favors instead the scientific classification, "spectra." The concept of "complex sounds" remains unaltered and, indeed, the term reappears in articles published later in the 1980s and 1990s often in a broader, more introductory sense. The term itself, however, is noticeably absent from "Spectra and Sprites," replaced in this lecture by something more scientific. In addition to spectra, Murail now speaks of partials, the components of a spectrum, and states that each partial consists of a frequency, an amplitude, and a rank.[53] These three items should be familiar to anyone with even a rudimentary knowledge of acoustics. In "The Revolution of Complex Sounds," Murail had given, albeit in less clear terms, these items as the components of a harmony-timbre,[54] so the substitution may be reduced to the simple exchange of a vague aesthetic term—"complex sounds"—for a more precise, scientific one. Twenty years on, Fineberg describes spectra as harmony-timbre as such: "In spectral music, at least, it is often more relevant to combine the two concepts […] this hybrid concept preserves aspects of both its component ideas and captures the interdependence and indivisibility that has developed between them."[55] As this quote hints, surely, the fusion of harmony and timbre does not diminish their functional connotations; it simply conflates them—an idea Murail only latches onto beyond his Darmstadt lectures.

[53] Ibid., 139.
[54] Murail, "Revolution of Complex Sounds," 131.
[55] Joshua Fineberg, "Appendix 1: Guide to the Basic Concepts and Techniques of Spectral Music," *Contemporary Music Review* 19, no. 2 (2000): 98-99.

For now though, Murail focuses on the musical potential of particularly interesting types of spectra, including defective and inharmonic, as well as the processes that can render perfectly harmonic spectra imperfect and thereby more musically interesting. The harmonic series and its spectrum are totally linear and predictable with open octaves and fifths in its louder, lower register and progressively smaller intervals in the quieter, higher registers. Other, less-harmonic spectra have more varied intervallic content and amplify particular regions to form distinctive timbres. Many inharmonic spectra exist in nature, and, as Murail reminds us, several common instruments, including the piano and bells, have attributes which make their spectra inharmonic. Electronic studio techniques, such as frequency modulation, ring modulation, additive synthesis, and filtering can also be emulated in instrumental composition, to not only create single spectra but also transform one spectrum into the next. Though, looking back, this recourse to studio techniques might seem like an idle fascination of the day, it has had two important consequences for spectral music. First, it allowed the spectralists to replicate how sounds change over time; the techniques themselves become irrelevant but for the desired results. Second, imitation of these techniques brought direction through process and without recourse to tonal practices; in other words, the spectral idiom could remain completely modern but the stasis of so many preceding modernisms was undermined.

In his discussion of processes, Murail's prevailing claim is that new sounds also demand a new grammar. Murail rails against postmodernism as well as the new complexity when he writes, "Too often where integration is required there is merely collage, in which complex sounds merely serve—at best—to create 'special effects'

within a traditional musical discourse made up of conventional sonorities."[56] Collage, messy eclecticism, the property of the postmodernists, is a retreat from grammar, rhetoric, and integration of these new materials. The new complexity, according to Murail, also has little regard for grammar, so long as the virtuoso performer establishes his preeminence over all others in attempting the novel, extended techniques of a fancy score. Against these grammarless aesthetics, Murail retorts, "We need, in fact, new organizing principles […] there is no such thing, in itself, as a beautiful or an ugly sound: sounds are beautiful or ugly as determined by their contexts."[57] A new grammar will find ways to integrate spectra where the traditional division between harmony and timbre is no longer apparent. All sounds must be able to enter into this enhanced rhetoric, for all sounds exist in acoustic reality. And, only by better understanding sounds—their sonic properties, what Murail had initially called "the interior of sounds"—can composers hope to integrate them fully and logically.

Daniel Pressnitzer and Stephen McAdams make an important point that, "Rather than establish a series of arbitrary rules, the spectral intuition consisted in founding compositional systems on the structure of sound, and thus in deriving fields of musical relations from sound itself."[58] Music has lived by arbitrary rules for centuries: the job of the spectralists has been to reevaluate those rules, keep those that are acoustically sound, and, where necessary, introduce new protocol more in line with sonic properties. Moreover, with the spectralists' newfound access into the interior of sounds, it is only natural that they would model their formal designs on sonic properties and processes—

[56] Murail, "Revolution of Complex Sounds," 124.
[57] Ibid.
[58] Daniel Pressnitzer and Stephen McAdams, "Acoustics, Psychoacoustics, and Spectral Music," *Contemporary Music Review* 19, no. 2 (2000): 34.

indeed, they would likely argue that this access necessitates such a modeling. One thing informs the other, so that music is modeled on sound; so that harmony permeates timbre and timbre permeates harmony; so that the exterior reflects the interior; and so that the individual reflects the global. Less abstractly, chords may be structured after spectra and form may be structured after sonic processes. Murail is quite resolute about this: he writes, "The sonic material is also the form of the piece. It cannot even be said that one follows from the other […] They are truly one and the same phenomenon."[59] This dynamism of music, founded on the internal dynamism of sound, is beauty for the French spectralists in the same way that balance had been beauty for the Viennese classicists two centuries earlier. The materials have, of course, changed but the effort has remained much the same.

Murail declares that this compositional approach which is concerned with dynamism and the internal nature of sound distinguishes the spectralists from many composers before them. Even as early as "The Revolution of Complex Sounds," Murail has drafted his now familiar metaphor of the spectralist as a sculptor. A more concise delivery of the metaphor is given in a later lecture, however. There he writes, "The composer becomes like a sculptor: he disengages a form from a single mass, rather than constructing a form with a number of bricks like a mason."[60] Murail's proposition is that, whereas many previous composers have built from assorted elements, the spectralist chisels and molds one sound until a finished product emerges from the mass. It is what he terms a "global approach" for it works with sound as a whole.[61] A sonic mass is broken

[59] Murail, "Scelsi and *L'Itinéraire*, 183. This quote is taken from Murail's 1988 lecture on the influence of Scelsi, but it reaffirms a position already taken up by Murail as early as his Darmstadt lectures.
[60] Ibid.
[61] Murail, "Revolution of Complex Sounds," 123.

into its constituent parts through sonic analysis; the interior of the mass is understood. Sound, likewise, is sculpted into music. The oneness of the sound and all its nuances are maintained and reevaluated as music. Existing formal structures are not recklessly borrowed from traditional music, but sound itself—and, specifically, the sound undergoing composition—gives form to the music.

II. Applying Aesthetics // Tracing Liminality in *Gondwana*

This, therefore, is the aesthetic context in which *Gondwana* was composed and then introduced at the 1980 Darmstadt festival. Several important ideas can be extracted from this weighty discourse and observed directly in the music. The idea of continuity between harmony and timbre as well as the permeation and indistinction of these elements must be considered. So too must harmony-timbres and their transformation through formal processes command our attention. These processes, then, shall give rise to directionality, that characteristic which most distinguishes the music of Murail from that of either Messiaen or Saariaho. Ultimately, my approach shall be to examine each of these elements throughout *Gondwana*. Specific moments shall be analyzed vertically as harmony had in the analysis of tonal music; this shall resemble the chordal analysis I have already conducted for Messiaen's *Chronochromie*. Additionally, motion from one moment to the next shall undergo the horizontal examination which in tonal music had been the exclusive property of harmonic progressions and now sees itself expanded into the realm of timbre. To be successful, my analysis shall show how the aesthetic claims which Murail makes about harmony, timbre, and liminality in his two Darmstadt lectures are realized in his composition, *Gondwana*.

When Murail himself has discussed *Gondwana*, he has concentrated on its first section in which a spectral chord modeled after the shape of a bell spectrum gradually transforms into another chord more closely resembling a brass spectrum.[62] Though Murail refers to these entities as "aggregates," I find the usage of this term misleading, for there is no presumption of the chromatic completion which the term "aggregate" often implies in post-tonal theory.[63] Rather than "aggregate," I shall favor the term "spectral chord" or simply "chord" when discussing Murail's sonic entities for they resemble chords in both their function and their cohesion despite their enlarged size. "Spectral chord" is a term which Jon Hargreaves has already used in a discussion of Saariaho's music. There he writes, "Within a 'spectral chord,' one of the notes is presented as the fundamental, implying that it projects a harmonic spectrum into which the other ones are subsumed. […] When listened to spectrally, [it] is experienced as a single composite sonority rather than as a vertical combination intervals."[64] Murail's intent, moreover, is to describe something larger than the typical, tonal chord or even the color chords of Messiaen in which not only pitch class, but also register, orchestration, and dynamics are vital to the configuration of the sonority. Accordingly, all four of these aspects shall be discussed and diagramed in the analysis which follows. The significance of these added dimensions follows from the modeling of these sonorities after spectra, and they match a spectrum's components—namely, frequency, amplitude, and rank.

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[62] Tristan Murail, "Villeneuve-lès-Avignon Conferences, Centre Acanthes, 9-11 and 13 July 1992," trans. Aaron Berkowitz and Joshua Fineberg, *Contemporary Music Review* 24, no. 2/3 (April/June 2005): 205-09; Tristan Murail, "Time and Form in Spectral Music," in *Spectral World Musics: Proceedings of the Istanbul Spectral Music Conference*, ed. Robert Reigle and Paul Whitehead (Istanbul: Pan Yayıncılık, 2008), 250-51.

[63] Murail, "Avignon Conferences," 208-09.

[64] Jon Hargreaves, "Networks of Communication: (De)Crystallization and Perceptual Zoom in *Du cristal*," in *Kaija Saariaho: Visions, Narratives, Dialogues*, ed. Tim Howell, Jon Hargreaves, and Michael Rolfe (Farnham, UK: Ashgate, 2011), 182.

Gondwana was composed before Murail had access to the computer technologies of IRCAM so in this piece, like in many early spectral compositions, the sonic models are approximated through mathematical calculations and more generalized knowledge rather than analyzed from actual recorded sounds.[65] Specifically, Murail employed the electronic studio technique of frequency modulation in which one frequency—referred to as the carrier—interacts with another frequency—the modulator—in order to generate the pitch material of *Gondwana*. From there, he applied his knowledge of bell and brass spectra, including an attention to their characteristic attacks and decays, to decide how he would orchestrate his spectral chords. It is less important for me to compare just how closely Murail's chords resemble their acoustic models than it is for me to describe their construction and then set their gradual transformation within the aesthetic framework I have already established. To accomplish this, I shall begin my examination with the first bell-like sonority and then gradually move toward the final brass chord.

Figure 2.1 shows the first occurrence of the bell chord which arrives in m. 4-8 of Rehearsal A in the winds and percussion. As one can easily observe, the harmonic makeup is far from triadic. On the contrary, it consists of several clusters of pitches: one in a lower register at F♯3-G♯3-A♯3 and others in the middle and higher ranges, including twenty-two different pitches scattered from G4 to C♯7. Two additional pitches are heard in the crotales at C8 and C♯8. In addition to its non-triadic construction, the chord includes several other pitch-related attributes which cause it to resemble an acoustic spectrum more than a tertian chord. Several pitches are microtones, especially in the middle register. As emphasized earlier, microtones for Murail and other spectralists are

[65] Murail, "Time and Form in Spectral Music," 251.

not derived arbitrarily from the tempered scale with further equal divisions in-between the standard semitones. Instead, Murail's microtones are approximations of acoustic frequencies rounded, as in *Gondwana*, to the nearest quartertone. In this way, their approximation to quartertones is wholly practical, for the ease of the musicians and not for the apparent inventiveness of the system. Also, as in Messiaen's music, register matters, so that we are talking about pitch and not merely pitch class; G♯3, for example, is not equal to G♯4. These considerations, informed by acoustics, allow for a closer modeling of the spectral chord to its acoustic prototype, i.e. the bell. The use of quartertones allows Murail to represent component frequencies of the bell which fall between the standard twelve-note scale. Meanwhile, the registral approach accepts that partials possess mathematical relationships to their octave transpositions, but within the frequency continuum are something else entirely. Without making these considerations, the bell spectrum cannot be properly evoked instrumentally.

Another important consideration is the chord's inharmonicity. A harmonic spectrum possesses a very distinctive shape with open octaves and fifths in its lower register and increasingly smaller intervals in the higher registers. This is not the shape present in this chord. Instead of perfect octaves, there are gaps of eleven semitones between the pairs G♯3 and G4 and A♯3 and A4. In fact, none of the three lower pitches which, under different circumstances, could have been the spectrum's fundamental are transposed at the single octave: G♯3 and F♯3 are only answered after two octaves and A♯3 at three. Fifth relations are also absent: the only C♯ is four octaves away from F♯3; the only D♯s are two and three octaves away from G♯3; and the F is also three octaves away from A♯3. Instead of the linearity of a harmonic spectrum, we are left with a loose

collection of non-fundamentals in the low register and an extensive chain of pitches in the upper registers. In tandem with the chord's inharmonicity, it should be added that many of the intervals in the upper registers are minor thirds, perfect fourths, or major sixths. These intervals are associated with bell spectra,[66] and they occur as a result of frequency modulation. Significantly, this state of inharmonicity as well as the prominence of bell intervals gives the chord a quality which Murail can alter in successive appearances of similar entities. In its very constitution, then, we have the seeds for directionality as inharmonicity will shift into harmonicity.

For all the apparent complexity of this chord, its harmonic ingredients ultimately fuse into a nearly singular sound which takes on timbral constitution. This occurs, regardless of its inharmonicity, through the special relationship of its pitches as the result of their generation through frequency modulation. Aside from the harmonic resources Murail uses to evoke the bell spectrum, his specification of dynamics and choice of orchestration also contribute to the bell image. The chord's entrance—its attack, in other words—comes with all the participating instruments playing no less than *forte* dynamics. The percussion, which includes the chiming tubular bells and vibraphone as well as crotales and piano, even strike their notes at triple *forte*. The woodwinds, to keep from being drowned-out by the brass, play at *fortissimo*. Lower winds, such as the bassoons and trombones, are noticeably excluded from the initial bell sonority with the single exception of the tuba; additionally, the string family is excluded altogether. The simultaneous entrances of the participating instruments also encourage perceptual fusion, though different instruments will fade away at different rates. Fade out in the woodwinds

[66] Hasegawa, "Timbre as Harmony," 1.

and brass is orchestrated by sustaining a particular pitch but slowly decreasing in dynamics until reaching silence. The percussion, meanwhile, is instructed to let their instruments vibrate until the next chord which arrives in m. 9. The woodwinds, generally, fade away quicker than the brass, removing the bright attack before the more resonant sound of the brass. The clarinets, in particular, but also other instruments reinject the sound with specific frequencies at a quieter dynamic even after their initial sound has dropped away. The tuba, though, is given the special role of sustaining its pitch as a drone until almost the next chord begins.

All of these factors contribute to our perception of this sonority not as a reckless mass of notes, but as something much more recognizable and familiar. It is less important, however, that we consciously recognize it as a bell—when it is obviously not an actual bell producing the sound we hear—than that we perceive it as one type of sound, not immediately known to be a harmony or a timbre but still thoroughly discernable from the surrounding sounds. This distinctiveness allows us to recognize the arrival of the next chord and also comprehend its differences from the first. In recognizing each chord as a single entity which slowly transforms into another entity, we can hear the directionality which Murail has established. Meanwhile, the non-triadic, frequential, and complex nature of these spectral chords contribute to the modern sound which Murail also does not wish to forgo. Throughout this procession of chords, one component, however, remains unchanged—specifically, the pitch G♯3 which the tuba had continued to drone after this first entity. As Murail reveals in his writings, he considers G♯3 to be his modulator frequency in his repeated application of frequency

modulation.[67] By leaving the modulator as G♯3 and changing the carrier every few applications, Murail gradually alters his sonority. Through this process, he slowly moves from the inharmonicity of the first chord toward greater harmonicity. Not only do our ears recognize the results of this process, we can also trace it by deconstructing later chords in the same manner as we did the first. Throughout my diagrams, I show the modulator and carrier frequencies in black and give emphasis to other significant pitches with dark gray; these secondary pitches are often octave transpositions of bass notes, but in more harmonic situations also include pitches which are a perfect fifth or major third apart from other significant pitches.

There are a total of twelve chordal entities in the A section of *Gondwana*. Figure 2.2 illustrates the seventh such entity, beginning at m. 25, which, though starting to gain some harmonic elements, is still largely inharmonic. Like in the first chord, there are several clusters of pitches which have gaps of almost an octave in-between. The bottom-most cluster includes the modulator and carrier frequencies, G♯3 and B3, respectively. These pitches are well-emphasized through Murail's orchestration: the first trombone plays the G♯3 at *forte* whereas the piano, fourth horn, and second bassoon all play the B3. Aside from the fifth and sixth octaves where only small intervals separate most of the pitches, there are also more isolated clusters in the fourth, seventh, and eighth octaves. Several interesting intervallic relationships emerge between the pitches of this chord, including attributes that begin to resemble the harmonic series. Firstly, between the members of the third and fourth octaves—in other words, between G♯3 and F♯4 as well as B3 and A♯4—there is nearly an octave of intervallic space; this hints at the octave

[67] Murail, "Avignon Conferences," 206-07.

between the first and second partials in any harmonic series as well as between the second and fourth partials. Secondly, between the B3 and F♯4, there is an open perfect fifth, much like the space between the second and third partials of the harmonic series. Additionally, throughout the chord, there are many instances where pitches are separated by thirds and seconds, the relationships that emerge next in the harmonic series after the octave and fifth. These kinds of relationships, though far from perfectly harmonic, occur much less in the first chord.

Orchestration is also necessary to consider. The tuba, which Murail had given such a special role in the first chord, is excluded from this one. Its G♯3, which was again its property in the sixth chord, is here reassigned to the first trombone. The trombone, however, does not drone the G♯3 for the same length that the tuba had; it drops out within three measures, in-sync with other instruments, whereas the tuba had droned for four measures, including one whole measure where it played by itself. The trombones and bassoons had been excluded from the first chord, but now, in addition to the first trombone's prominence, both the first and second bassoon add force to significant pitches which the horns introduce—the B3 and A♯4, specifically. The percussion which had possessed so much significance in the first chord, see themselves reduced somewhat here in the seventh. Only the glockenspiel and crotales continue into the eighth and, by the ninth, all percussion has gone silent. The initial metallic attack of the percussion which was necessary to create the bell spectrum of the first chord has lost ground as the brass spectrum gradually becomes the new model. The first violins also contribute for the first time here in the seventh chordal iteration; indeed, their playing *divisi* contributes quite a new sound. The second violins had contributed in a limited way since the second chord

and continue to do so here, but, with the addition of the *divisi* first violins, the resultant timbre changes immensely. It is also worth noting that, though all the instruments which contribute still do so at *forte* or *fortissimo* dynamics, their entrances have become somewhat staggered since the first chord. Most instruments also fade in from silence before quickly reaching their peak dynamic. All of these factors contribute to a sonority which has changed immensely since the first chord and which will continue to change.

By the twelfth chordal iteration, which begins at m. 49 of the A section and is shown as Figure 2.3, Murail has arrived at harmonicity. The materials played by the brass, woodwinds, piano, violins, and violas belong almost exclusively to two harmonic series, one related to the G♯3 modulator and another to the F♯4 carrier. The presence of two harmonic series grants Murail a larger pitch collection while also avoiding the obvious, clichéd sound of the harmonic series. The way Murail structures his chord, however, retains the desired effect of harmonicity as he emphasizes certain pitches and intervals which are vital to our perception of this harmonicity. The two series also relate to our previous chords by employing the persistent modulator, G♯3, as well as the most recent carrier, F♯4. These pitches serve as stand-in fundamentals, since the two series are actually constructed on the pitches an octave lower than each. In other words, G♯3 and F♯4 are the second partials and not the first of their respective series whereas the fundamentals themselves are absent from the present pitch collection. Murail, meanwhile, replicates the characteristic shape of the harmonic series by leaving wide open intervals at the bottom of his chord and a tighter concentration of pitches in the higher register. Specifically, the open spaces in the lower register are the open fifth intervals between G♯3 and D♯4 and again between F♯4 and C♯5. This replicates the open fifth between the

second and third partials within the harmonic series, and even G♯4—the fourth partial of the first series—is not played so as to leave uncluttered the open fifth of the second series. The important major third interval which first appears between the fourth and fifth partials is also completed for both series through the inclusion of C5 and A♯5.

Murail's orchestration again emphasizes these vital intervallic relationships. The brass instruments themselves play many of the pitches just mentioned. The second trombone carries the all-important G♯3, playing it at *fortissimo*; this instrument is ultimately joined by the third trombone. The first trombone plays the F♯4 at *fortissimo*, joined in this case by the third horn. Concurrently, the first and fourth horns have the D♯4 at *fortissimo* and the second trumpet has C♯5 also at *fortissimo*. The brass introduce these pitches early in the entity's onset and sustain them nobly throughout. Other important pitches, such as F♯5 and A♯5, which appear in both series receive similarly elevated treatment. The first trumpet plays F♯5 while the third oboe has A♯5; these pitches, too, are sustained for quite some time. Upper partials are taken by the other woodwinds and, while they are sounded at triple *forte* near the outset, they are among the first to fade away. Again, Murail's chord has been shown to be far from simple and triadic. It is, instead, constructed from much richer harmonic materials which, when combined at particular dynamics and through a particular orchestration, evoke a particular timbre. Here, the model is a brass spectrum, but more significantly, it is an entity with a great deal of harmonicity, an attribute which distinguishes it from both the initial inharmonic chord and also from later chords with their decreasing inharmonicity. Within this first section at least, this procession from inharmonicity toward increasing harmonicity is that aspect which most assuredly promotes directionality among the musical materials.

To continue our discussion beyond the A section of *Gondwana*, we must temporarily expand our focus from harmony and timbre to grasp at the larger liminal aesthetic. The continuum of harmony and timbre is, of course, one force acting within sound, but there is also a temporal continuum upon which lies rhythm and meter. So far, we have discussed Murail's spectral chords as isolated events—events which albeit occur in procession and possess identifying harmonic-timbral qualities—without describing the temporal space between their occurrences. The term "periodicity," therefore, can be used to describe the reoccurrence of an event, such as the onset of an entity identifiable as a spectral chord. All sounds possess a certain periodicity in that they are waves which vibrate periodically. Murail, Grisey, and other spectralists have looked to emulate this natural periodicity of sounds, and apply it to the rhythmic and metric dimensions of their music; in fact, they have claimed this to be an even more important innovation than their harmonic-timbral emphasis.[68]

We may observe a flexible periodicity in the A section of *Gondwana* in relation to the onset of the chordal entities. At the outset, the time between each onset averaged at fifteen seconds—in other words, it was periodic at fifteen seconds—but, quickly, this periodicity shrank, so that later chords sounded every five to ten seconds. This hastening built intensity while it also bestowed direction. When the B section begins, however, periodicity gains a much greater degree of flexibility. The awaited thirteenth iteration, which begins at Rehearsal B, unexpectedly shatters, and we listeners would seem to "enter" the sound at this moment. Previously, we had only observed it from the outside; now, instead, the shimmering texture wraps around us and transports us within the sound.

[68] Tristan Murail, "Time and Form in Spectral Music," 247-48; Gérard Grisey, "*Tempus ex Machina*: A Composer's Reflections on Musical Time," *Contemporary Music Review* 2 (1987): 244-47.

Our perception of time expands as the almost steady pulsing of the A section—as it seems in retrospect—vanishes and gives way to longer durations.

Gondwana consists of six large sections, each defined by its texture and demarcated by its rehearsal letter, A through F. We have described section A in detail: its character, moreover, is the regular pulsing of distinct chordal entities above a substructure consistently outlined by the low strings. Section B has the character of one, extensive swath of sound as defined by the short, repeated figures in the winds and strings alike; rhythmically, these figures are unaligned, giving the impression of continuity and the vast expansion of pulse. In section C, pulsing has returned at a more perceptible level, but it is staggered and different groups of instruments pulse at their own speeds as if out of sync with each other. Section D is the decomposition of everything that we have heard previously, the result of the gradual desynchronization over section C; pulse is almost non-existent and pitch too has given way to noise. Approximately halfway through section D, around its m. 50, pulse starts to reemerge and, soon into section E, pulsing has become quite strong. After the dense texture of E, section F admits more space which allows chordal entities to start reshaping as they had in section A; dynamics again fade in and out, peaking only after an initial rise to strength. In the last moments of the piece, one final entity sounds; it is the most definitive since section A and its implosion signals the end of *Gondwana*.

Through this procession of textures, we again find directionality. One distinctive texture gives way to another, and a certain formal shape emerges. We should not, however, call this a "progression," for unlike we shall observe in regard to Saariaho's music, nothing demands that we move from one texture to the next: moreover, this is not

music which is built on tension and release, merely on contrast and gradual change. In this capacity at least, Murail's processions are more like those of Messiaen in *Chronochromie* and, especially, in its *Antistrophes*. Messiaen had exchanged static blocks of sound for other similarly-conceived blocks. With Messiaen though, there were almost always clear divides between movements and sections—borders not transgressed. On the contrary, in *Gondwana*, although sections are distinctive by their textures, their beginnings and ends are fluid. One texture fades away as the other fades in, so that the listener realizes only belatedly that he has entered something new. In other words, the sections themselves are distinctive but their boundaries are not. This is a higher-level liminality, one which we will encounter again in Saariaho's music. In some sense, then, the rehearsal markers are arbitrary. Fade in and fade out had also occurred at the smaller plane of the individual instrument, as we observed in our consideration of section A, and here it is emulated between formal sections and among groups of instruments. Fade in and fade out are also observable sonic processes—attacks and decays can be sudden or sharp, but might also be gradual or flat. Once more sound itself is Murail's model.

I shall conclude this chapter by examining two specific moments from later in *Gondwana* beyond its A section. Now that the formal content of the full composition has been outlined, it should be easier to extract these moments without eliminating their context. My emphasis in these excerpts shall again return to the liminality of harmony and timbre. Example 2.1 is taken from the outset of section D. This example marks an extreme in the entropic process which guides *Gondwana* in that the rich harmony-timbres of the chordal entities and much preceding material has been reduced almost to pure noise. As our formal outline has shown, it comes at the very middle of the composition

before an attempted rehabilitation returns many of the things which had gradually collapsed over the previous sections. In Example 2.1, pitch devolves into noise through several innovative notations as well as written instructions. Foremost among these is the instruction that the winds play only with breath, not creating a heard pitch. Murail notates this with triangular noteheads in the woodwinds and the brass. Nonetheless, noteheads are still placed at specific pitches: while fingering corresponds to the normally-voiced pitches, the sound produced lacks specific pitch in the same way that unpitched percussion does. All that remains is a breathy sound which Murail instructs should gradually become quieter. Meanwhile, the strings—although pitched—play in their extreme upper registers where pitch is less stable due to the instruments' construction as well as the difficulty with which these pitches are reached by their players. With the basses silent and even the cellos playing well above C4, the lack of lower registers subverts the harmonic series, so that the strings are in effect voicing the unstable upper partials of an unknown and unheard fundamental.

The expanded percussion section also adds to the level of noise in this excerpt. Cymbals are struck repeatedly creating a wash of noise that, in fact, overwhelms many of the other instruments. The celesta and harp are notated graphically. Both are given specific ranges to play within, but then told to simply run through these sets of pitches incessantly throughout the excerpt. The celesta is given cues when to speed up or slow down; the harp is only instructed to rub the strings with the palm. These instructions are similar to those given to the other instruments: indeed, every instrument except the vibraphone is asked to repeat their specific gesture without rhythmic rigor, paying more attention to their dynamic levels than anything else. Dynamics fluctuate so rapidly that it

is difficult, if not impossible, for listeners to consciously perceive the moment-to-moment changes, just their overall effect. The vibraphone is actually the only instrument given specific pitches and specific rhythms to carry-out; its contribution, though small, is the only aspect of regularity that remains among the surrounding noise. All of these aspects contribute to a texture which is much noisier than that in any of my other excerpts from *Gondwana*. While the others vary between harmonicity and inharmonicity, none of them are so inharmonic as to devolve into noise. While those excerpts have been constructed, like in Messiaen's music, largely through their specific pitch makeup and orchestration, this excerpt hints at something Saariaho will do repeatedly: manipulate a sound by altering its pitch materials through specific instrumental articulations. Though this also appears in less extreme instances elsewhere in Murail's music, it gains a significant tensional aspect in Saariaho's compositions.

Figure 2.4, my last excerpt from *Gondwana*, shows the final chordal entity which arrives in the closing moments of the piece. Its constitution is not totally dissimilar to the earlier chords which I have examined, but it does differ from these quite significantly. While certain similarities make it comparable to those earlier entities, its intervallic relationships, in particular, suggest a decay that has arisen over the long span of the piece. Whereas the very first entity displayed potential for the harmonic relationships which would emerge by the twelfth iteration, this final entity has lost that cohesion and, it would seem, even the potential to regain that level of focused harmonicity. Most significantly, the G♯3 modulator frequency is absent. Throughout the A section, G♯3 could be relied upon to bring stability to each chord, not only through its own presence but also often through the structural relationships which would accompany it. Its absence already

suggests the dysfunctionality of this last chord. Furthermore, the tuba which had established the predominance of this pitch is also gone from Murail's orchestration. Indeed, the tuba, by this point, has not uttered a single sound for some forty measures at which time it had played a G♯2, an octave transposition of the reliable modulator and the unheard pitch which had been suggested as a fundamental in the harmonic twelfth chord. In the entire final iteration, the only G♯ is in the fifth octave where it is played by the third oboe, first trumpet, and several second violins. G♯5, however, is one of the final pitches to enter, suggesting that its presence is not as a substitute for G♯3, but as an upper partial to another pitch.

The role of G♯3 as sustainer is instead less reliably split between C♮4 and the D♯ pitch class. Whereas C♮4 acquires the temporal function of G♯3, the D♯ class inherits its intervallic, structural aspect. More specifically, C♮4 is the first member of the entity to sound and, significantly, in the role of a drone in the second and fourth horns. Playing in succession, these horns sustain the C♮4 while other instruments enter, enriching the spectrum with their diverse pitch materials. This process is the reverse of the sole tuba drone that lingered from the first entity. Later, the third trombone and the violas reiterate the C♮4. Meanwhile, the role of the D♯ pitch class is vertical. Its lowest transpositions, D♯1 and D♯2, offer one of two instances of an open perfect octave in this chord; the other is between F♯2 and F♯3. These open octaves, while suggesting the significance of these pitches, constitute the only harmonic relationships of the chord; the other intervallic relationships are inharmonic. As far as orchestration, the basses and third bassoon play the D♯1 and D♯2, respectively. In other transpositions, D♯5 is heard early on in the first flute and first clarinet and later in the third trumpet whereas D♯7 is played by the piccolo.

This periodicity across six octaves suggests that, under more harmonic circumstances, D♯1 might have been the fundamental of this final chord. Under the current circumstances, though, harmonic partials only begin filling in around G4 and A♯4, the tenth and twelfth partials.

In the more critical lower regions of the spectrum, the pitches actually confound each other. Besides the two open octaves, the other prominent intervals are minor thirds and detuned fifths. Both of these interval classes are gravely inharmonic, yet they are what we encounter in this pitch space. D♯2 and F♯2 yield a minor third as do F♯3 and A3. The interactions of the microtonal C♮4 with F♯3 and A3 constrict these intervals and creates too much space with G4. Additionally, the interval between A3 and A♯4 exceeds an octave. Thanks to these impure intervals, the resulting spectrum is tense and dissonant. It is also worth noting that many of these pitches or their close relatives appeared in the first or twelfth chords we examined earlier. Recall, that F♯3, G♯3, and A♯3 were the lowest members of the first chord, all played in the left hand of the piano; A4 also appeared in the first horn. The horn now plays a semitone higher at A♯4 while the first trombone and several cellos carry an A3, lowered a semitone from the first chord. Meanwhile, the second trombone and the other cellos have taken the F♯3. The A and A♯ pitch classes did not figure into the twelfth chord to any great extent, but the F♯ pitch class did; there, it was the carrier frequency. With the exception of the added C♮4, the harmonic materials, therefore, have not changed that significantly between this final chord and the earlier ones. Regardless, these changes have had profound consequences for the configuration of this final entity.

As before, the orchestration assigned to the chord's members also impacts our perception of the total sound. The overall image is that of the dynamics of every woodwind, brass, and string instrument eventually growing to *forte* or *fortissimo* before suddenly dropping-out at the equally powerful entrance of the percussion. Nevertheless, before this crucial moment, the texture consists of a great deal of staggering, so that this final chord only very slowly builds in strength. First to enter is the second horn, followed by the first flute, and then the bass clarinet; the fourth horn also, imperceptibly, substitutes for the second horn. This staggering is reminiscent of the later chords of the A section and also the immediately preceding E and F sections. The woodwinds are the first family to really gain strength in this final iteration, giving a suggestion of the first, bell-like chord where they and the percussion had predominated. The woodwinds, however, lose their advantage when the brass and strings reach their full dynamics; these instruments, recall, had predominated in the twelfth, brass-like chord. The woodwinds do not relent, so that the result is a cluttering of the perceived spectrum, especially when the percussion suddenly enter at their peak dynamics. This cluttering, which occurs in a more traditionally timbral realm, matches the confounding of the pitch space—an attribute which is more traditionally harmonic, although its constitution exceeds purely harmonic considerations. Taken together, these traits mark an endpoint in the process which has guided the entire composition; it is a point past which *Gondwana* cannot continue.

That this final chord would involve so many harmonic-timbral aspects related to preceding moments in *Gondwana* implies that these moments are, indeed, related harmonically and timbrally. Moreover, it suggests a continuing harmonic-timbral dialogue which runs throughout *Gondwana*. Messiaen, on the contrary, had given no such

horizontal, functional role to his expanded harmony-timbres in his *Strophes*, requiring instead that form appear as a bright mosaic of smaller images. Even in the *Antistrophes*, motion was created by the contrast of instrumental timbres, and not the color chords which had defined liminality in their counterparts. Ultimately, my excerpts have been just that—excerpts—but they have already demonstrated how in the music of Murail sounds existing in the harmony-timbre continuum might transform through their own harmonic-timbral means. Periodicity, invoked earlier to summarize the formal shape of this piece, is, consequently, not the only way in which *Gondwana* holds together formally. My excerpts, then, show that an aesthetic can be built around the liminality of harmony and timbre—specifically, how Murail builds such an aesthetic—through the gradual transformation of these materials.

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My analysis proves that Murail's Darmstadt lectures of 1980 and 1982 were not just empty talk, but a projection of his aesthetic aims and a reflection of their consequences in *Gondwana*. The composer who had been so insistent on modeling his music on sound and accomplishing this modeling through computer analysis has demonstrated that these aims can be productive. Specifically, in *Gondwana*, Murail has modeled every aspect of his composition after frequency modulation. He has derived his expanded harmony-timbres from pitch material calculated from frequency modulation; its repeated application has also provided form to the piece. He has, therefore, accomplished what he meant when he claimed the sonic material *is* the form of the piece. Even without recourse to frequency modulation, we can observe this dynamism of acoustic continuities

simply through score analysis. My excerpts have shown that Murail's spectral chords contain all the same attributes of acoustic spectra. Pitch, with its registral context intact, matches frequency; dynamics correspond to amplitude; and orchestration allows the mass to cohere. In expanding our conception of the chord beyond a trite stacking of pitch classes, Murail has brought his spectral chords more in line with acoustic reality. In recognizing the differences within and between these spectral chords, he is also able to reestablish motion, this time as a consquence of harmony as well as timbre.

In Murail's liminal aesthetic, directionality through process is teamed with complex sounds which defy the traditional boundary between harmony and timbre. These two aspects of his liminality—one horizontal and the other vertical—are much more connected than such a statement would suggest. They are, instead, the consequences of each other as has been shown through my formulation of Murail's aesthetic and examination of it in *Gondwana*. This aesthetic is one which Murail will continue to construct, quite gradually, throughout his career. Though we shall not see in this thesis how it develops in his own hands, we shall see in my next chapter how Kaija Saariaho develops her own liminal aesthetic, aware of Murail's approach but also driven by her own experiences. While she will undoubtedly question some of Murail's tenets, his innovations will also inspire her own. She will, in the process, draft something quite different and also more nuanced, resolving some of the questions left unanswered by Murail as well as pose new ones for her and others to answer.

CHAPTER THREE: KAIJA SAARIAHO // *DU CRISTAL*

We saw in Chapter Two that the accomplishment made in the 1970s by the French spectralists—Tristan Murail and Gérard Grisey, most notably—was to restore directionality to music without compromising a fully modern aesthetic. It was their vision, their aesthetic of liminality, one founded on process and continuity, which they then shared at Darmstadt through lectures and performances of their music beginning in 1978. Chapter Three now considers the Finnish composer, Kaija Saariaho, who has desired of her aesthetic more than mere directionality and instead has sought the contrast of musical materials in real-time—an aspect which in music of the common practice era has sometimes been referred to as "drama." For her, contrast had to occur from moment to moment and could not consist only in a gradual evolution over the span of a composition as it had for Murail or Grisey. Neither was a return to the stasis of Olivier Messiaen a viable option. This drama is what makes Saariaho's aesthetic so different from theirs for, whereas her music also exploits a liminality between harmony and timbre, her application of these musical elements instead resembles an extended tonality in which tension and release once again occur. After describing her distinct liminal aesthetic through Saariaho's own writings and those of others, I examine one of the most definitive realizations of this aesthetic, namely her orchestral composition *Du Cristal*.

I. Defining Aesthetics // Generating Tension between Harmony and Timbre

Kaija Saariaho, like many outside the immediate circle of French spectralists, first came into contact with this new music while at the Darmstadt summer courses. She was in attendance in 1980, the same year that she completed her formal composition studies at the Sibelius Academy with the modernist Paavo Heininen. After Darmstadt, however, she would not pursue study with either Murail or Grisey, but instead went to Freiburg where Brian Ferneyhough and Klaus Huber became her instructors. Their strict, post-serial aesthetic did not agree with her own emerging idiom, nor did she feel comfortable in the culture of unfeeling rationalism it engendered. As soon as 1982, she had relocated to Paris where she felt she identified better, despite her initial unfamiliarity with the French language.[69] Saariaho has spoken of the freedom she found in Paris: "It's so good for me, the value Parisians give to their senses […] the wines, the scents, the multitude of possibilities: it somehow relaxed me, gave me a freedom."[70] Her sensory and communicative aesthetic could take root here outside of the confines of post-serialism and amid a musical environment prepared for her explorations by those of the French spectralists. Her aesthetic was additionally strengthened through her work with computers and the digital sound analysis technologies available at IRCAM. Her studies at this institute, the proximate cause for her move to Paris, provided her with the technological and acoustical foundations so essential to spectral music which, under different circumstances, she might have received through firsthand studies with either Murail or Grisey.

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[69] Pirkko Moisala, *Kaija Saariaho* (Urbana and Chicago: University of Illinois Press, 2009), 10.
[70] Cori Ellison, "Uncovering Beauty in Ordinary Noise," *New York Times*, November 7, 1999, https://www.nytimes.com/1999/11/07/arts/music-uncovering-beauty-in-ordinary-noise.html.

Though Saariaho has been an admirer of the music of the French spectralists, she has also insisted on developing her own aesthetic apart from theirs. She borrows from them a post-electronic way of thinking about music, one which draws microtones from the full frequency continuum and prefers continuous, sonic masses to isolated notes. Like them, she also utilizes electronics to add fixed tracks to acoustic works as well as manipulate instrumental sounds in real-time. While she, indeed, valued their recourse to technology, she disparaged their grounding of compositional structure in sonic processes. As Eric Drott explains, "The problem was that, in privileging acoustic models, this approach established an asymmetry between [timbral and harmonic] domains: the microstructure of spectra generated harmonies, but the macrostructure of harmonies never generated spectra."[71] What had seemed like a dynamism between harmony and timbre began to prove vague and limiting for the thinking composer. She would have to find new formal principles, if she was to be satisfied. For her distinct aesthetic stance, Damien Pousset has considered Saariaho, along with Philippe Hurel and Marc-André Dalbavie, composers who studied with Murail, to be a "post-spectralist."[72] With greater historical distance than Pousset, however, I am more willing to see these composers and others as a second generation of spectralists: despite their aesthetic differences, they possess many shared concerns with the first spectralists, which further distinguish their stances from post-serialism, the new complexity, neo-romanticism, postmodern

[71] Eric Drott, "Saariaho, Timbre, and Tonality," in *Tonality Since 1950*, ed. Felix Wörner, Ullrich Schneider, and Philip Rupprecht (Stuttgart: Franz Steiner Verlag, 2017), 265-66.
[72] Damien Pousset, "The Works of Kaija Saariaho, Philippe Hurel, and Marc-André Dalbavie—*Stile Concertato, Stile Concitato, Stile Rappresentativo*," trans. Joshua Fineberg and Ronan Hyacinthe, *Contemporary Music Review* 19 (2000): 68-69.

eclecticism, or some other artistic trend.[73] Moreover, Saariaho and these contemporaries have entered the spectral dialogue, one which arose in Paris in the 1970s through the innovations of Murail, Grisey, and the others, but which has persisted to the present day.

Saariaho's insistent questioning of received wisdom is in part driven by the inspiration she takes from extra-musical sources including literature, poetry, visual art, and nature. In her youth, female authors like Simone Weil, Virginia Woolf, Anaïs Nin, and others frequently stood-in as the inspiration for her artistic aims as she knew of few female composers who could be her models. She has written, "I tried in vain to find a model in the world of music […] No doubt this is why I was interested in the lives of female writers, and took pleasure in reading their diaries, letters, and biographies."[74] To this day, she often finds a structural prototype for a composition in one of her non-musical interests, translating some aspect of its structure into her composition. Her interests outside of music have, furthermore, enriched her worldview and encouraged her to find connections between her compositions and the long history of Western culture. If something traditional pervades her music, it is a carefully considered stance, for modernist, progressive views are also unrelenting forces in her music. With her student colleagues at the Sibelius Academy, she had cofounded the Ears Open Society in 1977 for the express purpose of breaking away from the cloistered, neo-romantic bent in Finnish music at that time. Saariaho once described the camaraderie and friendship that existed between their members, which also included Magnus Lindberg and Esa-Pekka

[73] I also see Magnus Lindberg, Georg Friedrich Haas, and George Benjamin as potential members of this second generation whereas the so-called saturationists—namely, Franck Bedrossian, Raphaël Cendo, and Yann Robin—might be considered to be among a third generation.
[74] Kaija Saariaho, "My Library, from Words to Music," trans. Jeffrey Zuckerman, *Music and Literature* 5 (2014): 13.

Salonen, as follows: "Everyone was active and enthusiastic. If someone found an interesting record, we would all listen to it."[75] An openness to both modernism and tradition has persisted in Saariaho's aesthetic.

Saariaho's article, "Timbre and Harmony: Interpolations of Timbral Structures," published in *Contemporary Music Review* in 1987, is pivotal as a summation of her research and compositional aims to that point. Indeed, it responds to many of the concerns which worried her about the music of the first spectralists, even if she does not challenge these forebearers upfront in the same way Murail had challenged his. The aesthetic stance it voices is particularly relevant to *Du Cristal*, which was composed in 1989, only two years after the article's publication. Her article centers on a discussion of form, and specifically how her revised conceptions of harmony and timbre contribute to form. Form for her, she states, depends on the material itself, and she quotes the painter Kandinsky's definition of this term as "the external manifestation of inner meaning."[76] In other words, form in her music is generative, not prescriptive. On a most basic level this means that she does not apply well-known formal structures, such as sonata or the rondo, as she voluntarily admits.[77] Instead, she looks to her musical materials themselves for formal guidance. Though this stance would seem to connect her to Murail and the first spectralists, whereas they had been insistent on learning from the "inner consequences of sound," she is much more open to intuition. "With the ear," she writes, "I always [find] a means of remodeling an uninteresting chord, often without even breaking the rules that I

[75] Quoted in Kimmo Korhonen, "New Music of Finland," in *New Music of the Nordic Countries*, ed. John D. White (Hillsdale, NY: Pendragon Press, 2002): 228.
[76] Kaija Saariaho, "Timbre and Harmony: Interpolations of Timbral Structures," *Contemporary Music Review* 2 (1987): 93.
[77] Ibid.

had fixed for myself."[78] An aesthetic consumed with "consequences" and sonic modeling is not what she is after, though she, indeed, uses their same word—"dynamism"—to refer to the interrelatedness of the generative materials and their formal realization.

Within her materials is contained a tensional element which goes largely unexplained in her article. This tensional aspect, it would seem, is both essential to Saariaho's creation of dynamic form and inherent in the materials with which she composes. Moreover, her inability or unwillingness to explain her insistence on moment-to-moment tension and release makes this aspect seem inexplicable, assumed, or taken for granted. That her musical upbringing was in Finland and not central Europe might influence this. In some of its most foundational respects, Saariaho's aesthetic is still a reaction to Sibelius, and not the serial and post-serial lineage of central Europe, as is the aesthetic of the French spectralists. Pirkko Moisala, in her biography of Saariaho, writes that, prior to her studies with Heininen, "Her image of what composers were like was largely inspired by Beethoven and Jean Sibelius, the Finnish national hero who was always pictured as a sturdy old man with a big cigar […] a real composer was a decidedly serious, male character."[79] The legacy of Sibelius was ultimately paralyzing for her in her youth. In finding her own aesthetic, Saariaho has inevitably wrestled with his influence, avoiding the symphony—the definitive genre for him and so many later Finnish composers whom he inspired—but pursuing his more innovative interests in texture, timbre, and continuity.[80] So too might her insistence on dynamism descend from Sibelius and his enduring hold on Finnish music.

[78] Ibid., 122.
[79] Moisala, *Kaija Saariaho*, 4.
[80] Korhonen, "New Music in Finland," 134-35.

Along with the importance she assigns tension and release, she finds in her aesthetic greater parallels with traditional tonality than most modern music. She writes, "Amongst familiar organizational models concerning pitch, the tonal system is, in my own experience, the most effective means of using harmony to construct and control dynamic musical forms."[81] The extended, dynamic forms to have emerged in the tonal era are evidence enough for her of that system's validity—at least in its own time, as she is quick to point out. She responds, tonality remains "only a potential model" which, importantly, is suited exclusively "for the creation of tensions through the use of pitches."[82] Tonality, in Saariaho's view, therefore, can serve as an example for the contemporary composer, but it cannot replace the exploration or innovation still required to construct dynamic forms with the new vocabulary which modernism has made available. Indeed, she remains always the modernist despite several of her more conservative leanings. As Drott summarizes, from Saariaho's perspective, "Tonality, it appears, is one system that builds upon this innate human propensity to apprehend the world through a grid of significant differences. But it is not the only one. Others might be identified—or invented."[83] Tonality can serve as a model for contemporary composers in creating new systems, but it should not be embraced absentmindedly for it has exceeded its usage as such. Her concerns about tonality in contemporary composition harken back to those of Debussy and Schoenberg a century earlier: well aware of tonality's limitations beyond the realm of pitch, they too had sought a language which could better account for other musical parameters.

[81] Saariaho, "Timbre and Harmony," 94.
[82] Ibid.
[83] Drott, "Saariaho, Timbre, and Tonality," 260.

An important undercurrent to this discussion is the idea that harmony and timbre, at least as musical elements, nonetheless, exist separately and independently of each other. Although acoustic reality demands an interrelationship of harmony and timbre, as we saw in our examination of Murail's aesthetic, harmony and timbre act separately in Saariaho's music and can be manipulated independently, sometimes even at odds with each other. Moreover, she claims to consider harmony and timbre to be parameters which have "frequent points of contact."[84] From the standpoint of her spectral predecessors, this would be a controversial, if not heretical, admission! Composers like Murail and Grisey had shunned any kind of parametrization as a failing of post-serialism; Murail, as we saw, was particularly vocal about this point in his Darmstadt lectures. Her article, however, utilizes the term "parameter" repeatedly and freely, never shying away from it as Murail would have. In this stance, she is more traditional—and also less vague—than Murail who had maintained that harmony and timbre exist in music precisely as they do in acoustic reality: one as the natural extension of the other and immutable apart from each other. Saariaho's parametrization of harmony and timbre resembles either the traditional, tonal approach or that of the serialists and post-serialists—her teachers, Heininen, Ferneyhough, and Huber included. Saariaho, perhaps in deference to her spectral forebearers, nevertheless, is certain that these musical parameters are distinctive dimensions of a larger sonic whole and insists that they be deployed dynamically.

Quite late in her article, Saariaho poses the pivotal question which has driven this discourse: that is, "Can timbre, like tonal harmony, serve to construct similar tensions on several levels, or would it be in spite of everything a secondary parameter in relation to

[84] Saariaho, "Timbre and Harmony," 124.

rhythm and tonality [i.e. pitch], as has often been supposed?"[85] It is a question which hinges on parameters and which considers function and hierarchies; it extends beyond mere directionality and opens the debate to moment-to-moment tension and release. The American musicologist and aesthetician, Leonard B. Meyer, in his contemporaneous text, *Style and Music*, describes the traditional distinction between primary and secondary parameters when he writes:

> The primary parameters of tonal music—melody, harmony, and rhythm—are syntactic. That is, they establish explicit functional relationships (such as tonic and fifth, subdominant and dominant, accent and weak beat) and specific kinds of closure (authentic or deceptive cadences, masculine or feminine rhythms) that make articulated hierarchic relationships possible. Secondary parameters, on the other hand, are statistical in the sense that the relationships to which they give rise are typically ones of degree. … [They] cannot readily act as the basis for articulated hierarchies, but only for continuous, emergent ones.[86]

Saariaho, though she might agree with Meyer's definitions of primary and secondary parameters, is resolute that timbre can, in fact, become a primary parameter. She intends to demonstrate this both through the many analytical examples she quotes from her compositions and by citing the scientific research she has conducted with acoustician Stephen McAdams. Some of this research had appeared in the earlier article Saariaho and McAdams had co-authored titled, "Qualities and Functions of Musical Timbre," published in 1985, and she previews their further research toward this goal in the final pages of "Timbre and Harmony."

But, how does timbre gain hierarchy, function, and closure—Meyer's qualifications for a primary parameter? In light of the sonic interrelatedness of harmony and timbre, it already possesses these qualities, though they remain undeveloped in so

[85] Ibid., 131.
[86] Leonard B. Meyer, *Style and Music: Theory, History, and Ideology* (Philadelphia: University of Pennsylvania Press, 1989): 209.

much Western music. Once again, liminality enters the equation and, though Saariaho denies Murail's accession that music exists as sound, this realization which originates in acoustics and technology allows Saariaho to apply harmonic constructs to the realm of timbre. Whether the interconnection of harmony and timbre is physical or only metaphorical, this becomes a first step in conquering the untamed entity of timbre. In effect, her timbral thinking becomes like an extended tonality—a dynamic language founded on dramatic tension and release. As Vesa Kankaanpää writes, in Saariaho's music, "potential for form is seen where it has not been seen before, and instead of tonal form, we have timbral form."[87] Saariaho discovers timbre to be just as nuanced and malleable as harmony, if still novel in the little it has been explored. Moreover, harmonic constructs like consonance and dissonance can be applied to the realm of timbre; tension and release follow as do concepts of progression, melody, counterpoint, and, broadly speaking, function.

Critical to her functional understanding of timbre is the sound/noise axis which she has devised and describes in "Timbre and Harmony." On this continuum of timbral consonance and dissonance, she considers pure sounds like sine tones, string harmonics, *sul tasto* bowing, and birdsong near the consonant terminus and noisier sounds like *sul ponticello* and whispering into the flute near the dissonant terminus; many other sounds fall somewhere in-between.[88] She portrays her axis as both abstract and subjective; its primary usefulness is to her, in her compositions, and to setup tensional contrast. She writes, "The terms that I use in the context of my work are subjective and

[87] Vesa Kankaanpää, "Dichotomies, Relationships: Timbre and Harmony in Revolution," in *Kaija Saariaho: Visions, Narratives, Dialogues*, ed. Tim Howell, Jon Hargreaves, and Michael Rolfe (Farnham, UK: Ashgate, 2011), 159.
[88] Saariaho, "Timbre and Harmony," 94; Pousset, "Saariaho, Hurel, and Dalbavie," 82-83.

unconventional, and have actually nothing in common with the usual psychoacoustic terminology."[89] Yet, it should be noted that, the purer sounds generally exhibit greater harmonicity while the noisier ones possess greater inharmonicity. For example, *sul tasto,* which is situated on the purer end of the axis, reduces the strength of the overtones, whereas *sul ponticello,* on the noisier end, encourages these overtones. String harmonics, though they reduce the fundamental—transpose it more accurately—again bring focus to select partials and minimize the noisy interference of others. On the other hand, whispering into the flute replaces pitched sound with unpitched noise. A major exception, however, from the rule that inharmonicity and noise are equivalent in Saariaho's music is the sound produced by the ringing of a bell; this she considers a pure sound despite its inharmonicity.[90] At a larger plane, texture also figures into the consideration of timbral hierarchies. Saariaho explains, "A rough, noisy texture would thus be parallel to dissonance, whilst a smooth, clear texture would correspond to consonance."[91] Timbre, moreover, is a synthesis of the relative purity of a sound and also that sound's texture—grainy or rough, smooth or consistent. All of these factors, theoretically, have their place on Saariaho's sound/noise axis.

The first generation of spectralists had made similar distinctions between purer and noisier sounds. Their compositions, indeed, often track this same entropic movement from purer sound into noise or vice versa over the extent of the piece. Saariaho's true accomplishment, then, is that, in making these distinctions *a priori*, she allows herself to employ them in real-time and thereby suit her dramatic intentions. In this way, she is no

[89] Saariaho, "Timbre and Harmony," 93.
[90] Ibid., 94.
[91] Ibid.

longer limited to the gradual, sonic transformation of Murail and his colleagues. Saariaho's views on harmony and timbre, ultimately, differ enough from those of the first spectralists that they entail a different conception—a recontextualization—of the liminality that exists between these parameters. For Murail, liminality had been something hazy or otherwise unclear where harmony *became* timbre. Conceptually, harmony and timbre were two extremes on a continuum where there was also a rich middle ground which could be described neither as harmony nor timbre. In practical terms, liminality amounted to uncertainty: not knowing where the border lay between harmony and timbre or if there even was one.[92] On the contrary, for Saariaho, there exist specific liminal points where harmony and timbre intersect; significantly, it is her privilege as composer to manipulate where we as listeners perceive their intersection. This ability to control liminality furthers the tensional aspect of her aesthetic as harmony and timbre can, and often do, come into conflict with each other. None of this would be possible without her conceptual separation of harmony and timbre despite their acoustic continuity. In this way, she restores *musical* meaning to these terms, apart but informed by their understanding in the science of acoustics.

II. Applying Aesthetics // Tracing Liminality in *Du Cristal*

Now that I have described the broad aesthetic vision which Saariaho projected in the late 1980s through her article "Timbre and Harmony," I shall examine her contemporaneous composition *Du Cristal* within this context and as representative of this

[92] Anne Sivuoja-Gunaratnam, "Miniatures and Tensions: Phenomenological Reverberations in and around Kaija Saariaho's *Lichtbogen* (1985-86)," *Intersections* 25, no. 1/2 (2005): 56.

vision. Saariaho's liminal stance in regard to harmony and timbre may be observed in two interrelated ways. Indeed, while I define them individually here, I shall consider them simultaneously. First, the analyst should observe how Saariaho reverses the traditional roles of harmony and timbre: suddenly, timbre is the functional, progressive element, as harmony had been in tonal music, and moments of timbral tension transfer into moments of timbral release and vice versa. This first consideration, understood horizontally, may be examined on several planes, as occurring within a single instrumental line, across a complete section, or throughout the piece in its entirety. The idea is that noisier sounds resolve into purer sounds, or that there is a progression from timbral consonance to timbral dissonance as these states are understood on the sound/noise axis. Saariaho describes what happens when timbre, and not harmony, is used in her music as the functional element: "These two elements become confused when timbre becomes an integral part of form and when harmony, by contrast, is confined to determining the general sonority."[93] In her expanded tonal conception, gradations of timbral consonance and dissonance exist, so that movement from one state to the next gives the composition momentum as timbre gains a functional context. Timbre, in effect, becomes a primary parameter while harmony is made secondary. According to this first approach, then, my aim will be to highlight areas of tension as well as their necessary release.

Concurrently, a real-time tension can be observed between harmony and timbre when timbral articulations or orchestration affect pitch content and, thereby, the harmonic makeup of a spectral chord. This second approach, essentially vertical in conception, was

[93] Saariaho, "Timbre and Harmony," 94.

a consideration for Murail as well—especially in the D section of *Gondwana*—but through Saariaho it gains a tensional connotation when she uses it to her advantage in opposing musical materials. Articulations like *sul ponticello* and increased bow pressure not only increase the noise content of the sound in a vague sense, but measurably alter the volume of certain partials, affecting the spectral expression of the total sound. Whereas Murail is more concerned with the specific pitch content of his complex chords, Saariaho's concern is the broader tensional effect which these noisier articulations can create. In this way, while the acoustic classifications of harmonicity and inharmonicity were key considerations for Murail, with Saariaho, we must think in terms of sonic purity and noise, even when these things become more metaphorical and contextual than scientific. Furthermore, because tension, and particularly tension from moment to moment, distinguishes Saariaho's music from that of either Murail or Messiaen, we must seek tension and the resolution of tension in our study of *Du Cristal*. For Saariaho, liminality is not ambiguity, but tension in the timbral dimension and also tension between harmony and timbre. This tension is what gives her music momentum and a sense of drama, and it is this drama which we must locate in *Du Cristal*.

On the smallest of planes, that of the single instrumental line, the placement of a sound on the sound/noise axis can often serve as a sufficient indicator of timbral tension and release. At other times, and especially on larger planes, texture must also be considered as the individual sounds intersect, fuse, and possibly interfere with one another. We begin our analysis on the smallest plane, gradually turning to larger planes. To this extent, Example 3.1 shows a violin solo which begins at Rehearsal B. Here, as usual in her music, Saariaho notates bow positions and dynamics quite rigorously, so that

these elements become indicators of timbral tension and release. Articulations and dynamics such as these affect the notated pitches and have special consequences for timbre; moreover, they are often used in conjunction with pitch materials to foster tension and release. Specifically, quieter moments are often accompanied by the purer sound of *sul tasto* bowing, whereas the intensity of louder moments is increased through noisier *sul ponticello* bowing. Also characteristic of Saariaho's writing, there is continual transition between these states as indicated through the arrows above the staff and the *crescendi* and *decrescendi* below. This consideration additionally reveals flux as a significant component of her aesthetic. These timbral transitions happen in sync with the repetition of an essential motivic figure—namely, an ascending semitone which at its simplest moves from E6 to F6. Iterations of this motive, bracketed in Example 3.1, contribute to a sense of periodicity in the same way that the chordal entities of Murail's A section gained periodicity through their iterations. Also like in *Gondwana*, periodicity tends to be flexible, continually tightening and loosening but always recognizable through the elements which remain constant.

There are a total of eight iterations of the motive which grow from its simple, ascending semitone form into a more extended ascending gesture before finally smoothing into a semitone trill. The first iteration possesses a certain tension simply through its emergence of a solo, melody voice from amid the mass. Above the staff, Saariaho instructs, "*sempre intenso, espressivo*," and this can be taken to imply a degree of tension regardless of the moderate dynamics and normal bow position. While the attack on E6 is played *mezzo-forte*, by the release of F6, dynamics have decreased to *piano*. The greatest tension, however, is not at the attack, but at the transition to F6. The

harmonic dissonance of the semitone interval contributes to this tension as does the mechanical act of shifting pitches on the violin. This liminal moment, when E6 crosses a threshold and suddenly becomes F6, has the strongest tension in this first iteration in the same way that Saariaho observes the sudden, irrevocable shift from a consonant to a vowel to be a tense, liminal moment in spoken language.[94] In taking such a microscopic approach, she amplifies the overlooked tension in the routine transition from one interval to another. The second iteration gains a small degree of tension as a repetition of an already tense moment at a slightly quicker rhythmic value.

Tension builds further with the third iteration which has now grown to include two ascending figures—the first, the original semitone interval of E6-F6 and, the second, from A5 to E6. Though the two arcs would suggest this could also be viewed as two independent iterations, I choose to consider it a single iteration owing to its tied bowing, these arcs' shared dynamic decrease, and their shared bowing shift. Though the dynamics do not differ from the first or second iterations, tension increases through the rhythmic elongation of the semitone interval, the extension of the motive through the double arc, and, most importantly, the bowing shift from *sul ponticello* to *sul tasto*. The sudden attack at the noisier *sul ponticello* increases tension while the gradual switch to the more sonorous *sul tasto* decreases tension. With this bow change, moreover, both the tension and release are greater than in the previous iterations. The trajectory of this bow change, from tension to release, again matches the trajectory of the dynamic decrease from *mezzo-forte* to *piano*. The motive once more expands in the fourth and fifth iterations; so too does the level of tension as the attack dynamic is amplified to *forte*. Although the

[94] Ibid., 104.

fourth iteration still contains the semitone from E6 to F6, the fifth iteration has settled on the widened interval of A5 to E6, which we should notice is an ascending perfect fifth. Tension also increases in this fifth iteration through the imitations of the other strings; they, indeed, do not have the same restraint as the soloist and take over for a moment while the solo violin is forced into silence before the sixth iteration.

As of the sixth and seventh iterations, the interval has expanded well beyond a semitone. Though these iterations keep the ascending shape of their predecessors, the figures are otherwise less directional: they remain in normal bowing position throughout with the sixth gradually fading in and the seventh gradually fading away again to *piano*. The final eighth iteration begins to regain its shape, initiating at C5 and peaking at C♯6—which, spelled enharmonically as D♭, will soon be shown to have harmonic significance to *Du Cristal*—while falling in dynamics from the familiar *mezzo-forte* to *piano*. The smoothing process then begins as the figure devolves into an ascending trill, again at the interval of a semitone. That the figure would transform into an ascending trill is revealing in that this gesture still maintains the essential shape and intervallic content of the initial two-note figure. As a trill, its periodicity has hastened, but the motivic shape has remained unchanged. Bow position and dynamics again come into play in increasing and decreasing tension across this figure, as heard at Rehearsal D. Normal bowing position yields to *sul tasto* and then fades into silence. When sound resumes, bowing begins at the purer *sul tasto* before peaking at a noisy *sul ponticello* played at a *mezzo-forte* dynamic. Though the interval of the semitone remains, it has now been transposed down from E6-F6 to A5-B♭5. This is the same perfect fifth relationship that we encountered as of the fifth iteration. The perfect fifth is, of course, one of the essential intervals in both tonal

harmony and within the harmonic series, though it would take further investigation to uncover its relevance in Saariaho's music.

Overall, we can say that timbre is the primary determinant of form in this excerpt: the changes in articulation and dynamics which so critically affect timbre provide the moment-to-moment contrasts lacking in the slow harmonic transition down a perfect fifth. I have already discussed this minimization of other parameters, such as harmony and melody, in order to foreground timbre; now we see it in action. Furthermore, the periodicity of the figure lengthens and contracts according to these timbral shifts. The essential interval of the first several iterations remains no more than an ascending semitone. Its widest expansion in the fourth and fifth iterations comes in direct reaction to the building tension. Toward the end of this excerpt as the directionality of the iterations is reestablished and its smoothing into a trill, the figure has regained only some of the intensity that had led to its demise in the fifth iteration, before finally it weakens fully and fades into silence. Unlike in the music of the first spectralists, there is not one slow transition from pure sound into noise or vice versa. Instead, transitions like these happen intermittently throughout the piece and, even at this smallest scale, the image is one of constant flux between tension and release. This essential shape—an initial moderate intensity which builds to peak intensity before gradually decreasing toward release—remains of critical importance throughout *Du Cristal*. It was the formal shape of the first iteration which then expanded in many of the following iterations; indeed, it was also the shape of the succession of eight iterations ending in the trills. Later, I shall demonstrate it to also be the broad formal outline of the entire composition by describing the relative tension and relaxation of large sections.

Strings have a ready arsenal of articulations which can affect timbre and which are well-described on the sound/noise axis. Timbral articulations for wind and percussion instruments are, however, less-thoroughly described on Saariaho's axis. Percussion instruments, as expected, create noise as they always have: through increased rhythmic activity and heightened dynamics. Wind instruments are more interesting to consider, and, often in her compositions, Saariaho has them create noisy timbres through breathier playing and overblown notes as well as syllables spoken into the body of the flute. She does not, albeit, make extensive use of these wind articulations in *Du Cristal*, possibly because she knows the rehearsal constraints of an orchestra. She instead, and quite subtly, creates timbral contrasts in wind lines through more familiar playing techniques, such as trills, *glissandi*, and fluctuations in dynamics. Example 3.2 quotes the brief piccolo solo which begins at Rehearsal J. As in Example 3.1, the piccolo also reiterates a motivic figure which expands and contracts over the course of its short-lived solo. This is now a descending semitone on C7-B6 which again eventually moves down a perfect interval to G6. The trilled attacks establish tension through the graininess of the texture they create, as if a ringing alarm. The *forte* dynamics do not merely make the sound louder but also more intense and, thereby, noisy in the intensity of breath which they require. The formal shape is much like that of the previous example: quickly arising from quiet to an initial strength, fading some in the middle, and then peaking again before finally fading to total silence. Harmonically, the descending pitches relieve tension whereas the *glissandi*, always ascending in this excerpt until the final fall, contribute their own distinctive timbre while also broadening the harmonic palette.

In my remaining excerpts, I move beyond the plane of the single instrumental line as I gradually sketch the formal shape of *Du Cristal* as defined by the tensional regions which comprise it. We have already observed how timbral articulations can affect the sound/noise content of a single line. We have also witnessed harmonic activity minimized to allow timbral progression to rise to our perceptual foreground. At this larger plane, these timbral and harmonic considerations remain active, but now we must also think in terms of the larger pitch collection as we had for Messiaen and Murail; it will have its own timbral and harmonic implications. Figure 3.1 diagrams the opening sonority of *Du Cristal* as presented in its first four measures. Like the chordal entities of Murail, this sonic mass is very specifically orchestrated, and immediately we notice how different instruments provide different partials at different dynamic levels. Generally speaking, the winds and percussion attack at their loudest dynamic, giving this chord a metallic ring at its sudden onset—much like Murail's first bell-like entity. The horns and triangle are an exception to this rule, each of these instruments fading in gradually from silence as do the strings. While the percussionists are instructed to let their instruments vibrate, the winds quietly interchange as they run out of breath; both of these aspects have taken full effect toward measure five when the sonority changes slightly. It might be added that the strings uniformly enter in *sul tasto* position, so that their entrances maximize the fundamental and only later allow other partials to begin affecting the sound they create as they switch to their normal bowing.

With the delay in the strings and horns, the chord's full harmonic content does not come into focus until the second or third measure. The basses alone play the critical D♭2 which as, the lowest pitch in this sonority, acts like a fundamental. Without D♭2, the

sonority also initially lacks a strong perfect fifth interval. Instead, the emphasis at first rests on C3, which is initially sounded quite strongly by the tuba, gong, timpani, and harp and later re-enforced by the second horn and first bassoon. At this early stage, the attack itself overwhelms the harmonic construction of the chord, so that more than anything we perceive its noisiness as tension with the sudden disappearance of silence. It takes the emergence of D♭2 in the basses as well as the B3 in the cellos to balance and, thereby, focus the sonority. Only then, with the attack in the past, do the harmonic implications of this sonority come to the foreground. Treating D♭2 as the fundamental, the sonority possesses only a few intervallic relationships of the harmonic series; in other words, it is mostly inharmonic. Though there are wider spaces in the lower register, these are major sevenths between D♭2, C3, and B3, not perfect octaves. The upper register is tighter, but it is also not organized according to the harmonic series. While the G♭ pitch class, linked to the D♭ pitch class through a perfect fifth, has periodicity at both the fourth and fifth octaves, these are removed from the only D♭ in the second octave.

Register, while significant for detecting the inharmonicity of the sonority, provides only limited understanding of the tension inherent in this sonority. To detect this tension, we must strip away register and, instead, look at pitch class and not pitch. This is a radical break from Messiaen and Murail for whom register was vital! Furthermore, it speaks to Saariaho's stance that harmony and timbre are separable entities, for to abstractly remove register from pitch suggests that harmony can function without the registral concerns which accompany timbre. Eight tempered pitch classes are present in this sonority, including D♭-D-E♭-F-G♭-A♭-B-C; there are also two microtones—G𝄲4 and

B♯4—to be discussed momentarily. Among these pitch classes, all six interval classes are represented: four from the interaction of D♭ with other pitch classes; the tritone is present between D and A♭ and there also several perfect octaves. Excluding the microtones, the interval-class vector for this pitch class collection is <556453> with a Forte label of 8-13. The presence of all interval classes, and in some quantity too, makes this sonority dense and tight; through this feature, the sonority gains harmonic tension to complement the timbral tension of its inharmonic voicing. Additionally, there seems to be a preponderance of tight second and third intervals. These include the E♭6 and F6 at the very top of the sonority where the similar timbres of the flute and piccolo and the identical timbres of clarinets clash. Slightly lower, the first oboe and second clarinet clash in their simultaneous presentation of A♭5 and G♭5, respectively. The strings, likewise, hover within a single octave, sustaining B♯4, G𝄪4, and B3 between them. The reinforcement of harmonically-tight intervals by timbrally-similar instruments will be a means of creating tension which Saariaho will continue to employ throughout *Du Cristal*.

Saariaho creates tension in one last way in this example: the quick pulsing of the triangle. Its adamant *staccato* attacks build in dynamics throughout our example, so that the texture it creates is not only rough but also increasingly insistent. Like an alarm, it commandeers our attention. Beyond the confines of this example, this pulsing grows even stronger when the triangle is joined and eventually replaced by the glockenspiel; it too is finally replaced by two piccolos which reiterate this pulse at the interval of an octave between F6 and F7. There are, however, still several ways in which this sonority could become more tense, indicating that this opening sonority possesses only moderate tension compared to what is to come. Firstly, there is relatively little rhythmic activity at this

moment: other than the triangle, all of the other instruments gradually rise and fall in dynamics and sometimes exchange imperceptibly with others so that, underneath the pulsing of the triangle, the texture is actually relatively smooth. In other words, textural tension might still be increased exponentially. Secondly, timbral articulations, such as the bow position and pressure we witnessed in Example 3.1, really do not figure into this excerpt. Finally, outside of the initial attack, there is nothing in this example which is sudden or unexpected; this too—the diversion from process—shall increase tension at later moments in *Du Cristal*. Ultimately, this excerpt possesses a certain degree of timbral and harmonic tension through its inharmonicity, tight intervals, all-interval constitution, and insistent ringing of the triangle, but tension can still be increased, as indeed it will be in later sections of *Du Cristal*.

The formal plan of *Du Cristal* is not nearly as succinct as that of either *Chronochromie* or *Gondwana*. In both of those pieces, independent sections could easily be distinguished, though in *Gondwana*, transitions often blurred the precise dividing lines. In *Du Cristal*, however, there is a constant unfolding of musical material where each moment possesses a tensional relation to the preceding and the next. After the opening sonority, which we have just examined, there follows a more relaxed section, spanning from approximately Rehearsal B to Rehearsal L. My next graphic, Figure 3.2, diagrams this relaxed section at Rehearsal F. Harmonically, the sonority we encounter here is greatly reduced in complexity from the opening sonority. At its most essential, it is but an inverted dominant ninth chord consisting of the pitch classes, D-F♯-A-C-E♭. Considerations of harmonicity or inharmonicity become mostly irrelevant as we know this familiar chord to consist of harmonic intervals like fifths and thirds. Saariaho,

though, is fairly consistent in her registral voicing, so that a full spacing of the pitch collection can be expressed as C3-F♯3-D4-F♯4-A5-D6-E♭6. With the exception of the interval between the final two pitches, all of the other relationships are at least a major third in space, so that the tightness of the opening sonority has also disappeared. Each of these harmonic and registral considerations points to a relaxed atmosphere versus the tension of the opening sonority.

This written description, nevertheless, is greatly simplified from the aural reality. In the strings, where this harmonic constitution is most readily visible, there are persistent variations in pitch; in Figure 3.2, these fluctuations are indicated with brackets around the shifting pitches. There abound small *glissandi* to within a semitone or less, either higher or lower than the pitches I just listed. Saariaho also instructs the strings to alter their *vibrato,* so that sometimes there are additional small fluctuations in pitch. Rhythmic and dynamic alterations must also be considered. Entrances are often staggered between strings and tend to fade in from silence, peak, and then fade out again. The winds and percussion are similarly staggered and actually contribute some additional harmonic material. The overall effect is that, while the harmony can be described at its simplest as dominant, more often than not, the actual sonority heard only approximates the described harmony. We again encounter a state of flux where the dominant harmony, so easily described on paper, drifts in and out of focus. Under different circumstances, these conditions might create a chaotic environment, but here the generally soft dynamics of most instruments allow them to blend more peaceably. Also worth noting, the brass, horns, and bassoons with their brasher timbres have all fallen silent. Their absences contribute to the calmness of the staggered voices. The relative consistency of their

staggering means that, overall, the texture is fairly smooth without persistent ringing from a triangle, for instance, and also without sudden interruptions. There is a slight timbral change in the fourth measure of Rehearsal F as the percussion gains prominence and the winds are simultaneously reduced, but the shift is gradual. Only toward the end of Rehearsal F do things change more substantially as various instruments play lengthier *glissandi* and dynamics rise. At this moment, as we enter Rehearsal G, tension increases, but, otherwise, Rehearsal F is one of the more relaxed moments of *Du Cristal*.

As suggested by this excerpt, even at the most relaxed times, the potential for tension still remains. Tension and release, which in Saariaho's music exist timbrally, are just as momentary phenomena as harmonic tension and release are in tonal music. There is always the potential for tension to arise from release and vice versa, just as we encountered tension increasing as we approached Rehearsal G. Tension and release also do not exist only at fixed levels: one sound can be more or less tense than another sound, but both might still be considered more tense than yet another sound. In other words, timbral tension and release are as relative as harmonic tension and release. Timbral tension and release parallel harmonic tension and release in that there is a tensional hierarchy between perfect and imperfect intervals as well as major and minor intervals. Yet, timbral tension and release cannot be so easily hierarchized, or at least have not been so far, though several efforts have been made toward this end. From relative release in Rehearsals B to L, we begin to increase in tension. This tensional *crescendo*, as it were, peaks at Rehearsal P and again near Rehearsal Y. Along the way, timpani rolls, powerful calls in the brass, the incessant patter of the glockenspiel, and screams in the strings all do their part to build tension.

We pause at Rehearsal P for Figure 3.3 which, by any definition, is one of the most tense moments of *Du Cristal*. Like in the previous example, we have the semblance of an inverted dominant chord which goes in and out of focus. The strings, trombones, and first horn offer the constituent pitch classes, including E♭-G-B♭-D♭. Dominant harmony, however, is a crude approximation of the sonic reality. Firstly, the notated pitches played by the violas and cellos are not those of the suggested harmony. They actually play B𝄫4 and E4, respectively—pitches which are within a semitone of the component pitch classes, but have totally different harmonic implications. Dominant harmony is also brought out of focus through various timbral articulations. These include the *sul ponticello* bowing which encourages overtones at the expense of the written pitches. Indeed, Saariaho's specific instruction is, "*sul ponticello con violenza*," implying that this position be taken up with added intensity. The extreme bow pressure in the strings further blocks out the fundamentals. Finally, the *ffff* dynamics of the strings and *fff* dynamics of the trombones and first horn also heighten the noise content by amplifying the articulations already in play. Taken together, these considerations—harmonic and timbral—turn the implied dominant harmony into a much different sonic palette, one which maintains traces of dominant but is overwhelmed by noise.

The remaining instruments do even more to confound the suggested harmony. The percussion, piano, and harp inject several pitches unrelated to the principal harmony in their quick movements; the synthesizer does the same through its sustained cluster. Two, more critical clusters exist, however, at the very top and near the bottom of the sonority. At the top, the four piccolos shout four pitches within a single tone of space: A7-A𝄫7-G♯7-G♮7 all sound at once; these come at a distance of approximately two

octaves from the next nearest pitches. At the bottom, the bass clarinet, two bassoons, and the fourth horn thump an equally tight cluster: B♯2-B2-B𝄪2-B♭2. Below this cluster, the second trombone makes its contribution at G♭2 while the piano and harp fluctuate on a semitone interval between C2 and D♭2. The intervallic closeness within these clusters as well as their instruments' similar if not identical timbres—as in the case of the piccolos—make these clusters particularly dissonant: the harmonic, intervallic tightness of the clusters is compounded by the timbral, spectral configuration of the instruments playing these pitches. These tight clusters effectively encapsulate the sonority at its highest and lowest registers, so that its resulting shape has little in common with a harmonic spectrum. Between the tightness at the top and bottom, there is a loose configuration of pitches—the ones belonging to the dominant harmony as well as others contributed by the expanded percussion section. Many of these are, furthermore, overwhelmed by noisy articulations, emphasizing their overtones. The prevailing sonic image, then, is not dominant harmony but inharmonicity, noise, tension, and, ultimately, timbral dissonance.

More can be said texturally and rhythmically. Most of the instruments play in this excerpt, and almost all of these do so at their maximum dynamics. This density of activity also contributes to the high level of tension. The bass clarinet and two bassoons are first to enter, at *mezzo-piano*. They peak in dynamics just after the frenzied entrance of the strings and piccolos at the same moment that the strings reach their greatest bow pressure. Right as this collection of instruments begins to relax, the next group enters just as fiercely: these are the horns, trombones, vibraphone, tubular bells, and synthesizer. In the very next measure, the bass drum and timpani launch their own pounding. The result is that, within three measures, three different groups of instruments assault our ears,

hammering out their sounds. This staggering, unlike the smooth interchanges of previous examples, detracts from sonic fusion and promotes an incredibly tense, disjunct texture with sudden crashes. The sonic thrashing does not stop here and, as other instruments fade behind the pounding of the timpani and tam-tam, they prepare for a renewed attack at Rehearsal Q. A second attack and the strings come to a sudden halt—a gesture they will execute another few times to intensify the texture even further. Tension decreases some in Rehearsal S through the downward *glissandi* of the strings and the stasis established by the pitched percussion; at Rehearsal U, there is even the suggestion in the flutes of birdcalls—a purer sound on Saariaho's sound/noise axis. This section of release proves fleeting, however, as tension peaks again at Rehearsal Y. Tension persists until a sudden deception at Rehearsal CC, after which the solo violin resumes its activities from earlier. Tension builds again until another sudden release at Rehearsal KK when the winds and most percussion back away and allow the strings to guide the composition toward final release.

I take my last excerpt from this relaxed concluding section. Though some tension persists in these final moments of *Du Cristal*, the overall atmosphere is much calmer than we have experienced since Rehearsal L, some ten minutes earlier. Figure 3.4 shows Rehearsals MM and NN in which the strings predominate with some accents from the bass drum and crotales. Throughout the concluding fifteen measures of the piece, harmony changes little; indeed, it may be considered static. The harmonic constitution of this final chord is strikingly similar to the opening sonority, though much else is different. Specifically, it consists of nine pitch classes rising from a D♭ class; these are loosely spaced in the bottom register with a few tighter intervals in the top. Without considering

register, the nine pitch classes of this final sonority are D♭-D-E♭-F-G-A♭-A-B-C; there are also two microtones at B♯ and C♯. The opening sonority, recall, consisted of D♭-D-E♭-F-G♭-A♭-B-C and the microtones, G𝄲 and B♯. This slight reconfiguration means that the D♭ now fulfills the tritone relationship with G, though it does not fulfill a minor third on its own. Instead, this sonority must rely on the minor thirds between D-F-A♭-B, a relationship that was already present in the opening sonority. Thinking only in terms of harmony, this final sonority has all the traits that brought harmonic tension to the opening sonority: inharmonicity, tight intervals, and an all interval class constitution.

Registral and timbral considerations, however, lessen tension in this final sonority whereas they had increased tension in the opening sonority. In terms of pitch space, this sonority is considerably wider than the first. It spans from D♭1 to C♯8 while the earlier sonority had only extended from D♭2 to F6. This means that, for the most part, voicing is more open; in fact, there is more than an octave of intervallic space between each of the lowest members—D♭1-E♭2-F3—and similar space in the uppermost register. The cast of instruments is also smaller: it is now limited almost exclusively to the strings, and they play at quieter dynamics than anyone had in the opening sonority. The insistent ringing of the triangle has also been replaced by a much nimbler and often steady interchange between the bass drum and crotales. This slow pulsing of the percussion contributes to a smooth texture and a relaxed atmosphere. Timbral articulations in the strings, likewise, add to this mood. Throughout, they gradually shift bow position between normal, *sul ponticello*, and *sul tasto*; decrease and increase their dynamics; and switch from trilled to non-trilled playing. Their slow motion through these articulations as well as their

staggering between players means that, though individual lines become more and less tense, the overall texture remains smooth and non-directional. This final relaxation comes in reaction to preceding moments in *Du Cristal* which have been incredibly tense. It also brings closure. Harmonically, the similarities between the opening and final sonorities bring a kind of tonal resolution—it should be remembered that, in tonal music, a closing tonic chord did not need to be voiced identically to the first tonic to bring resolution. Timbrally, the texture is relaxed and smooth, a resolution to the tension which has preceded.

Throughout *Du Cristal*, Saariaho has demonstrated harmony and timbre to be related parameters in her music: elements which may permeate each other at times as in the music of Messiaen and Murail, but which can also come into direct opposition with each other. For her, harmony and timbre are separable parameters as evidenced in the way pitch class can have severe consequences even without considering register. They are also capable of complementing each other as when timbral articulations expand the written harmony into a much richer perceived sonority. Though many of my examples attempt to reduce this perceived sonority to its harmonic minimum, this effort has been made primarily to show its harmonic function and not to diminish the importance of its other, more timbral attributes or the constant flux which characterizes Saariaho's aesthetic. Harmony is not without motion in Saariaho's music as witnessed in the persistent fifth relationships. Timbre, however, guides much of the progressive activity as timbral tensions resolve into areas of significantly less tension. That function would rise out of harmony and into timbre also speaks to their interrelatedness, for while harmony can determine motion to a limited degree, timbre is the greater determinant of motion in

Saariaho's music. Through the drama and moment-to-moment contrast of this music, Saariaho reveals her aesthetic to be quite different from that of many modernists and, indeed, from the aesthetics of Messiaen and Murail as well. Although her aesthetic is in some ways more conservative, her attempt to craft a dynamic language from resources as diverse as spectralism, serialism, and traditional tonality make her evermore the progressive. This breaking down of compositional boundaries is as liminal as her approach to harmony and timbre.

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Together my formulation of Saariaho's liminal aesthetic as well as its examination in *Du Cristal* have shown this aesthetic to be quite complex. This aesthetic is one which exists beyond the boundaries of past idioms and acts in a totally personal way, accountable only to Saariaho's own creative aims. Owing to the difficulty of explaining this aesthetic, it was necessary for me to begin my analysis at the level of the single instrument. There I could demonstrate timbral tension and release without regard to harmony. Then, in expanding my analysis to the full ensemble, I could show how harmony still contributes to this tension, release, and progression while timbre was expanded and reinforced by harmony. All sounds could be shown to exist on an extended axis of consonance and dissonance where extreme beauty can arise from extreme ugliness. In due course, Saariaho's aesthetic becomes an extended tonality, reinforced by spectral as well as serial thinking. Ultimately, she has shown herself to be as interested in learning from her predecessors as she is in charting unexplored sonic worlds.

CONCLUSION

This thesis has explored the liminality between harmony and timbre as envisioned in the aesthetics of Olivier Messiaen, Tristan Murail, and Kaija Saariaho. It has investigated these composers' own writings and examined their representative compositions in order to accomplish its stated goal. Ultimately, it has depicted three different aesthetics as well as several concepts of liminality. These range from the conceptual continuity between harmony and timbre envisioned by Messiaen and Murail to the subjective intersections of these elements in the vision of Saariaho. Harmony has been shown capable of expanding into timbre, and timbre simplifying into harmony. Harmony and timbre have also been demonstrated as capable of affecting one another, either through the alteration of pitch materials or modification of articulations and playing styles. Timbre has also been shown to be a capable substitute for harmony's functional role in traditional tonality, either through the contrast and procession of timbres or the dramatic progression of timbres. The role of harmony has, in some cases, been reduced to emphasize the role timbre can play. In other cases, the role of harmony has even been expanded, as an antidote to serial stasis and parametrization, as reinforced by its transcendence into timbre. All of these instances have proven that one, singular liminal aesthetic does not exist: rather, each composer I have considered exudes his or her own particular vision of liminality as it applies to harmony and timbre.

In the course of this thesis, I have painted a narrative. It tells the story of spectral music: how certain aspects of this thinking were prefigured by Claude Debussy and Arnold Schoenberg; how liminality entered into Olivier Messiaen's aesthetic; how this vision passed to his students, Tristan Murail and Gérard Grisey; and then how their vision has been transformed by Kaija Saariaho. It investigates in depth three pivotal moments in this story, by highlighting three representative musical works and the contemporaneous writings of their composers: 1960—*Chronochromie*; 1980—*Gondwana*; 1989—*Du Cristal*. In this procession, the approach to liminality has become incredibly more nuanced. In Messiaen's aesthetic, liminality consisted in constructing expanded harmonies which possessed the precision of timbre, if not modeled on true acoustic spectra. This vertical approach was reinforced by Murail when he took this added step, and modeled his spectral chords on bell, brass, and other spectra and also on electronic studio techniques such as frequency modulation. Saariaho, while not as adamant on exactly replicating acoustic spectra as Murail, still learned from sonic observations and instead found tension between harmony and timbre which had been overlooked in trusting computer analysis too closely and overriding intuition. From a horizontal perspective, Messiaen had setup timbral motion through contrast but apart from the color chords which defined his vertical liminality. Murail then took this opportunity to gradually alter his spectral chords and establish directionality through their procession. Saariaho, ultimately, established drama—true moment-to-moment progression—through the tension she found among her harmonic and timbral materials. Though I hesitate to call this "progress in the arts" for each composer's aesthetic is valid on its own terms, we

can definitely perceive the change which has made the approach to liminality more nuanced with each successive aesthetic.

The contribution of this thesis, moreover, is not only aesthetic, but also musicological. The reigning narrative of twentieth-century music has too long remained the questionable progression from impressionism into neo-classicism, expressionism into serialism, and finally serialism into the avant-garde of the post-war years. As my narrative suggests, the turn toward modality and total chromaticism at the turn of the twentieth century had less to do with defiantly challenging tonality and more to do with pursuing sound in all its majesty. Debussy, Schoenberg, and those around them were, indeed, after similar ends in their sonic explorations. Messiaen learned from the innovations of both of these predecessors and, his students—the first generation of spectralists—have been the successors to this quest as have others, like Saariaho. This narrative, but more importantly, its vantage point, is one which we must continue to reinforce, if we are to avoid either slipping back into outmoded tonality or, through the inflexibility of the rational elitists, remove the listening experience from music altogether. As Murail writes, "To ignore the aural results of the composition act is, for me, a refusal to communicate. And, if composers no longer communicate, it is no surprise that the concert halls are empty."[95] The works of all three of the composers who I have considered in this thesis demonstrate an eagerness to communicate with a listening public. Though the ideas which they attempt to communicate are complex, they do not debase their vision: they simply make a greater effort to communicate it effectively.

[95] Tristan Murail, "Target Practice," trans. Joshua Cody, *Contemporary Music Review* 24, no. 2/3 (April/June 2005): 160.

Before closing, I would like to pose a few additional questions for future research. These are questions which fall outside the necessarily limited scope of this thesis, but which have occurred to me in my research. Firstly, this thesis could undoubtedly be expanded into a book-length project in two ways: one, by incorporating the aesthetics of additional composers into its scope; the other, by including in my study other presumed dichotomies, aside from harmony and timbre, which have also been demonstrated to possess liminality. These include rhythm and meter, timbre and melody, directionality and stasis, electronic and instrumental, and music and verbal expression. Spectral music has had a wide influence and derives from an even wider context. Taking the first route toward expansion, it would undoubtedly be interesting to examine other precursors to spectral music besides Messiaen, such as Henri Dutilleux or Giacinto Scelsi. Jeremy Thurlow has already begun the discussion on Dutilleux in his article "*Métaboles* as a Fork in the Road: Twin Paths in Dutilleux's Later Music," through his consideration of Dutilleux's primary sonority and how it transforms over the course of a composition. Murail's writings on Scelsi, considered briefly in this thesis, might be a starting place for a more thorough examination of liminality in Scelsi's music.

In reading the articles by Cagney and Goldman which I had mentioned in the Introduction, Pierre Boulez also becomes an intriguing candidate, especially in his works from the 1970s and beyond. His *Répons*, like Murail's *Désintégrations*, has been hailed as one of the first definitive electroacoustic compositions to have been produced at IRCAM; it would be fascinating to compare these two works and how their reliance on electronics shaped their composers' thought processes. The music of Grisey himself, the composer who introduced "liminal" into the dialogue, could likewise be further

investigated and compared alongside Dufourt who had offered instead the lasting designation, "spectral." My investigation of liminality could additionally be expanded to the British composers Jonathan Harvey, who is always described as an "interested observer" rather than a true spectralist,[96] or George Benjamin, another protégé of Messiaen who has taken interest in spectral music. Beyond Saariaho, other successors to the initial French spectralism of the 1970s, such as Magnus Lindberg, Georg Friedrich Haas, Raphaël Cendo, and so many others, would also make fine candidates for this enlarged study.

In its initial scope, however, this thesis has provided new insights into its three composers' aesthetics, working directly from their own intellectual and creative products. It can, moreover, persist in its current form without the expansions suggested above. An even more fruitful direction might be to apply the context I have gained from this work to more specialized topics. These could include, an interdisciplinary investigation into transitions in the work of Saariaho and the female authors, such as Virginia Woolf, who were her chief inspirations in her formative years. In the course of my work on this thesis, I took time to read Woolf's classic novel, *To the Lighthouse*, and I was struck by the way this author anticipates, toward the end of one chapter, the activities of the next chapter. In some sense, there is no need for divisions between chapters, except to aid the reader. Saariaho similarly prefers long, evolving forms in her music, smoothed by transitions; this is certainly the case in *Du Cristal*. This could also be said of *Gondwana* but not *Chronochromie*. I suspect Woolf to be as great an influence on Saariaho's transitions as

[96] Fineberg, "Spectral Music," 5.

any musical precursor, but it would take further research to make this statement definitively.

Two topics come to mind which investigate additional correlations between the composers considered in this thesis. An intriguing and so far little-explored correlation between Messiaen, Murail, and their liminal approach to harmony-timbre is their experience as organists. Benitez briefly mentions the mechanics of an organ's mixture stops and other scholars have related additive synthesis to the way organs have historically produced their timbrally-varied sounds, by merging pitches at different amplitudes.[97] How this function of organ mechanics, certainly in the back of many organists' minds, might have influenced the development of harmony-timbre in the music of Messiaen and Murail, if not coloristic approaches of many organist-composers before them, has to my knowledge not been explored to any great extent. More than likely, it will be the investigation of an organist, and not myself, a choral singer. Another correlation worth exploring, this time between Messiaen and Saariaho, concerns their dramatic works—the operatic output they have each produced in their later careers after expressing some initial reluctance. *Saint François d'Assise* could be compared to *L'Amour de loin*, or, perhaps also, any of Saariaho's more recent operas. Both *Saint François* and *L'Amour* have medieval settings and center on characters with strong religious convictions. The transfiguration of Clémence at the end of Saariaho's opera, indeed, parallels the gaining of the stigmata by St. Francis. *L'Amour*, almost an anti-opera in its dramatic stillness, additionally evokes so much of Messiaen's aesthetic with its harmonic stasis, symmetrical modes, and "eternal" rhythms.

[97] Benitez, "Aspects of Harmony," 203.

Neither of these correlations might have been made without first exploring the aesthetic stances of these three composers in depth as I have done in this thesis. Now that I have gained this understanding and expressed it in this thesis, these specialized inquiries may be undertaken. Another, equally important direction can be taken in questioning the validity of the aesthetic statements which each of these composers have made and which I have described here. In this thesis, I have approached these composers' claims as truths—certainly, within their own aesthetics, they are truths—and it was important that I did so in order to understand their aesthetics. Yet, Murail did not hesitate to question Messiaen, and Saariaho did not hesitate to question Murail; to bring things full circle, Messiaen, in fact, encouraged his successors to question his statements in the Preface to his *Technique*. Murail's claims about the necessity that the contemporary composer take sound, and not music, as his proper material are particularly worth evaluating, and this could be another topic for future research. Murail offers a valid point that today's composers have the ability to better understand sound than any previous generation; he might not be wrong to further insist that they take advantage of this situation. His adamancy, however, encourages the same doubt which the unyielding insistence on the serial method among his predecessors anticipated its downfall. As Drott might attest, however, the adamancy in Murail's early lectures likely amounts to putting-up a strong defense against the reigning avant-garde styles at spectral music's inception.[98]

These are all topics lying outside the direct context of this thesis which, nonetheless, have intrigued me in my research. They pose questions to which I might eventually return to offer answers myself, or, on the other hand, which I might someday

[98] Drott, "Spectralism, Politics, and the Post-Industrial Imagination," 40-42.

find answered in the work of another scholar. Moreover, they suggest just how much is left to explore in regard to this music. As I had stated quite early in this thesis, so much of the scholarly research into spectral music which so far has been done concerns only its technical and theoretical dimensions. Certainly, these pose many difficulties for those wishing to understand this music who possess only a musician's training, but, as these dimensions are better understood, we should also begin focusing on the creative, intellectual, and cultural aspects of this music. One does not understand the music of Beethoven only through an explication of its cadences; likewise, one cannot understand spectral music with only a technical knowledge of frequency modulation. The aesthetic visions outlined in this thesis complement the musicological work done by a growing number of scholars. They offer, not only an approximation of these three composers' aesthetics, but also an entry into a larger exploration of their music.

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APPENDIX: FIGURES AND EXAMPLES

Figure 1.1: Nine forms of color chords in *Chronochromie*

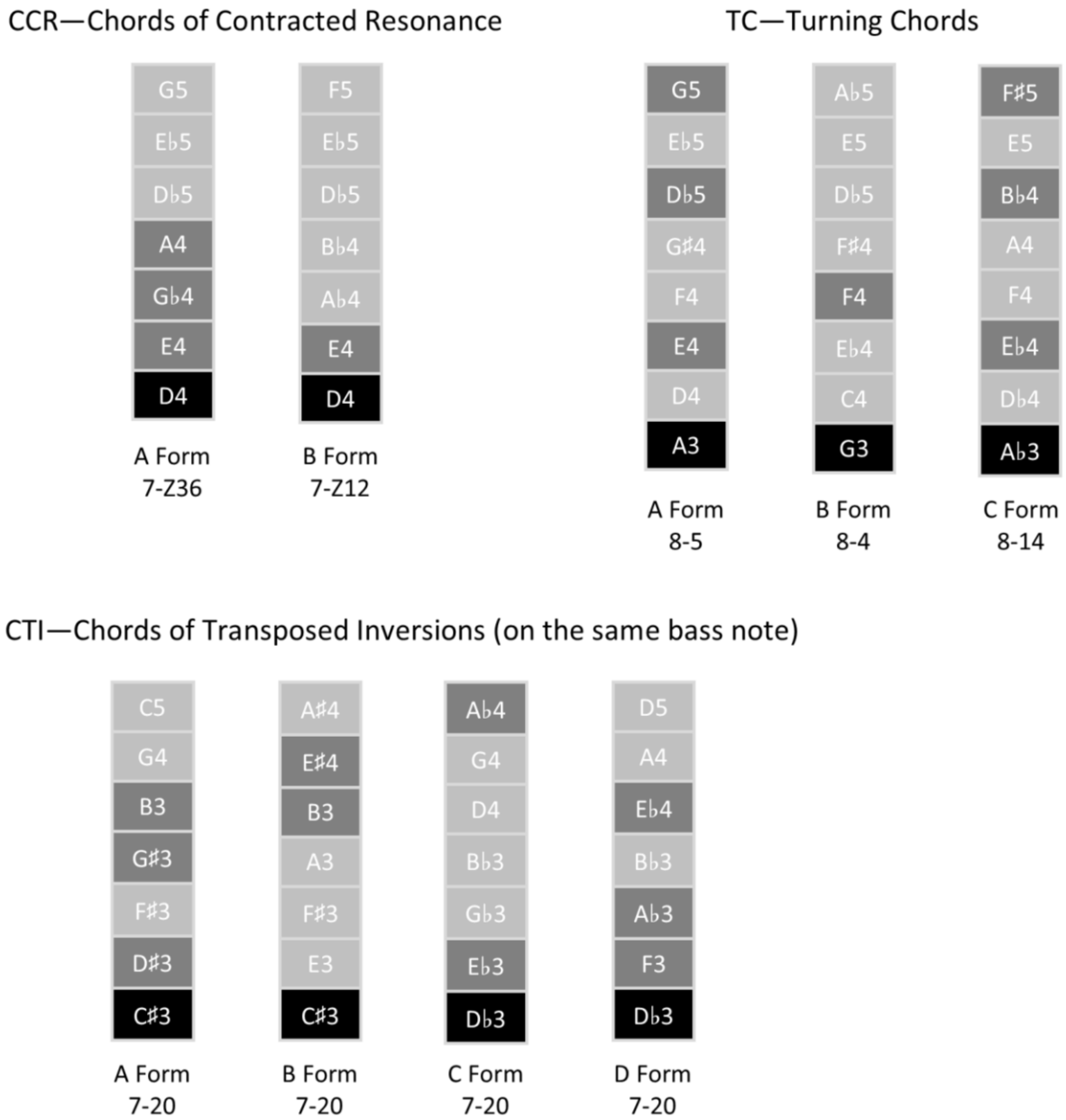


Figure 1.2: First chordal intersection in *Strophe I* of *Chronochromie*

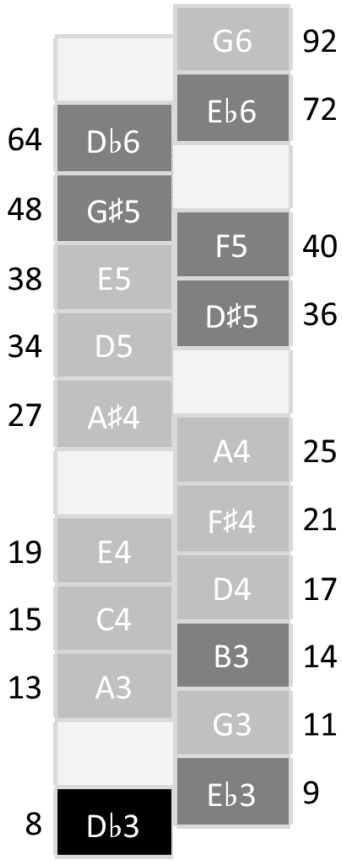


Figure 1.3: Formal outline of *Antistrophe I* of *Chronochromie*

Section	Measures/ Timestamp	Tempo	Instrumentation	Texture / Traits
1	mm. 1-11 0:00-0:06	Un peu vif (♪ = 160)	3 flutes, 2 oboes, English horn, 2 clarinets, bass clarinet, 3 bassoons	chorale, birdsong
2	mm. 12-29 0:07-0:23	Un peu vif (♪ = 144)	xylophone, marimba, bells, suspended cymbal, 2 violins I, 4 violins II, 4 violas, 4 cellos, 1 bass (later: add glockenspiel)	statistical, birdsong
3	mm. 29-39 0:24-0:32	Un peu vif (♪ = 160)	same as 1, add E♭ clarinet	chorale, birdsong
4	mm. 39-77 0:33-1:04	Un peu vif (♪ = 144)	same as 2, add glockenspiel	statistical, birdsong
5	mm. 78-100 1:05-1:23	Un peu vif (♪ = 160)	same as 1, add E♭ clarinet	chorale, birdsong
6.1	mm. 101-113 1:24-2:02	Lent (♪ = 120)	2 flutes, 1 oboe, 2 clarinets, xylophone, marimba, bells, 3 gongs, suspended cymbal, Chinese cymbal, tam-tam, all strings	statistical
6.2	mm. 114-128 2:03-2:41	Lent (♪ = 50)	2 oboes, English horn, 2 clarinets, bass clarinet, 3 bassoons, trumpet in D, 3 trumpets, 4 horns, 3 trombones, tuba, tam-tam, all strings (no basses)	chorale
7	mm. 129-158 2:42-3:13	Bien modéré (♪ = 168)	3 flutes, 2 oboes, English horn, E♭ clarinet, 2 clarinets, bass clarinet, 3 bassoons, 3 trumpets, 4 horns, 3 trombones, tuba, bells, 3 gongs, suspended cymbal, Chinese cymbal, tam-tam, 12 violins I, 12 violins II, 4 violas	imitative, birdsong

Figure 2.1: First inharmonic chord of *Gondwana* at mm. 4-8 of Rehearsal A

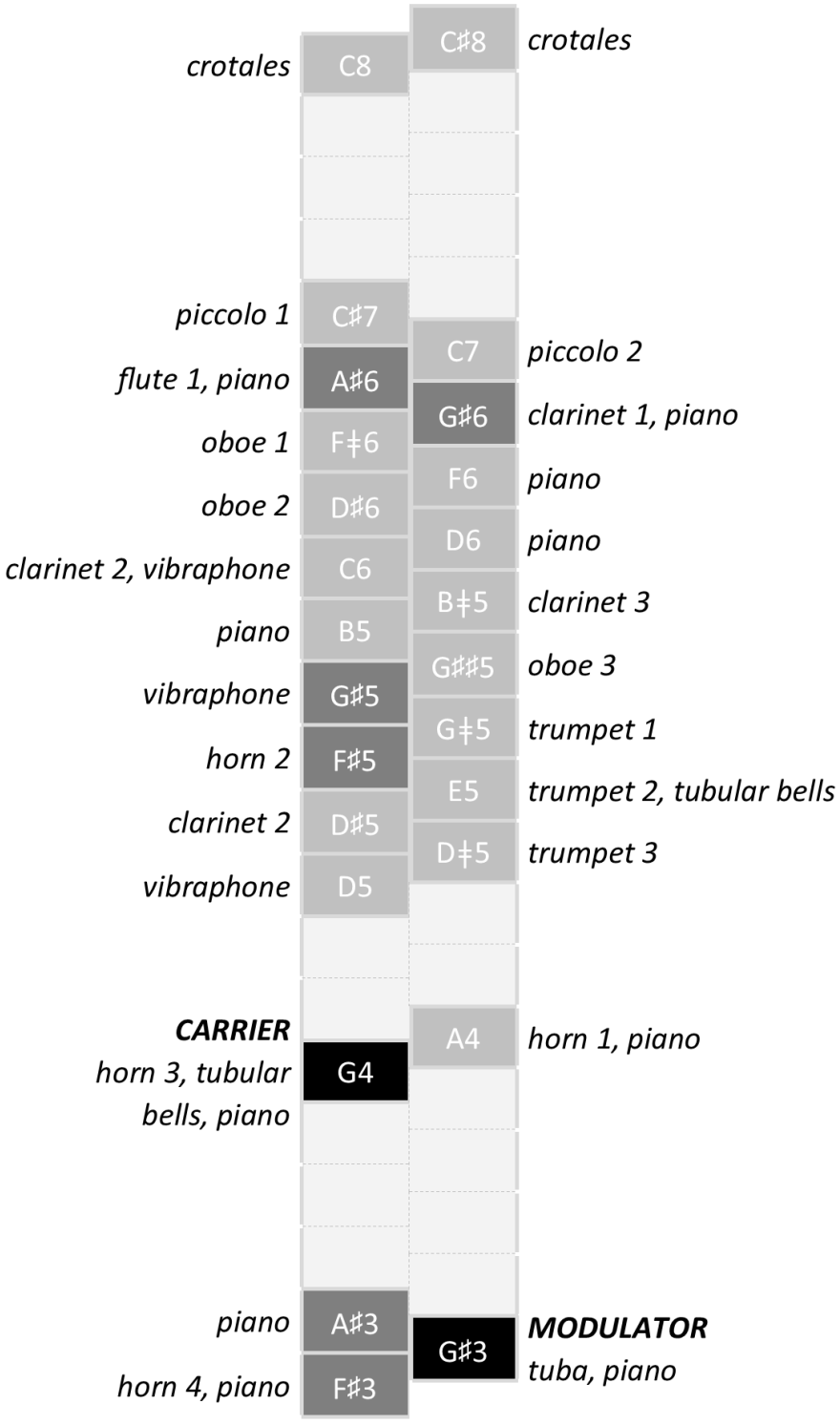


Figure 2.2: Seventh inharmonic chord of *Gondwana* at mm. 25-28 of Rehearsal A

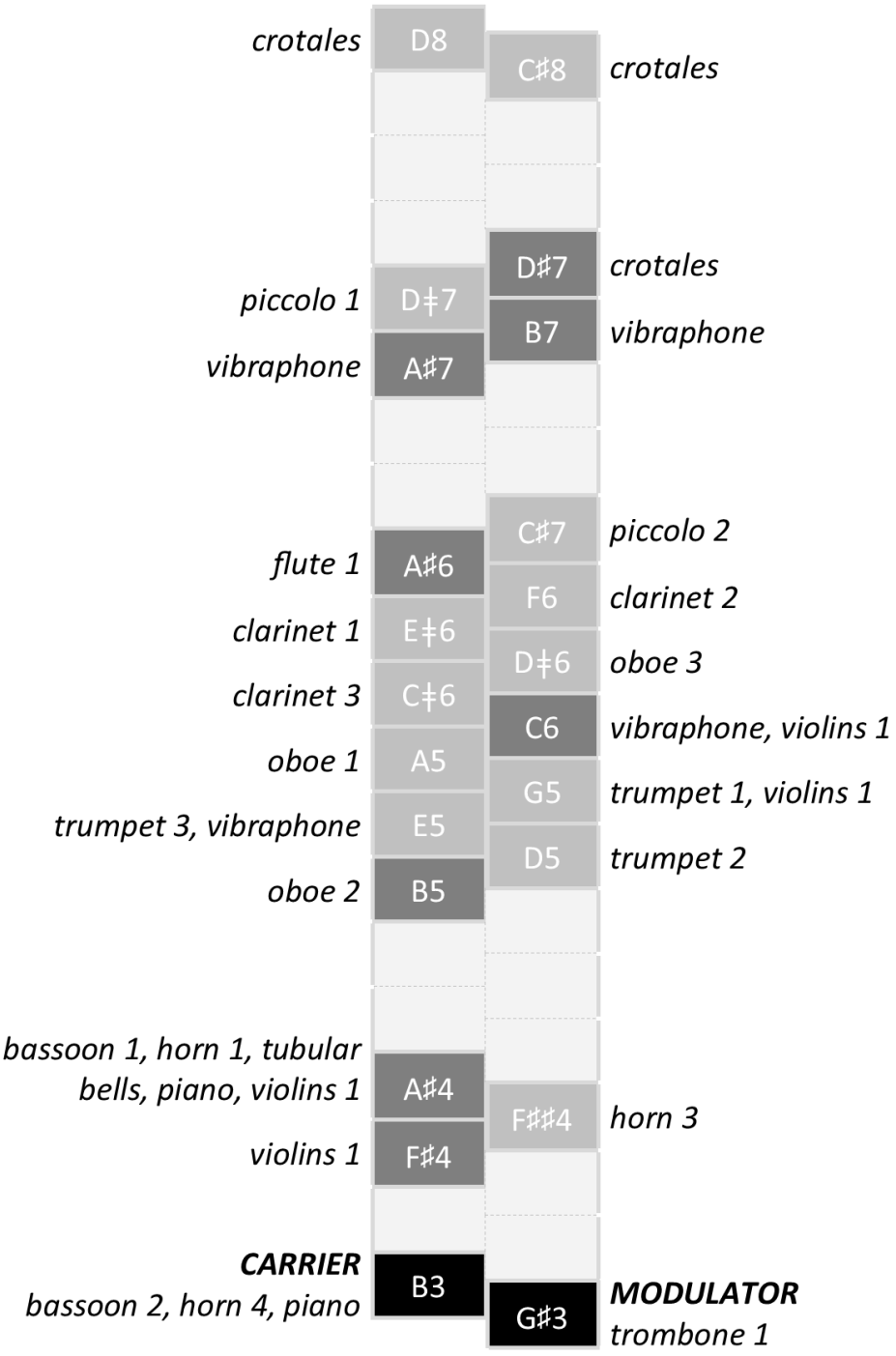
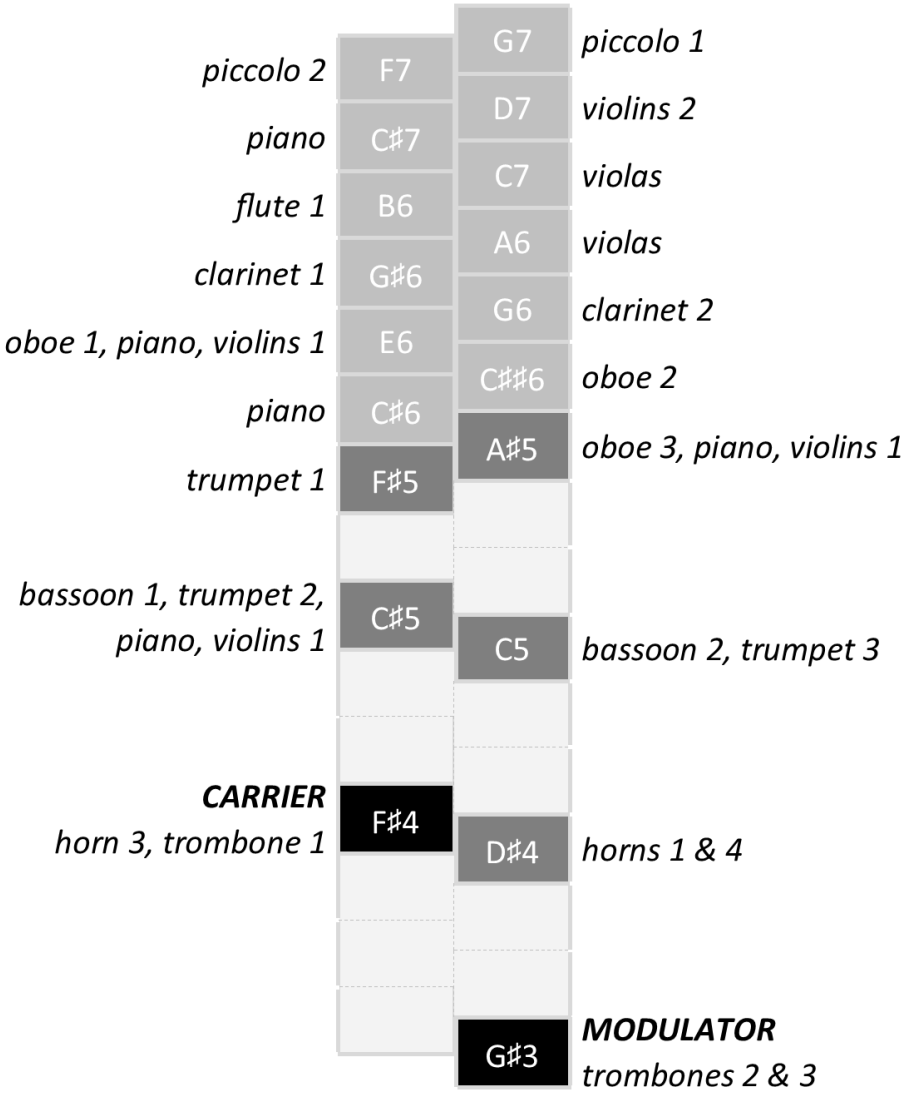
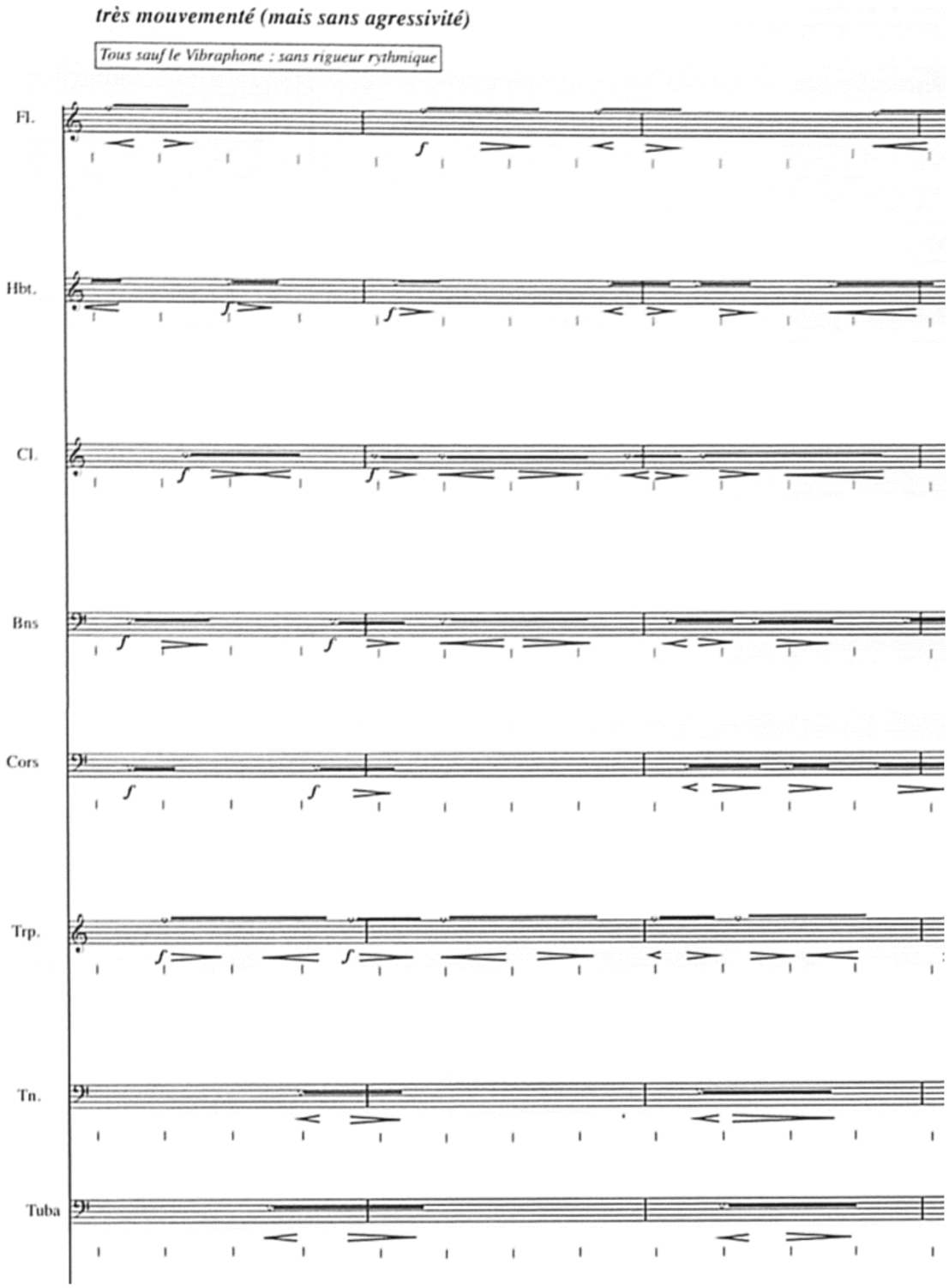


Figure 2.3: Twelfth harmonic chord of *Gondwana* at mm. 49-54 of Rehearsal A



Example 2.1: Noise elements at Rehearsal D of *Gondwana*



Example 2.1: Noise elements at Rehearsal D of *Gondwana* (continued)

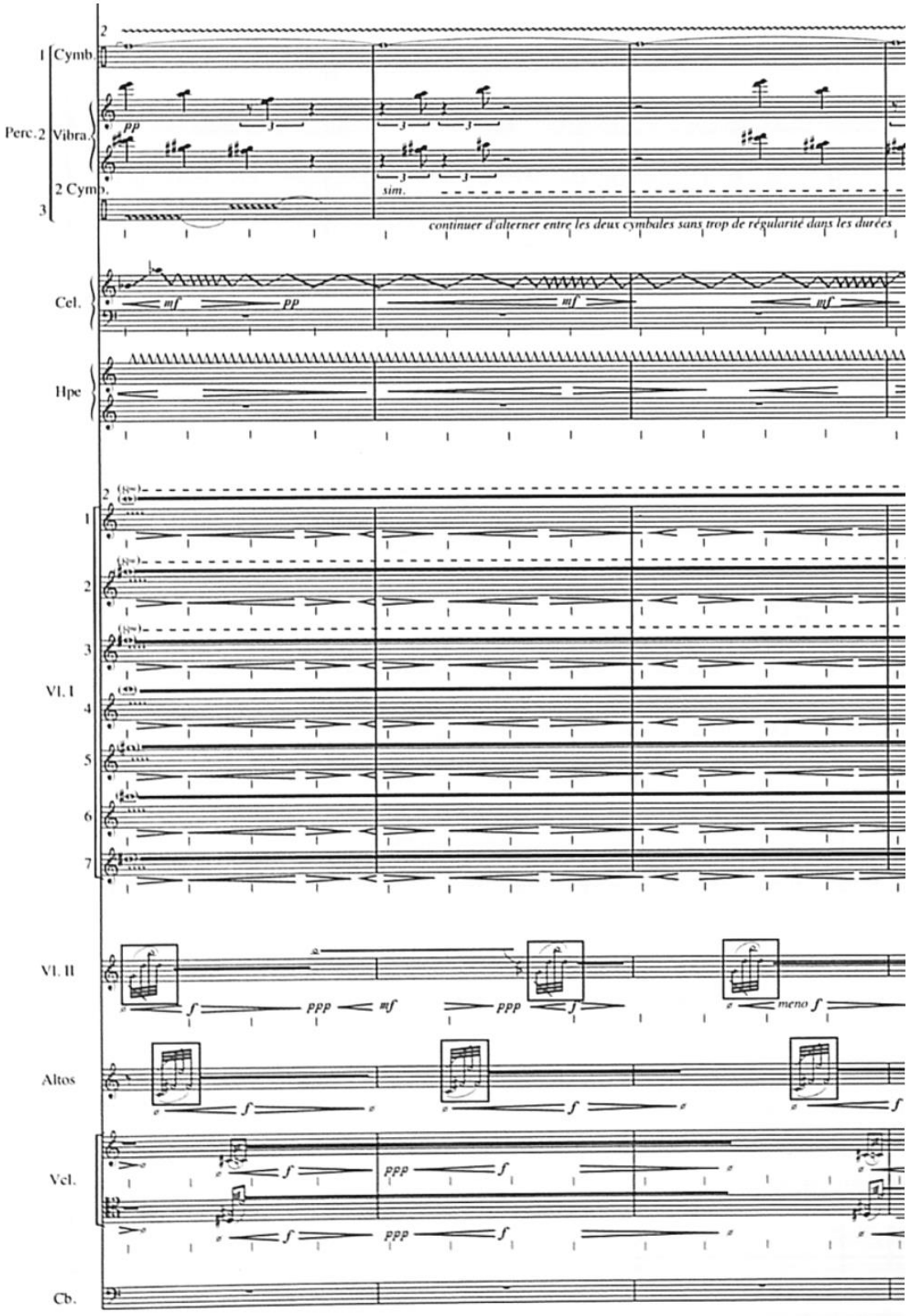
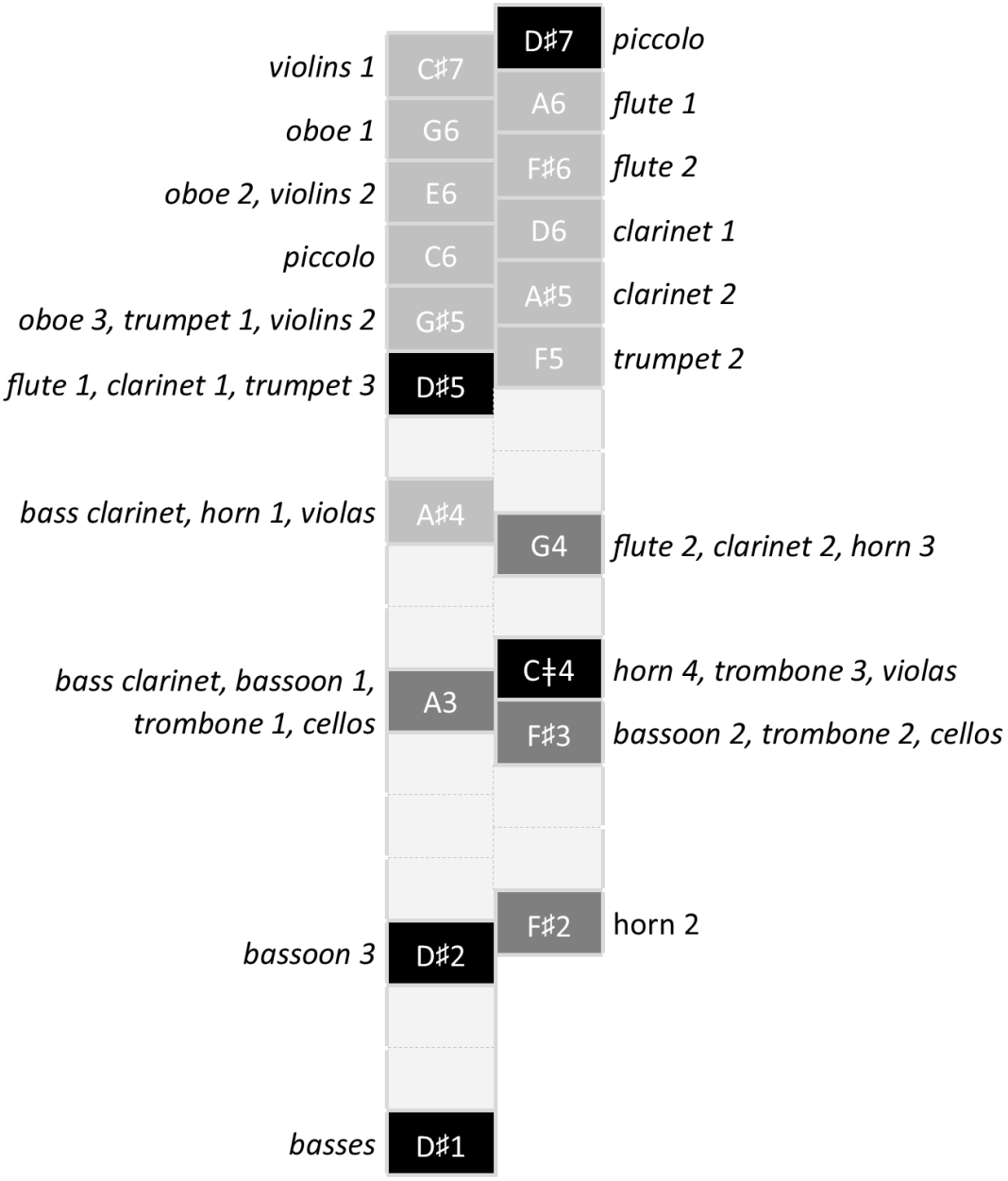
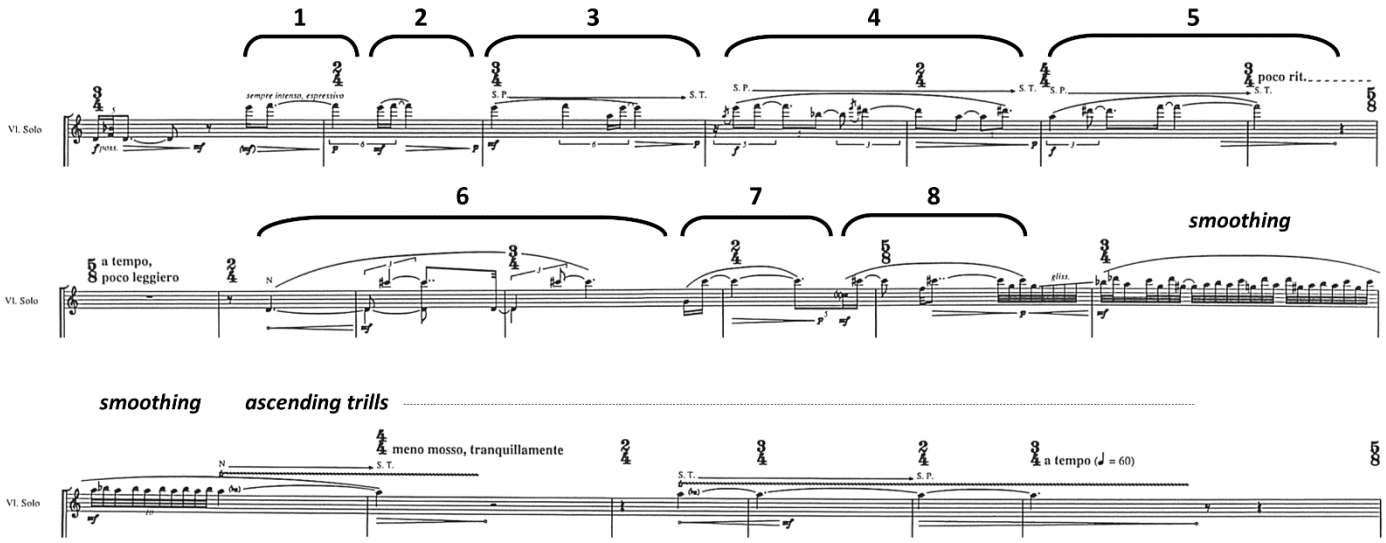


Figure 2.4: Final inharmonic chord of *Gondwana* at mm. 46-50 of Rehearsal F



Example 3.1: Iterations in violin solo at Rehearsal B of *Du Cristal*



Example 3.2: Iterations in piccolo solo at Rehearsal J of *Du Cristal*

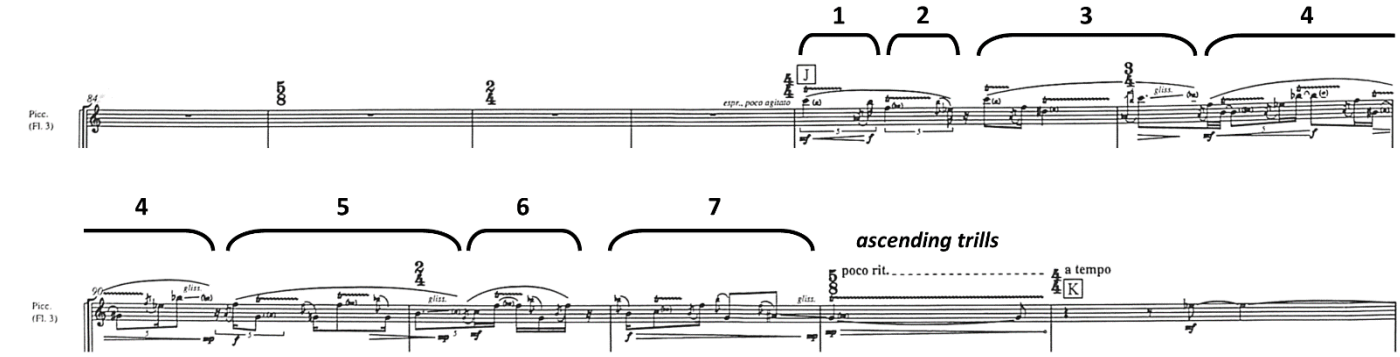


Figure 3.1: Tense opening sonority of *Du Cristal*

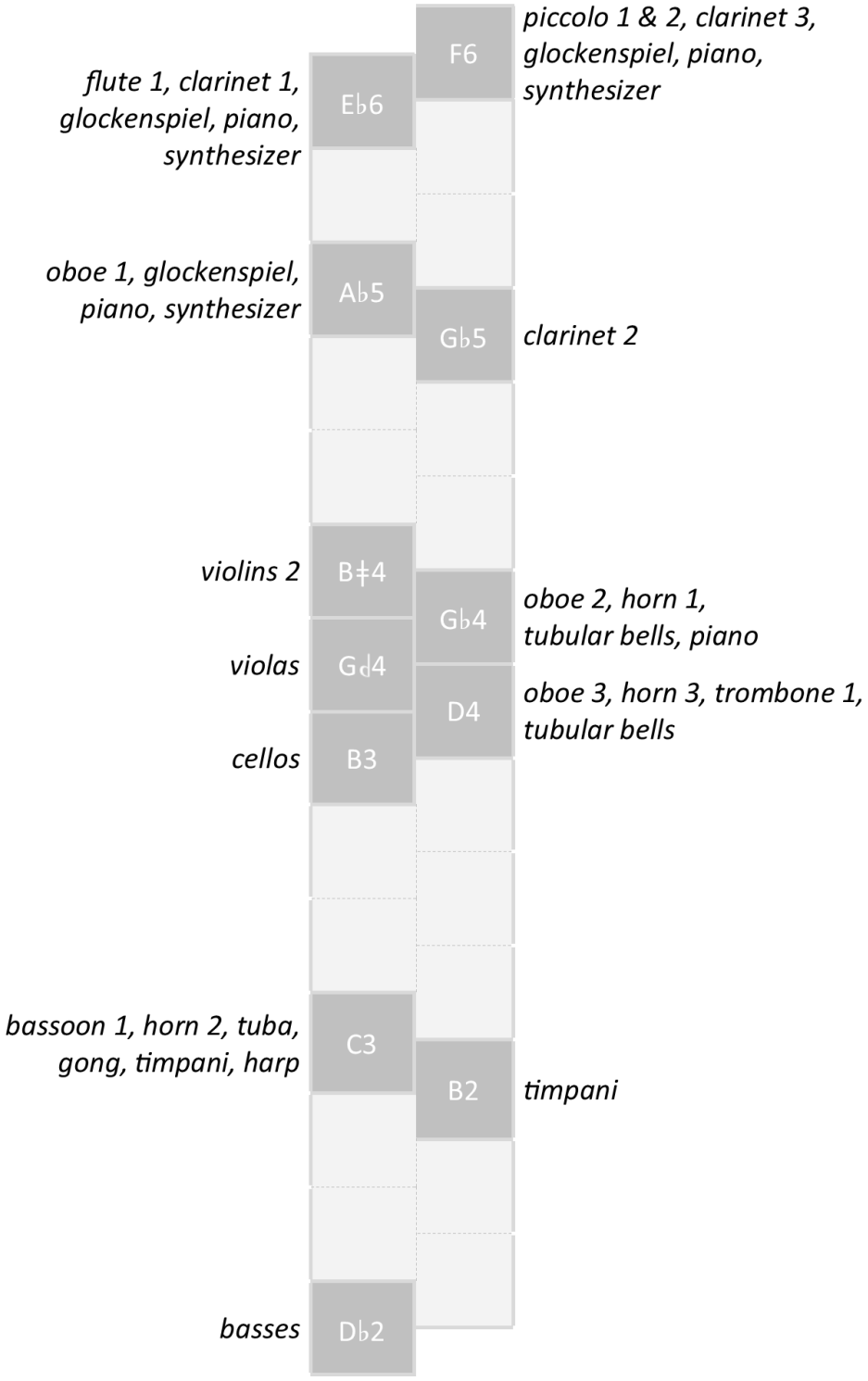


Figure 3.2: Relaxed sonority at Rehearsal F of *Du Cristal*

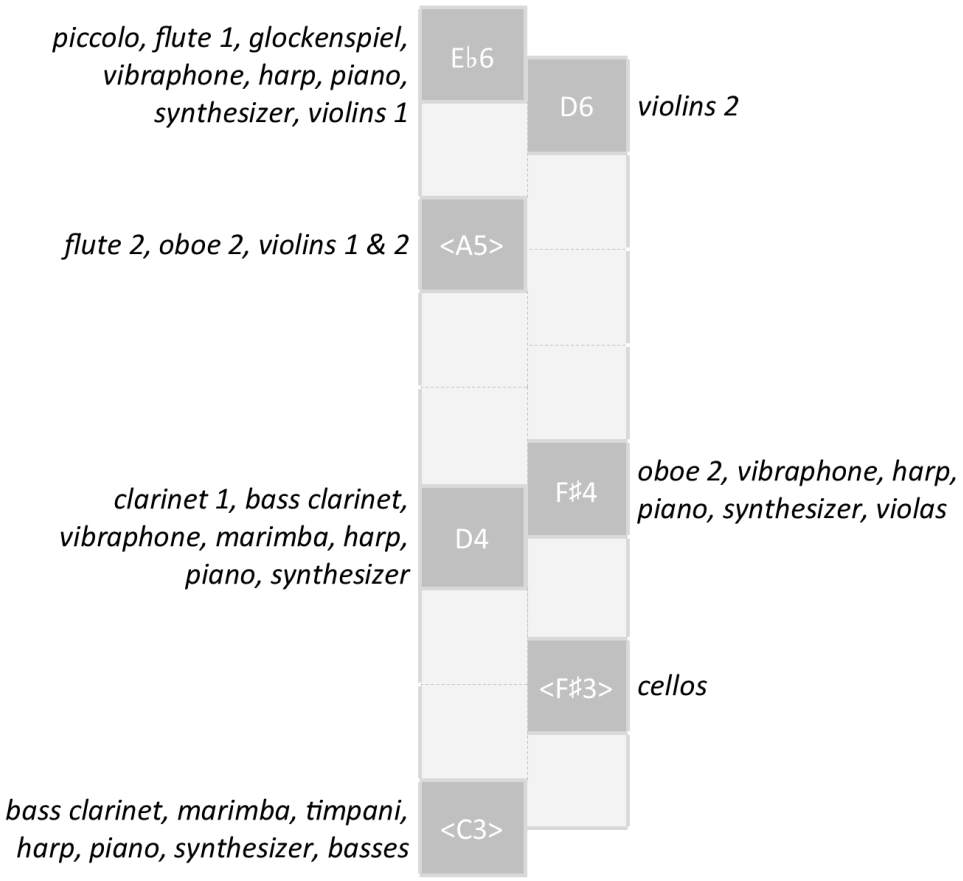


Figure 3.3: Tense sonority at Rehearsal P of *Du Cristal*

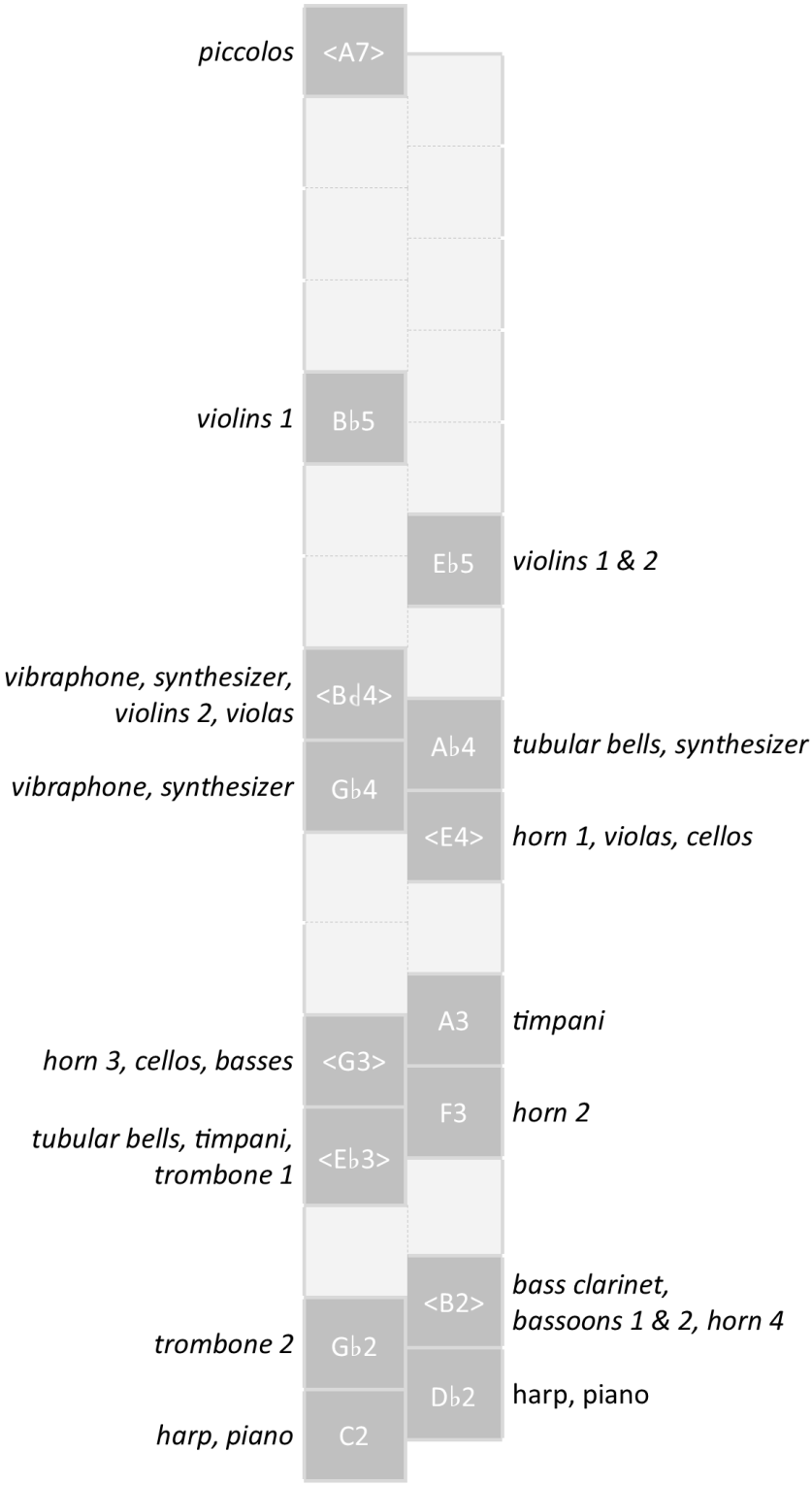
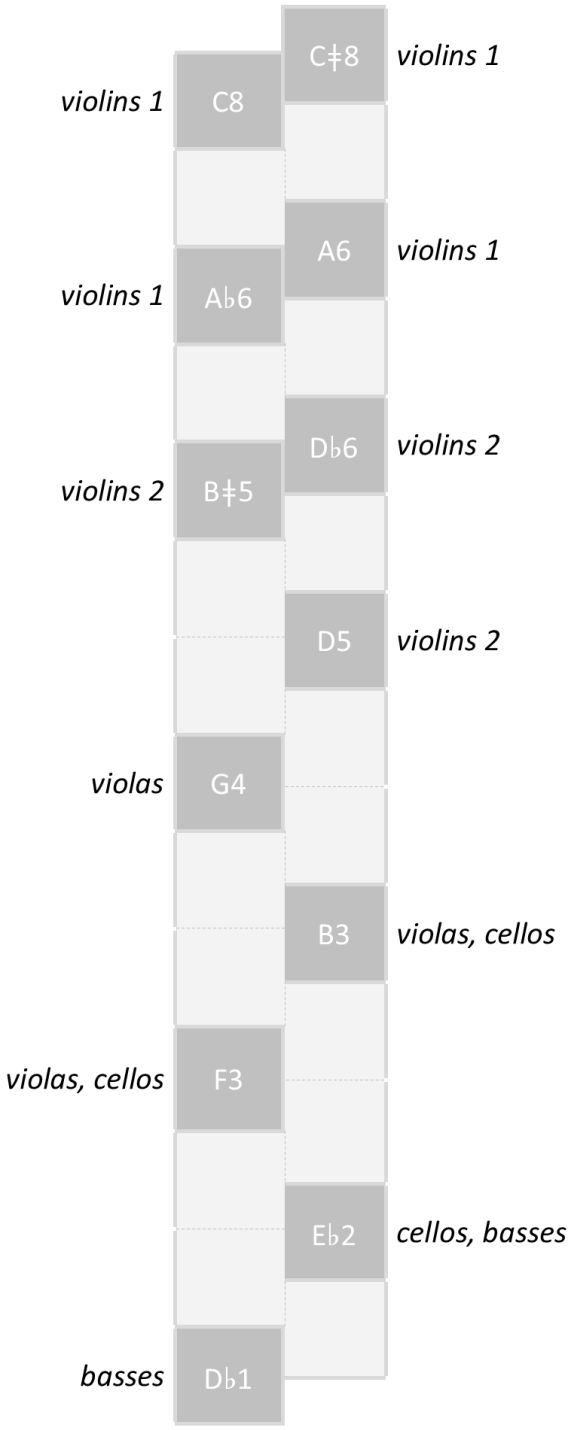


Figure 3.4: Relaxed sonority at Rehearsals MM and NN of *Du Cristal*



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