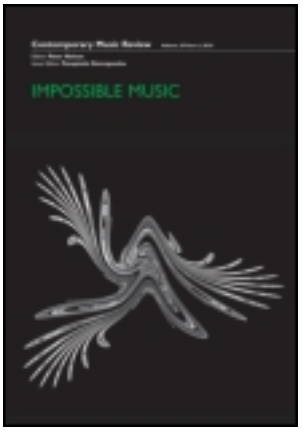

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The Emergence of Spectra in Gérard Grisey's Compositional Process: From *Dérives* (1973–74) to *Les espaces acoustiques* (1974–85)

François-Xavier Féron

This article aims to document how spectral models became an essential component of Gérard Grisey's creative approach at the beginning of the 1970s. In Dérives *(1974–75), though the spectral model remains rather broad, it determines both the work's temporal structure and the choice of harmonic polarities and progressions. In* Périodes *(1974), which marks the beginning of the cycle* Les espaces acoustiques *(1974–85), Grisey specifically transcribes the harmonic spectrum of fundamental frequency E1 (41.2 Hz) and uses it to govern most compositional processes, thus laying the foundations of the spectral music. This study highlights the importance of data drawn from the spectral (de)composition of sound in the compositional processes of both works. It also reveals how Grisey establishes a number of complex compositional techniques then used to structure each detail in the piece, and how he consequently defines a musical project quite comparable to that of serial music.*

Cet article vise à documenter la manière dont les modèles spectraux sont devenus une composante essentielle dans la démarche créative de Gérard Grisey au début des années 1970. Dans Dérives *(1974–75), le modèle spectral, bien qu'encore très approximatif, conditionne déjà la structuration temporelle de l'œuvre ainsi que le choix des polarités et progressions harmoniques. Dans* Périodes *(1974), œuvre à l'origine du cycle* Les espaces acoustiques *(1974–85), Grisey transcrit de manière beaucoup plus précise les harmoniques d'un spectre de fréquence fondamentale 41,2 Hz (E1) et s'en sert pour contrôler la majorité des processus compositionnels, posant ainsi les fondements du langage musical spectral. Cette étude souligne l'importance des données issues de la (dé)composition spectrale du son dans le processus de composition de ces deux œuvres. Elle montre comment Grisey met en place des procédures d'écriture complexes pour*

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structurer l'œuvre dans ses moindres détails et définir ainsi un projet compositionnel pas si éloigné de celui de la musique sérielle.

Keywords: Gérard Grisey; Dérives*;* Les espaces acoustiques*; Spectrum; Spectral music; Sketch studies; Musical acoustics*

Introduction

In his manifesto-like article, entitled *Musique spectrale*, Hugues Dufourt (1979) describes the concerns and overall aesthetic shared by composers belonging to *L'Itinéraire*, a collective founded in 1973 thanks to Tristan Murail's initiative. Dufourt compares spectral and serial aesthetics, considering their similarities and differences. Where these aesthetics fundamentally differ is in the compositional dialectic between detailed structure and overall organisation. Serial composers develop the piece through the convergence of isolated parameters, whereas spectral composers focus first on a synthetic construct before exploring its details. Also, in spectral music, compositional work applies itself directly to the internal dimensions of the sound spectrum.

> It is built upon the overall control of the musical spectrum. Then, from its matter, the structures are established. The only characteristics upon which we might act are of a dynamic nature. These are fluent forms, transitional environments whose movements depend upon the laws of continuous transformation. Thus, it might be referred to as fashioned from fluxes and exchanges. Music may be envisioned as thresholds, oscillations and interferences. (Dufourt, 1979, p. 291)

In outlining the fundamental divergences between these aesthetics, Dufourt chose to dismiss spectralism's procedures and stylistic influences, related to the post-serial heritage. However, the latter favoured a creative, though insufficient, context in which to explore spectra, natural echo and, more broadly, sound features and their objective perception by musical acoustics. In the MuTeC project, we studied the genesis of Gérard Grisey's *Les espaces acoustiques*, an archetype of the spectral aesthetic composed between 1974 and 1985.[1] We were determined to shed some light on the creative process that surrounded this cycle's composition and, in turn, on the emergence of spectral thought in the 1970s through the following questions: how did Grisey work? What were his primary concerns? What tools and methods did he therefore develop? What roles do the spectrum and spectral analysis occupy in the construction of his language?

The study of musical manuscripts—a term we apply to all documents produced by the composer during his preparation of a piece—demonstrates the fact that his music is not simply the result of intuition, guided by a knowledge and practice of considerations drawn from acoustics and psychoacoustics. The level of pre-compositional organisation is shown to be of utmost importance as it strives to govern the work as a whole, in addition to the individual structure of different

sections. Many techniques are consequently required, and most are far removed from the transcription of spectra or spectrograms. Through his work on the composer's manuscripts, Jérôme Baillet (2000) was able to demonstrate, in a synthetic manner, a number of Grisey's writing techniques and to thereby draw attention to the main characteristics of his approach to composition. This analysis, however extensive, only partially documents the works' creative processes and the genesis of individual techniques the composer developed.

In this article, we will focus on the creative processes of Grisey's first mature works (*Dérives* for two orchestras and *Périodes* for seven instruments) composed during his time at the Villa Médicis from 1972 to 1974. During this period and through these compositions, Grisey laid the foundations of both his own musical language as well as those of the spectral aesthetic. This was achieved through the use of spectral models that render objective sound data. Despite its role as a milestone in the adoption of spectral models, *Dérives* (1973–74) has been neither the focus of an in-depth musicological study nor has it been re-recorded since its 1981 release on vinyl (LP Erato-MFA, STU 71157). *Périodes* has, however, been recorded on several occasions and requires little introduction, given its emblematic position as the first work in the spectral music cycle *Les espaces acoustiques* (1974–85). In a past article (Féron, 2010b), we chose to focus on the origins of the compositional models Grisey develops in *Périodes*: the harmonic spectrum with fundamental frequency 41.2 Hz (E1) and the respiratory cycle. Once we have briefly recalled the harmonic spectrum's structure, we shall explore its impact on not only the construction of the work as a whole, but also many different writing procedures.

In addition to its interaction with the harmonic organisation of the musical discourse, the use of spectra also allows Grisey to structure his musical thought process, thereby establishing the procedures and calculations necessary to the consistent treatment of the variations on a relatively restricted matter. Therefore, it seems appropriate to study the conditions surrounding Grisey's use and conception of his acoustic models. Furthermore, we may explore how this use of objective sound data reflects his broader approach to composing. We shall begin by describing the content of the sources we used to study the compositional process (primarily the Gérard Grisey Collection at the Paul Sacher Foundation in Basel) and examine Olivier Messiaen and Karlheinz Stockhausen's influence on the artistic use of harmonic spectra. We will then focus on *Dérives* and *Périodes*, describing the characteristics of the acoustic models used in these pieces, in addition to the mental and technical tools conceived in order to work with such materials. Within this context, we shall present unpublished documents from the Paul Sacher Foundation. These contribute to our understanding of two constants, essential to the composer's craft: how spectral data fashion the work's temporal structure and the formal outlines. Finally, in order to comprehend fully the manner in which pre-compositional models interact with the specific implementation of writing procedures, we shall focus on one section of *Périodes*. In addition to demonstrating the omnipresence of spectral data in the pieces' structure, deciphering these

documents allows us to grasp a type of compositional logic that regularly appears in *Les espaces acoustiques*.

Studying the Genesis of Gérard Grisey's Spectral Thought

> During my time in Rome, from 1972 to 1974, I realised I could no longer compose using acquired habits, manic writing techniques inherited from those around me [...] I searched, experimentally, the primary acoustic and psychological foundations, according to a language, or at least a musical technique able to integrate sound phenomena as a whole and grant them a function. An ambitious project if there ever was. Of course this all took place as I composed, the theoretical reflection came long after. (Grisey, 1988, p. 238)

Archives and Methodology

The Gérard Grisey Collection, archived at the Paul Sacher Foundation in Basel, brings together all of the composer's musical manuscripts, i.e. the body of documents that contributed to the development of each piece, including technical notes, different versions of the score—often with the composer's comments and corrections... These documents, varied in format and in nature, and are written on separate sheets (single or double-sided). Each page containing notes is considered a working document. They are placed together in one or several files pertaining to each of the composer's works (most often, one file contains the preparatory documents while another holds the score's different editions). As a great number of these contain textual indications, diagrams, charts, frequency calculations ... they are not simply limited to notes of music. These documents, and the information they contain, afford us a greater understanding of the composer's singular logic and work methods. Parts of these manuscripts cannot, however, be reproduced for purposes other than academic publication. It is therefore necessary to copy them by hand in order to study them off-site. Given the size of these files (according to the Foundation's catalogue, *Dérives* contains 219 pages, *Périodes* contains 89 pages), their study requires both a large amount of time spent at the Foundation as well as the selection and transcription of documents one wishes to study at a later date.

There is, however, no doubt as to relevance of the study of Grisey's musical manuscripts. In addition to affording one the comprehension of his compositional methodology, they also generate a large number of hypotheses concerning the events' chronological progress and the development of writing techniques. We feel that this philological study is essential in order to piece together—if only partially—the composer's '*atelier*' (workshop). According to Nicolas Donin and Jacques Theureau, this term designates 'not only the material environment in which physical conditions are brought together (materials, tools, archives) but also the immaterial whole made up of the technical problems, stylistic options, anticipations and memorisations of elements belonging to the work in progress' (Donin & Theureau, 2008, p. 8). Dynamic in its nature, creative enterprise is guided by the body of knowledge and

techniques the composer builds during the course of his life. This is then enriched with each new compositional project. Genetic musical analysis is a way of documenting such an evolution through both the study of compositional procedures as well as the conditions in which they emerge, hence our belief that—unlike more traditional musical analysis—the score should not be isolated from the process and context with which it progressively evolved in the years prior to being published. Despite the considerable resources musical manuscripts provide for understanding the compositional process, it is nonetheless necessary to draw from a variety of additional sources.

In addition to musical manuscripts, the Gérard Grisey Collection at the Paul Sacher Foundation also contains text manuscripts (written texts by and belonging to the composer), letters received, his journal, his diaries, administrative documents, music programs, class notes … and part of his musical library. These documents provide invaluable information pertaining to the genesis of certain compositional preoccupations or the use of specific writing techniques. We also sought out the testimony and archives of those close to Grisey, drawing from their memories references to specific documents or events. During this genetic inquest, Jocelyne Grisey (the composers spouse, with whom he lived until the mid-1980s), Tristan Murail (with whom he established the fundamentals of the spectral aesthetic at the beginning of the 1970s), Michèle Castellengo (acoustic specialist within the *Laboratoire d'Acoustique Musicale* with whom he collaborated in the 1970s and 1980s) and Guy Lelong (friend and later, editor of his writings after the composer's death in 1998) were all interviewed.

A very rich file of diverse sources was thus compiled in order to study *Les espaces acoustiques.* As it will be frequently referenced throughout the article, the following acronyms shall be used: PSF-GGC for documents belonging to the Gérard Grisey collection at the Paul Sacher Foundation and ITW when referring to a specific interview. Before we turn our attention towards *Dérives* and *Périodes*, it seems important to underscore the crucial role we feel Olivier Messiaen and Karlheinz Stockhausen played in introducing the spectrum into Grisey's compositional approach.

Understanding Olivier Messiaen and Karlheinz Stockhausen's legacy

The summer of 1972 is a turning point in Gérard Grisey's musical career. First, as the winner of the *prix de Rome* he is granted the opportunity to dedicate the following two years to composing in Rome, within the walls of the Villa Médicis. Second, he attends the Darmstadt summer course, where he hears Stockhausen's *Stimmung* (1968) for six voices a cappella, apparently for the first time. This piece is the main topic of Stockhausen's conferences that year, conferences that Grisey attended, as reflected in his notes (PSF-GGC, text manuscripts). In addition to Oliver Messiaen's scores (a composer with whom Grisey had studied composition from 1968) this piece undoubtedly sowed the seeds of spectral thought in Grisey's creative approach.

A spectral chord could be described as a chord in which the pitches are selected such that their combination begins to match the spectral structure of a sound. When a pitch is well defined, the resulting spectrum is most often harmonic. The spectral chord's notes then tend to merge into a single entity on the fringe between timbre and harmony. Grisey—as a student of Messiaen—was undoubtedly familiar with such auditory archetypes based on the natural resonance of sounds. Julian Anderson reminds us that in *Couleurs de la Cité Céleste* (1963), 'Messiaen's interest in composing resonance is manifested in his attempts to transform the timbre of low trombone pedal tones played fortissimo by adding high three-part chords played piano on three clarinets' (Anderson, 2000, p. 10). Théo Hirsbrunner stresses that in *Neumes rythmiques*, one of the *Quatre études de rythme* (1949–50), Messiaen attempts to reconstruct the harmonics 4 (*p*), 5-6-7 (*pp*), 9-11-13-15 (*ppp*), from fundamental E2, which is not, however, played (Hirsbrunner, 2001).

As early as 1972, the spectral chords in Grisey's *D'eau et de pierre* for two ensembles, reflect Messiaen's influence, 'a pivotal piece of work, on the cusp between apprenticeship and maturity, between the Paris music conservatoire and his stay at the Villa Médicis' (Baillet, 2000, p. 8). The musical manuscripts related to this piece (PSF-GGC, *D'eau et de pierre*), demonstrate the presence of spectral chords based upon fundamental frequency F1. However, there is not yet—strictly speaking—a spectral model around which a formal structure was elaborated. Given that pitches fail to stray from an equal temperament, these chords are only a crude reconstruction of the harmonic spectrum. Here, the spectrum is simply perceived as an objective occurrence in the natural resonance of sounds. It is therefore integrated as such, and though this practice became more polished, there was nothing novel nor innovative about it. In Karlheinz Stockhausen's *Stimmung* (1968), however, the harmonic spectrum was freed from the confines of natural resonance to become a central element in the piece. It is upon discovering this piece that Grisey began to fashion his first spectral models in *Dérives* and *Périodes*; *Stimmung* consequently played a crucial role in the emergence of spectral thought.

In order to replicate faithfully the physical frequencies that make up a harmonic spectrum, Stockhausen uses in *Stimmung* a single pool of tuned pitches. In the score's guidelines (Stockhausen, 1969), he explains that one must begin by recording a chord produced by the seven sinusoidal or squared waves from the following respective frequencies: 57, 114, 228, 285, 399 and 513 Hz. The first frequency (57 Hz) is equal to the pitch located between A1 and B♭1, which is too low to be sung. This pitch is nonetheless the work's foundation, it is the fundamental element of the harmonic spectrum from which the six other frequencies (the 2nd, 3rd, 4th, 5th, 7th and 9th harmonics) are drawn. In an interview carried out little after the composition of *Dérives*, Grisey explains that Stockhausen 'conveys the heart of a sound', and goes on to say 'after an era of analysis, we are finally heading towards more synthetic writing' (Grisey, 1974c, p. 224).

Upon entering the Villa Médicis, Grisey wishes to 'give all sound phenomena purpose' (Grisey, 1988, p. 238) in order to include them in his own language. From

that point forward, the spectrum, as an objective representation of sound phenomena, becomes a structural model that guides the creative process as a whole, as well as in its details. Furthermore, no longer restricted to the aesthetic production of natural resonances, it becomes an auditory beacon within the musical structure.

Grisey began composing *Dérives* in 1973. The piece requires an orchestra made up of 50 executants in addition to an amplified ensemble of 13 instrumentalists. It lasts 30 minutes and its handwritten score measures 95 × 61 cm. These characteristics reflect its imposing nature. Completed on 17 September 1974 (Grisey, 1967–74), it is first played in Paris on 31 October by the *Orchestre National de France*, conducted by Reinhard Peters. During the winter of 1974, Grisey interrupts his work on *Dérives*, which was close to completion, to dedicate his time to *Périodes* that the ensemble *L'Itinéraire* would play on 11 June 1974 at the Villa Médicis. In both pieces—and more broadly in the cycle *Les espaces acoustiques*—the spectrum occupies a central role in the composition process. Not only does it represent a pool of singular pitches, but it also acts as the source of numerical values that both afford control over a large number of compositional actions, in addition to the temporal structure of the piece. Thus, the spectral model is no longer restricted to the static field of pitch. Its nature is significantly modified as it enters into the field of temporality. In the following, we will describe with greater precision the spectra used by Grisey in *Dérives* and *Les espaces acoustiques*, underscoring their differences from a conceptual standpoint. We shall then focus on how these models then guide many compositional procedures that are constantly renewed.

The 'Prism' as the Spectral Metaphor in *Dérives* (1973–74)

> *Dérives* resembles the course of a boat that sees itself constantly forced to correct its path as it journeys from one point to another. The entire piece evolves around an ideal path, from which we slowly stray up to a certain distance; once having tacked, we may then return. Maximal distance is equivalent to silence. This ideal path is defined through auditory tags that are immediately recognizable: the intersections (points of fusion) between the small ensemble's sequences and those of the large orchestra. It is in these moments that we hear the harmonic spectrum that makes up *Dérives*' axis. (Grisey, 1974b, p. 129)

Decomposing Sound through a Prism

Within the impressive stock of documents—over 200 pages, divided into three files—that contributed to the piece's preparation, we came across a particularly polished document. Originally in colour, it shows a spectral chord with fundamental $E_{\flat}1$ (Figure 1). This chord, which the composer calls a '*Prisme harmonique*' (harmonic prism), is both *Dérives*' starting point—for reasons we will elaborate further on—as well as the harmonic axis common to the two alternating instrumental ensembles. As opposed to focusing on the structure of objects as such, Grisey's interest in this piece

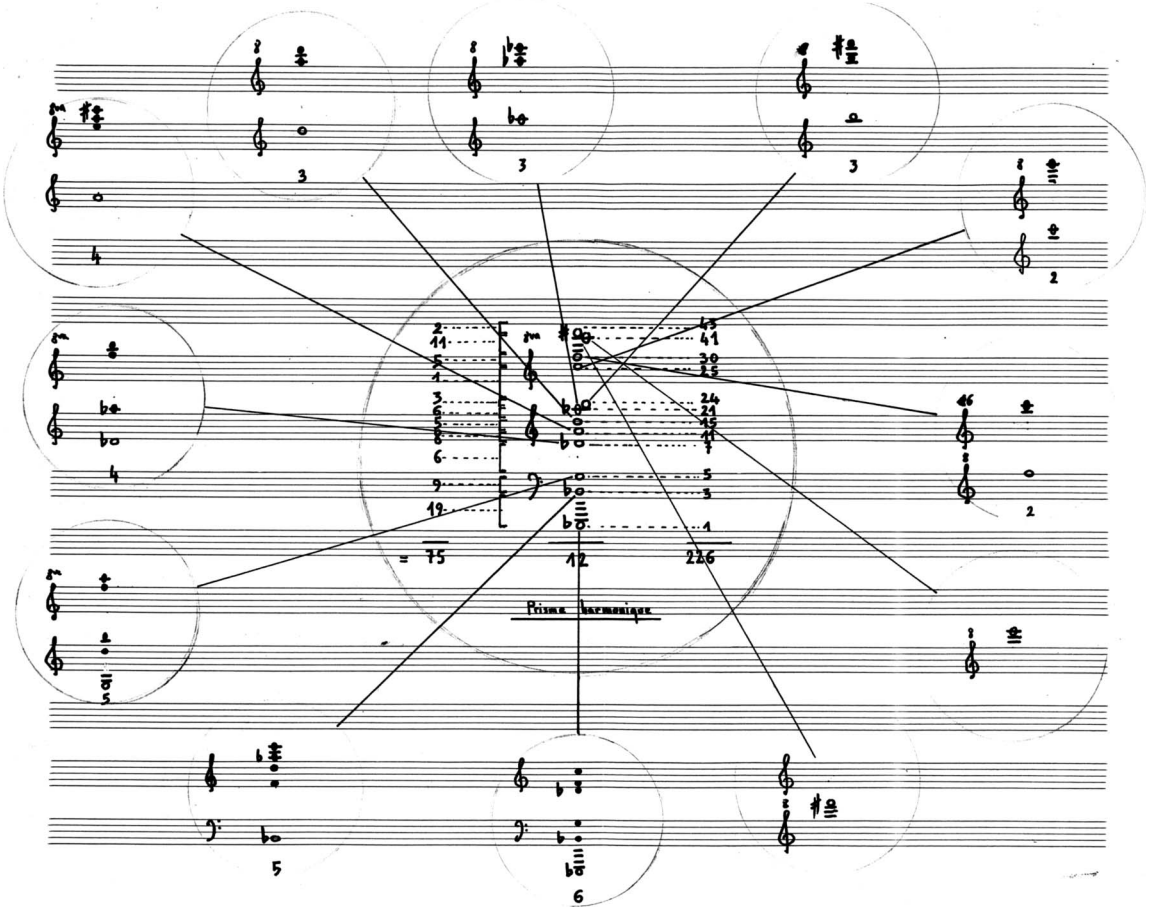

Figure 1 Harmonic prism from *Dérives*: left inside page (35.5 cm long and 27 cm high) from a double page of sheet music. Gérard Grisey Collection—*Dérives* (1/3) used with the permission of Paul Sacher Foundation, Basel, Switzerland.

lies instead in the transition from one musical entity to another. The spectral chord then becomes a steady reference counterbalancing a deliberate musical evolution, governed by complex compositional processes.

> What we see is not the musical entity as such but instead its evolution. We are unable to measure the pitch, the duration or the intensity of a given sound, however we immediately sense the difference in between one sound and the previous one. I no longer seek to compose an entity, but instead the transition from one to another, or of one structure to another; this is what I call the degree of change. (Grisey, 1974c, p. 224)

What is the exact nature of the document shown in Figure 1? Are we in the presence of a musical study or a first compositional draft of a specific fragment of the piece? The care with which Grisey elaborated the document (use of a compass, a ruler and several coloured felt tip pens) leads us to believe that he had in fact previously drawn one or several rough drafts. In any case, at its centre, the document features a 12-note spectral chord representing the 'zero point of musical development' (Grisey, 1974c, p. 224) and the axis from which the composer fashions his musical developments. Overlapping zones between both ensembles are built around this chord. Its stability and redundancy become a meaningful auditory tag from which the composer then progressively strays almost imperceptibly.

We must note that, Grisey describes the document as a 'harmonic prism' rather than a 'harmonic spectrum'. In optics, a prism refers to a transparent object of triangular shape that deviates beams of light, performing a spectral decomposition. By analogy, Grisey's harmonic prism acts as a fictitious filter through which few specific spectral components, i.e. parts of the spectrum, may pass. Perhaps Grisey was not yet familiar with the scientific jargon, or maybe he simply preferred the poetic spirit and luminescent metaphor the prism inspires. Nevertheless, this document illustrates the composer's first forays into a developing subject, acoustics, which went on to become the essence of his musical language. Thanks to our research within the Paul Sacher Foundation (PSF-GGC, library), we were able to prove that at that time Grisey was in possession of several works of musical acoustics, including Émile Leipp's *Acoustique et Musique* (1971) and Fritz Winckel's *Vues nouvelles sur le monde des sons* (1960). Both had an important impact on the integration of scientific knowledge into his musical language (Féron, 2010a, 2010b). From 1975 on, a period in which he studied under Émile Leipp in Paris, Grisey ceases to use the term prism and henceforth refers only to the spectrum.

The harmonic prism is an aggregate consisting of 12 equal temperament pitches ($E_{\flat}1$, $B_{\flat}2$, G3, $D_{\flat}4$, A4, D5, $A_{\flat}5$, B5, C6, F6, E7 and $F_{\sharp}7$) intended to approach the natural components of a harmonic spectrum with fundamental frequency $E_{\flat}1$. These pitches are consistent with the 12 notes of the chromatic scale, which tends to prove that this prism reflects the will to consider spectral structure chromatically, rather than transcribing a specific spectral model. Because of its approximate construction (equal temperament pitches), the harmonic prism is in keeping with Messiaen's

spectral chords. However, as both a pool and an active source of specific pitches, Grisey's process tends to align itself with Stockhausen's process in *Stimmung*.

The musical manuscripts also demonstrate how, from the prism, Grisey went on to identify '*antiprismes*' (antiprisms), made up only of notes outside fundamental frequency E♭1's harmonic spectrum; '*prismes complets (enrichis)*' (complete (enriched) prisms) that include additional notes from the set of natural harmonics; '*prismes d'harmoniques complémentaires*' (prisms made of complementary harmonics), made up solely of spectral harmonics absent from the initial prism; '*des contractions du prisme original autour de chaque note qui le constitue*' (contractions of the original prism around each of the notes it contains), or '*des renversements autour de l'axe de la note du prisme*' (reversals around the prism's notes' axis) … (PSF-GGC, *Dérives*). Given these variations, fundamental E♭l's prism emerges as a crucial element in the work's harmonic structure. The 12 smaller circles that revolve around the central core are fragments of new spectra. Each is fashioned from notes belonging to the main prism, these then become a fundamental (note represented in white). Most often, Grisey favours odd harmonics to even harmonics, and the latter often result redundancies. The numbers inside each circle refer to the number of notes that form the new, reduced prisms (the number of notes increases as the fundamental becomes lower).

Let us shift our attention back to the main prism by focusing on the series of numbers recorded on either side of the chord. On the right, are the numbers of the harmonics roughly related to the prism's notes and on the left are the intervals between each of the prism's subsequent pitches. A number of errors in the matches between harmonic numbers and prism pitches were noticed: the numbers (25, 30, 40 and 43) associated with the four highest notes (C6, F6, E7 and F♯7) reveal themselves to be completely off (Table 1). This reinforces our belief that Grisey used fundamental E♭1 as a starting point from which he composed the basis of this spectral chord. It was then completed using unused notes from the chromatic scale. It was only once the aggregate existed that he chose to identify the highest notes as components of the harmonic spectrum. Having relatively successfully identified the harmonic ranking of each note, Grisey then calculated the sum of these values as 226. This number is therefore not, in itself, representative of any type of objective data but rather reflects the implementation of a mental procedure.

Grisey also measures the intervals formed between each of the prism's notes, and expresses them as semitones on the left side of the central circle. The result is then 11 numbers (of which two appear twice) that can be ranked in the following ascending order: 1, 2, 3, 5, 5, 6, 6, 8, 9, 11 and 19. Unlike the sum of the harmonics' ranking, that of these 11 intervals, which add up to 75, report an objective fact because it reflects the aggregate's pitch range (E♭1–F♯7): six octaves and an augmented second. Therefore, the manuscript provides us with information concerning both the harmonic (groups of notes) and numerical (the ranking of harmonics, intervals expressed as semitones) structure of *Dérives*, which applies to the work as a whole as well as in its details. Let us now focus on how this spectral data influences the creative process.

Table 1 Elements of *Dérives*' harmonic prism

Prism's pitches	Frequency (Hz)	Corresponding harmonics	Prism's harmonics	Frequency (Hz)	Corresponding pitches
F♯7	2960	76	43	1672.7	A♭6
E7	2637	68	41	1594.9	G6
F6	1396.9	36	30	1167	D6
C6	1046.5	27	25	972.5	B5
B5	987.7	25	24	933.6	B♭5
A♭5	830.6	21	21	816.9	A♭5
D5	587.3	15	15	583.5	D5
A4	440	11	11	427.9	A♭4 or A4
D♭4	277.1	7	7	272.3	E♭4
G3	196	5	5	194.5	G3
B♭2	116.5	3	3	116.7	B♭2
E♭1	38.9	1	1	38.9	E♭1

The notes that make up the prism and their harmonic ranking, according to Grisey and as they appear on the musical manuscript (Figure 1), are on the grey background. On either side of the lighter background are the frequencies and rank of the harmonics derived from the prisms' notes (left side), and the frequencies and notes derived from the prism's harmonic numbers (right side). It is understood that harmonic 1 is equivalent to the fundamental (frequency f0 or f1). In the case of a harmonic spectrum, the frequency of each spectral component verifies the following relationship: $fn=n \times f0$.

The Temporal Structure of Dérives

In *Dérives*, save for during the piece's central and final sections, the large orchestra and the small amplified ensemble alternate, imperceptibly. A diagram drawn on grid paper (PSF-GGC, *Dérives* 3/3), not shown here, clearly demonstrates how Grisey had planned the individual length of each sequence around a specific series of eight numbers: 1, 2, 3, 5, 8, 9, 11 and 19. These values reflect the intervals, expressed as semitones, between each of the harmonic prism's notes (only the number 6 was not included). Once this set was defined, Grisey multiplies each number by two basic temporal units: the first, 11 seconds, is linked to the small ensemble; the second, 17 seconds, is linked to the large orchestra. The work revolves around 16 parts (Table 2), featuring the small ensemble's eight sequences (S_{SE}) and the large orchestra's eight sequences (S_{LO}). In the programme's notes, Grisey describes the existence of eight sections intended to reflect as many deviations from the harmonic prism (Grisey, 1974b, p. 129). Each section involves a sequence played by the small ensemble and one played by the large orchestra. The score's analysis (*Dérives*, Ricordi 132281, 1974) demonstrates the alternation between each ensemble's sequences, with the exception of the piece's fourth section, where both sequences ($S_{LO}5+S_{SE}4$) intentionally overlap.

Although a few minute differences appear in the duration, careful analysis of the score shows that the work's temporal structure and theoretical division are strictly respected. Also, one ensemble occasionally joins the other for unspecified lengths of time. For example, the small ensemble backs the large orchestra at the end of the piece, during the $S_{LO}7$ and $S_{LO}8$ sequences. In such a complex and precise structure,

Table 2 Theoretical durations (in seconds), as established by the composer and affiliated with *Dérives*' main sections

Intervals inside prism	1	2	3	5	8	9	11	19
Duration (Interval × 17″)	17	34	51	85	136	153	187	323
Section LO	$S_{LO}7$	$S_{LO}1$	$S_{LO}2$	$S_{LO}3$	$S_{LO}5$	$S_{LO}8$	$S_{LO}6$	$S_{LO}4$
Score cues	38	0	3–4	7–8	24–27	40–54	31–36	11–23
Duration (Interval × 11″)	11	22	33	55	88	99	121	209
Section SE	$S_{SE}8$	$S_{SE}7$	$S_{SE}6$	$S_{SE}3$	$S_{SE}4$	$S_{SE}2$	$S_{SE}5$	$S_{SE}1$
Score cues	39	37b	37a	9–10	24–25	5–6	28–30	1–2

The large orchestra (LO) and small ensemble (SE) play alternately, overlapping during a few measures in order to ensure the continuity. Only the fourth '*dérive*' (drift), is truly a meeting point where both ensembles play their sequences simultaneously.

the prism provides piece's temporal planning with essential theoretical support. Once the latter is established, it allows the composer to design a more formal outline, a sort of schematic synopsis of each sequences' musical intent.

Such an outline seeks to represent the musical flow over time—graphically, textually, musically, schematically . . . In order to do so Grisey often uses grid paper. In the case of *Dérives*, time is shown on *x*-axis on a scale of 5 mm (1 square)=10 seconds. The *y*-axis is separated into four categories, 'Duration, Pitch, Tone, Intensity', each including several sub-categories we shall not discuss here (PSF-GGC, *Dérives* 3/3). Measuring 35 cm in height and 3.15 m in length, the formal outline spans several sheets. Although it was undoubtedly amended as Grisey's composition progressed, this outline played a key role in the process and was largely elaborated at its onset. Jocelyne Grisey, who was by her husband's side at the Villa Médicis, confirmed that 'the piece's aspect had begun taking shape before a single note was written' (ITW with Jocelyne Grisey, 16 March 2010). There are a number of collages on the outline, mostly pieces of music paper featuring harmonic changes, groups of notes or other elements in need of musical notation. The outline shows that the $S_{LO}5$ sequence was originally located at the end of the piece, after $S_{LO}8$, as opposed to its current position, overlapping $S_{SE}4$. We therefore believe that Grisey had originally intended to alternate between the large orchestra and small ensemble sequences in a systematic fashion.

Nevertheless, the production of a temporal grid and a formal outline reflects both the main components of the composer's craft and the influence of the spectral model on the piece. Let us now move on to the last sequence during which Grisey introduces, for the first time, what he refers to as instrumental synthesis (Grisey, 1991). In this procedure, symbolic of spectralism, spectral components are assigned to different instruments within the orchestra.

Prismatic Revelry in Dérives' *Final Sequence*

As previously discussed, the harmonic prism acts as a junction between the piece's various sequences: shifts between the small ensemble and the orchestra are tied into

notes that make up the harmonic prism. Secondary prisms, which revolve around the main prism (Figure 1), are at the heart of the *Dérives*' final sequence. It begins at the cue 40 on the score, or 28 minutes into the recording on vinyl (LP Erato-MFA, STU 71157). Theoretically lasting 153 seconds, this sequence features six periodic events that Grisey briefly describes:

> Tied into this spectrum, six periodic events slowly come into being, resembling circles rotating at differing speeds.
>
> 1. Wood and brass instruments: melisma on sounds of the harmonic spectrum
> 2. Resonant percussions: changes in intensity of the same sound
> 3. Small ensemble: each harmonic produces its own harmonic spectrum
> 4. String instruments: elaboration through the addition of even harmonics and their glissandi
> 5. String instruments: beams of glissandi sweeping through the spectrum
> 6. Percussions: white noise (all frequencies)
> 7. The last circle represents the silence that disassembles the machinery (Grisey, 1991, p. 92)

Instrumental relays maintain the main prism's harmonics 1 ($E_\flat 1$), 3 ($B_\flat 2$) and 15 (D5) during the whole of this sequence. Two bass tubas (or contrabassoons) and a bass trombone provide the fundamental; trombones 1 and 2 provide harmonic 3; trumpets 3 and 4 provide harmonic 15. In order to expand upon this spectral harmony, the electric guitar appears at cue 44, playing harmonic 2 ($E_\flat 2$). Grisey then uses this vast spectral pedal gradually to set up his six periodic events.

From cue 41 (event 1), the wind instruments (flutes, oboes, clarinets, horns, bassoons and trumpets) produce melisma—small, relatively slow, melodic cells (the interprets rarely play more than two notes per second). Each cell is made up of alternating notes within a group of three, four or five notes that depend on the instruments solicited. The pattern's last note is maintained until the following iteration. These melisma generally occur at a rate equivalent to 11 or 22 quarter notes, and their dynamic profile is $pp < p > pp$. From cue 42 (event 2) onwards, the percussions contribute a new layer, playing harmonics that—without ever straying from the main prism—become successively higher according to a systematic *crescendi*: these periodic and regular rises in the spectrum occur on a cycle of 15 quarter notes. From cue 43 (event 3), the small ensemble essentially plays harmonics of harmonics—notes belonging to the secondary prisms (Figure 1)—that Grisey sweeps through in a clockwise fashion that begins with the fundamental's secondary prism and leads through to the piece's end with the single pitch, $F_\sharp 7$, held by the accordion, the violins 1 and 2, the viola and the cello. That said, before reaching this crystalline ending the composer adds three layers of sound: harmonic glissandi (event 4) and normal glissandi (event 5) are assigned to the string section from cues 44 to 47. Grisey also adds noise elements (event 6) at cue 50, in the form of drum rolls (cymbals, tam-tam) that fade in and out.

The harmonic prism is both the compositional project's heart and foundation. Not only does it determine *Dérives*' overall structure, but it also influences the development of several individual sequences, including, for example, the one that concludes the piece. The prism in *Dérives* is less of an attempt at genuinely objectifying sound data. It stems instead from a theoretical formalism seeking to enclose 12 chromatic notes into the objective reality of a sound: fundamental $E_{\flat}1$'s harmonic spectrum. By arranging the 12 notes of the chromatic scale (approximately) into components of this spectrum, Grisey reaches a sort of spectral atonalism. Therefore, the basis for Grisey's spectral language is unequivocally found in *Dérives*. These structuring principles reappear later, polished and renewed, in the entire cycle *Les espaces acoustiques*. In *Périodes*, Grisey truly paves the way for spectralism, as it becomes a coordinated and unified musical aesthetic from which is drawn an ensemble of techniques. He establishes a more precisely conceived spectral model, closer to the physical reality of sound. Once we have described this model and underscored its impact on the production of both a temporal matrix and a formal outline, we shall analyse a specific section of the piece in order to demonstrate how this model governs all compositional operations, and consequently, overcomes arbitrary choices.

From the Establishment of the Spectral Model in *Périodes* (1974) to the Birth of the Cycle *Les espaces acoustiques*

> … Today, 11 May 1974, after three months of suffering and torture I have completed my piece *Périodes*!
> Thus far, no work was ever at the expense of such tears … For three months I have isolated myself and done nothing but work on this score from morning until night …
> … nearly to death
> Yet it is here, and at last I understand the importance of the ternary in timing (tension, drop or inspiration, expiration, rest), the heartbeat (near periodicity) and the spectrum of harmonic partials (regulating prism, Alpha and Omega).
> (Grisey, 1967–74, p. 317)

Refining the Spectral Model

In *Périodes*, the use of objective acoustic data is more precise than in *Dérives*. The composer calculates the frequencies equivalent to the first harmonics of fundamental E1's spectrum. He then seeks to transcribe them as accurately as possible while taking into account the interpreter's options. In order to reconstruct certain spectral components in such a way that the note and the frequency coincide, the use of quarter tones and deviations of one-sixth of a tone is occasionally necessary. Given that the preliminary study for the establishment of such a spectrum was explained in a previous article (Féron, 2010b), we shall limit

ourselves to commenting the reproduction of its musical transcription as it appears in the score's guidelines (Figure 2) in lieu of a detailed description.

The composer selects 12 pitches: the first 11 odd harmonics (from the fundamental to the 21st) to which is joined the second harmonic. *Périodes*' original spectrum, made up of this set of notes, is based upon a physics model (the harmonic structure of a musical sound) that remains nonetheless abstract (because it does not stem from the analysis of a specific sound). Although Grisey had already used micro-intervals in the past, this is the first time he does so in order to reconstruct the spectral structure's harmonicity as closely as possible. In his guidelines, he specifies the importance of 'pursuing acoustic reality' (Grisey, 1974a)—seeking best to reconcile the note and the frequency. Therefore Grisey uses quarter tones (♯) to reconstruct harmonics 11 and 13, and deviations of approximately one-sixth of a tone (𝄳 ou ↓) for harmonics 7 and 21. The original spectrum's 12 notes, ranging from E1 (fundamental) to A𝄳5 (an approximation of the 21st harmonic), make up what we refer to as the *series of pitches*: S_p=[E1, E2, B2, G♯3, D𝄳4, F♯4, A♯4, C♯5, D♯5, F5, G5, A𝄳5]. As was the case in *Dérives*, the model is not just a pool of notes. The numbers shown above and under the stave are crucial: over the course of the piece, they control a large variety of compositional processes, as described below. The numbers shown above each note determine the harmonic ranking of the original spectrum and represent what we refer to as the *series of partial harmonic numbers*: S_n=[1, 2, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21]. The numbers under each note represent the intervals, expressed in quarter tones between two joint components—as opposed to semitones in *Dérives*. These make up the *series of intervals between harmonic partials*: S_i=[22, 14, 18, 12, 8, 7, 6, 5, 4, 4, 4].

Grisey therefore manages to extract three structural series from the original spectrum: one series of pitches and two numerical series. In the score's guidelines, the composer specifies that the number of the harmonics is 'used to define rhythmic density' and that the interval between the harmonics is 'used to define lengths in the

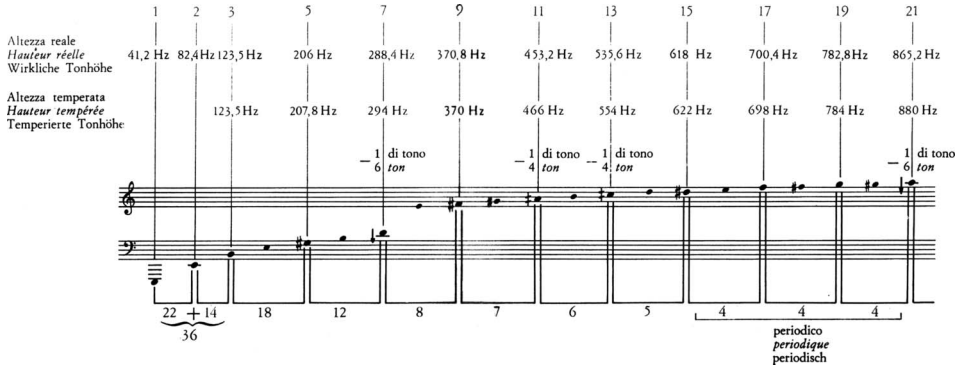

Figure 2 Musical rendition of the original spectrum as it appears in the score's guidelines (*Périodes,* Ricordi 132243, 1974).

piece' (Grisey, 1974a). Both series are in fact as important as the harmonics series because they are the invisible link that guides *Périodes*' composition process, and pieces from the cycle *Les espaces acoustiques* as a whole. Grisey uses S_i, for example, to determine the length in seconds of each of the sections belonging to the cycle (with the exception of *Prologue*). As we shall see below, in *Périodes* the composer measures the intervals in quarter tones and multiplies them by eight. However, in the cycle's other pieces, he expresses these intervals in savart before multiplying them by specific factors. The interval between two frequencies, in savart, is by definition, the logarithm of their ratio, multiplied by a thousand. Grisey became familiar with this scale of measurement after studying Leipp's *Acoustique et musique* (1971) and following the acoustician's teachings. In order to do so, Grisey was required to use a logarithmic slide rule, a tool whose complex operation Leipp explains well (1971, pp. 10–17). Thus, spectral models naturally lead the composer to develop both his cognitive and technical tools, in addition to constantly expanding his compositional '*atelier*'. Let us explore in greater detail how he uses S_i to design the temporal grid from which he builds the formal outline of *Périodes*.

The Temporal Structure of Périodes

The score's guidelines also contain Grisey's rather direct description: '*Périodes* is an unfinished cycle of analogue ternary periods based upon breathing: inspiration, expiration, rest' (Grisey, 1974a). As is the case in *Dérives*, the spectral model becomes an auditory tag: each resting phase is built around a specific musical cell, which is made up solely of notes from the original spectrum and repeated *ad libitum*. Thus, *Périodes* has a cyclic form in which moments of tension (inspiration), release (expiration) and rest follow one another. The piece begins with a resting phase (referred to as 0) and continues across four complete cycles, resulting in a total of 13 sections: five resting, four inspirations and four expirations. Contrary to the resting phases, the timing of the inspiration and expiration phases, based upon S_i, are perfectly defined from the beginning of the compositional process.

Before we proceed, it is important to make note of a mistake in S_i: as determined in a preliminary study (Féron, 2010b), the gap between the fundamental (E1) and the second harmonic (E2) is equal to an octave—24 quarter tones—and not 22 as indicated in the score's guidelines (Figure 2). This error may therefore have a direct impact on the piece's overall structure, given the link between S_i and the number of sections and their relative duration. It appears that Grisey dismisses S_i's first value, possibly because it is too high, and groups together the last three 4-quarter tone intervals. The musical manuscripts (PSF-GGC, *Périodes*) emphasise, as Baillet (2000) previously demonstrated, the composer's strategies when he decides to multiply each of S_i's remaining nine values by eight and combine the obtained results with times expressed in seconds and organised in a more or less random sequential order (Table 3).

Table 3 Time structure for inspiration and expiration phases, based upon S_i initially expressed in quarter tones

S_i	14	18	12	8	7	6	5	4-4-4
Duration (seconds)	112	144	96	64	56	48	40	32-32-32
Section	Exp. 2	Insp. 1	Exp. 3	Exp. 1	Insp. 4	Insp. 2	Insp. 3	Exp. 4

In one of the preliminary documents (PSF-GGC, *Périodes*), Grisey estimates the piece's overall duration by adding all the values in Table 3 and establishing the resting times as 30 seconds. Adding together 30+(144+64)+30+(48+112)+30+(40+96)+30+(56+32+32+32)+30, he obtains 806 seconds, or close to 14 minutes. It is only once he established the temporal grid, and organised the sections in relation to one another, that Grisey went on to determine the piece's length and design the formal outline in which he schematically represents the sound he wishes to achieve.

Périodes' *Formal Outline*

Originally in colour, and discovered in the musical manuscripts belonging to *Partiels* (PSF-GGC, *Partiels*), *Périodes*' formal outline is made of five fragments we assembled back to back (Figure 3). This synopsis measures 67 cm in length and 9.5 cm in height. It was drawn on grid paper in order to vertically plot the overall evolution of pitches/tessituras according to a linear temporal scale in abscissa (one square=5 seconds). As with *Dérives*, the design of this formal outline represents a pivotal step in the creative process, allowing the composer to both virtually structure his piece and its musical path. Grisey can therefore imagine the piece's general shape prior to entering *per se* into the writing of each of its sections. According to Dufourt, such an approach is characteristic of spectral composers:

> The musical object also changes appearance. It appears as a force field spontaneously distributed according to a dynamic configuration in which factors and fragments cannot be dissociated. Only the unity of its global form and the continuity of its gradual expression are of importance. (Dufourt, 1979, pp. 290–291)

Vertical black lines clearly separate each different section of *Périodes*. Diagonal, ascending and descending arrows respectively translate periods of inspiration (tension) and expiration (release). Upon each section—with the exception of the resting periods, designated with a fermata—Grisey defers the theoretical duration, indicating in parentheses the number drawn from S_i multiplied by eight. In specific cases, he also notes the harmonic couples from which he obtained S_i's values (e.g. inspiration 1: '5/3', expiration 2: '3/2' and expiration 3: '7/5'). The additional inscription '(Savart × 2/3 env.)', written in the first inspiration with a different pen was undoubtedly added afterwards, once Grisey had begun work on other pieces

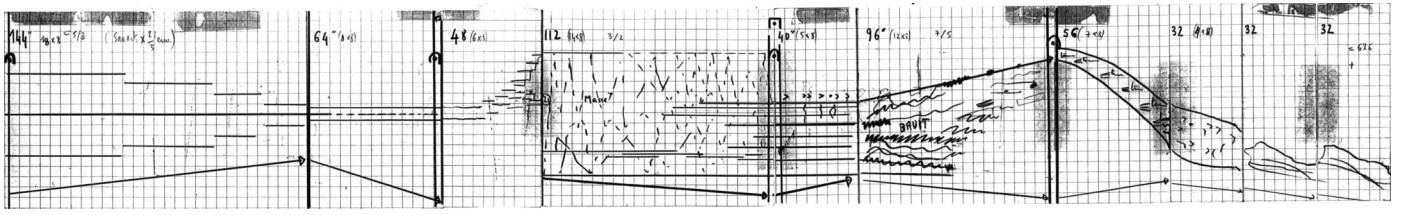

Figure 3 Formal outline of *Périodes*. Gérard Grisey Collection—*Partiels* used with the permission of the Paul Sacher Foundation, Basel, Switzerland.

within the cycle. The times derived through the multiplication of S_i values, expressed as quarter tones, by eight are in fact quite similar to the results of the same intervals, expressed in savart and multiplied by 2/3. Yet, in the cycle's other pieces—except for *Prologue* that deviates from the system—times are consistently calculated based upon intervals expressed in savart that are then multiplied by fractions whose numerator and denominator match the original spectrum's harmonic rankings (Baillet, 2000, p. 134). Though entirely abstract, such a practice affords the cycle a temporal coherence by constantly referring to the numerical values provided by the spectral model. The change of strategy that took place between *Périodes* and *Partiels* seems to indicate that Grisey was not yet comfortable with the use of the slide rule for logarithms during his time at the Villa Médicis from October 1972 and October 1974. It is likely that this gap was filled after he followed Leipp's teachings between 26 October 1974 and 25 May 1975 (PSF-GGC, folder '*Certificats*').

The formal outline therefore accurately reports the four ternary cycles' flow. The periods of inspiration (downward diagonal arrow) are translated musically through the gradual unfurling of tension that increases towards a climax, marked by a strong inharmonicity. Periods of expiration see this tension progressively release, and with it the harmonicity returns. While an inspiration period draws its harmonic matter mainly from the rest period that precedes it, a period of expiration guides this same material back towards the upcoming rest period. These latter moments of both quiet and static are associated with maximum release. However brief, the formal outline provided valuable insight into the evolution of auditory matter during the ternary cycles and took on all of its meaning upon listening to the piece. We shall attempt to provide a synthesis of the piece by concentrating solely on the pictorial information provided by this musical synopsis.

A polar note (horizontal and continuous line from inspiration 1—section 144'') is first held continuously while the two notes that surround it begin to gradually and symmetrically close in around it, implying the compression of the pitch range. The polar note is gradually replaced (expiration 1—section 64'') by a reduced interval maintained during rest 1. It then transforms into (inspiration 2—section 48'') an overlay of embedded strata becoming higher until a breaking point indicates expiration 2 (section 112''). The latter is imagined as a swarming sound mass that covers a large range, upon which notes drawn upon the original spectrum progressively emerge as rest 2's spectral chord. This chord is then subject to a series of irregular emphases (inspiration 3—section 40'') only to become a noisy sound as implied by the presence of the word '*BRUIT*' (noise) (expiration 3—section 96'') that gradually dissipates and diminishes to become the high harmonic cell of rest 3. During this last cycle, the musical matter becomes lower and lower, successively carried by trills (inspiration 4—section 56'') followed by accentuations in chains and finally musical lines (expiration 4—section 3×32'').

By both mapping the ranges' evolutions over time and providing information concerning the musical content (melodic, harmonic and textural trends), this formal outline allows the composer to design and clearly set the piece's dramaturgy. In fact,

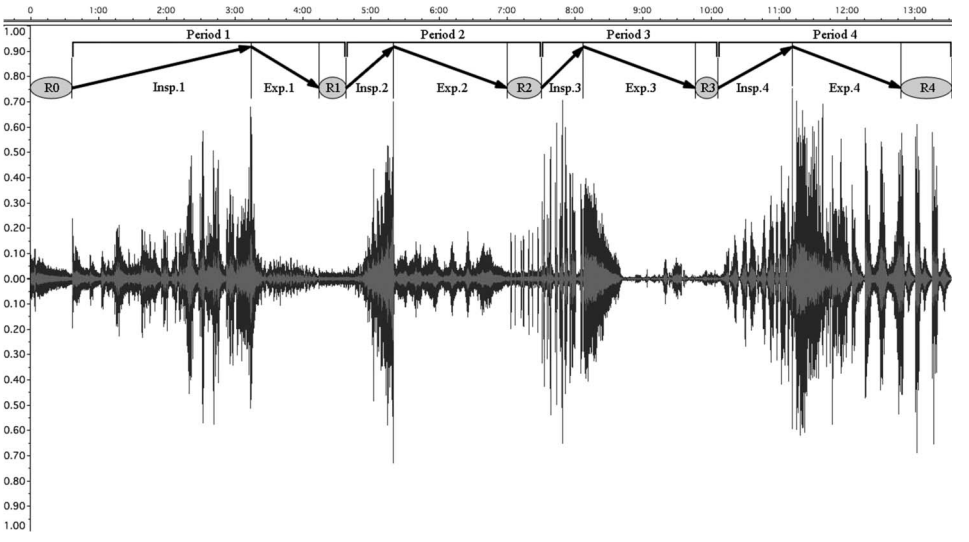

Figure 4 Waveform (amplitude variations depending on time) from *Périodes* as obtained with the program Audacity based on the recording of the *Ensemble Court-Circuit* conducted by Pierre-André Valade (CD *Les espaces acoustiques*, Accord una corda 465 386-2, 1999).

it appears interesting to establish a parallel between this outline and the waveform produced by a recording of *Périodes* (Figure 4). The four cycles of the ternary structure are distinctly visible, and the moments of inspiration and expiration are respectively associated with the amplitude's ebb and flow.

In short, *Périodes* could be described as a large-scale musical projection of the respiratory cycle. The temporal grid and formal outline, both linked to sound data as an objective notion, attest to the importance of the spectral model in the piece's overall conception. Though it may not be reflected from an auditory standpoint, the piece's temporal structure is the result of the spectral model given that the times are proportional to the gap that separates the notes from the original spectrum (S_i). However, the consistent use of the harmonic partial series (S_p) in each rest section produces a more significant auditory tag than was the case in *Dérives* because the consonant harmonies that define these sections stray from the equal temperament and time is deliberately suspended.

Using Spectral Harmony as an Auditory Tag

Rest sections are clearly defined both on the score, and to the ear. They are always combined with a fermata, which is a signal to repeat the associated musical cell for at least 30 seconds. From a harmonic and/or melodic standpoint, each cell is built around the series of pitches S_p, or its transposition into the octave above—as is the exceptionally the case in the last rest section at the end of the piece.

According to the composer, these sections exert 'a force of both attraction and repulsion on the sound's trajectory (Grisey, 1974a). From a rhythmic standpoint, they are either static and fixed (pedal chords), or pulsating, thereby exploring the notion of '*pseudo-périodicité*' (pseudo-periodicity) or blurred periodicity whose meaning and importance is revealed in the score's guidelines:

> Our heartbeats, our breathing, the beat of our steps and so many other unknown rhythms (nerve impulses, for example) are never as precisely periodic as a clock. They fluctuate ever so slightly. [...] So it is with these periods, as they stray from the strict and the automatic. Thus, periodicity is infused with a life it was previously lacking. (Grisey, 1974a)

Pseudo-periodicity aims to generate depth and gravity prior to each new development. In the final resting section, which concludes *Périodes* but coincides with the beginning of *Partiels*, Grisey dramatically refines the process of instrumental synthesis he had begun to sketch out in the last section of *Dérives*. He no longer only seeks to draw from the pool of notes created by the first spectrum, as he had in previous resting sections. Here, he attempts to instrumentally replicate all the pitches of the original spectrum, transposed an octave higher while respecting the temporal balance that characterises most instrumental sounds: attack, sustain and decay. We limit ourselves here to a brief summary of the process employed by Grisey (for more details, see Féron, 2010a, 2010b).

The instruments in the orchestra can be used to express the spectral components of a real or imaginary sound used as a model. Contrary to Grisey's remarks in one of his articles, and though it was later included in several musicological articles and books (e.g. Baillet, 2000; Cohen-Lévinas, 1998; Fineberg, 2000), we do not believe this resting section, nor the beginning of *Partiels*, is based upon the transcription of the spectrum or spectrogram from the analysis of a trombone sound sample. In this resting section, the composer only uses pitches of S_p, shifted an octave higher (E2 becomes the spectrum's fundamental), in order to build a spectral chord note by note. Each component's gradual entry aims to render perceptible what occurs in a sound's first milliseconds: the unsynchronised entrance of each of its components. In rebuilding the spectrum's harmonicity, Grisey draws from objective, yet nonetheless generalist, sound data. It is not until *Modulations* (1976–77) and *Transitoires* (1980–81) that we see Grisey objectively transcribe data obtained from the spectral analysis of the actual sounds of instruments. At this time, he and Michèle Castellengo, one of Émile Leipp's close collaborators, were involved in a number of recordings and spectrographic analyses that allowed him to continue to develop his instrumental synthesis process (ITW with Michèle Castellengo, 18 November 2009).

The three series drawn from the original spectrum are omnipresent in *Les espaces acoustiques* as a cycle, as well as in each piece individually and also, more specifically, within each section. In order to illustrate the omnipotence and interaction of these series in the creative process, next we shall focus on *Périodes*' fourth cycle, and particularly in the inspiration phase.

From Pre-composition to Detailed Implementation: The Spectrum's Imprint on *Périodes'* Fourth Respiratory Cycle

> The fascination with continuity that haunts so many of the XXth century's composers leads me to shift my attention not only towards sounds (the matter) but towards the differences that exist between them (the degree of change). (Grisey, 1979, p. 43)

In *Périodes*, inspiration 4 is located between cues 16 and 20 in the score and is consistent with timings (10'08''–11'15'') and (12'15''–13'44'') on the Accord and Kairos label recordings, respectively. Our analysis is based upon the composer's musical manuscripts (PSF-GGC, *Périodes*) and underscores the structural significance of the original spectrum's three series, while also demonstrating their role in the composer's strategies. According to the piece's formal outline, the fourth respiratory cycle's inspiration (section 56'') sets into motion a series of trills that become progressively lower (Figure 3). First, we shall describe the outline that depicts the harmonic progression Grisey had intended for the entire fourth respiratory cycle, which is based upon pulling into or away from the original spectrum. Then, we shall focus on an outline specifically related to inspiration 4, which reveals the structural importance of the original spectrum's series in Grisey's creative approach. Finally, in order to illustrate the synthetic quality of the latter document, we shall use a specific example to demonstrate the transition from outline to final draft, as shown on the published score. Through such an analysis, we hope to render tangible the mental and technical tools implemented via the spectral model.

The Harmonic Evolution of Périodes' *Fourth Cycle*

The notion of a process that connects, via a continuous path, one auditory event to another is essential to Grisey. The outline shown below (Figure 5) illustrates the '*Progression harm.*' (harmonic progression) of a chord whose the '*Densité*' (density) hovers around seven only to be sharply reduced to three by the end of the process. The composer's objective is to achieve '*éloignement progressif du prisme*' (gradual distance from the prism), that is, fundamental E1's spectrum. Here, the three processes involved are the degree of harmony, the range and the density of the chords. The document can be divided into three systems: the first (staves 1–4) contains 13 numbered chords and refers to the harmonic evolution of the score from cues 16–19; the second (staves 5–12 and the right side of stave 13 '*éloignement maximum*' (maximal distance)) includes chords 14–24 and refers to cues 20 and 21 of the score; finally, the third (left side of staves 13 and 14) includes chords 25–29 and refers to cues 22 and 23 of the score.

Control of the harmonicity occurs through three aggregates that Grisey refers to as A, B and C. Though we were able partially to reconstruct the chord (Figure 6), we did not find its complete written trace in the original manuscripts. Aggregate A refers to

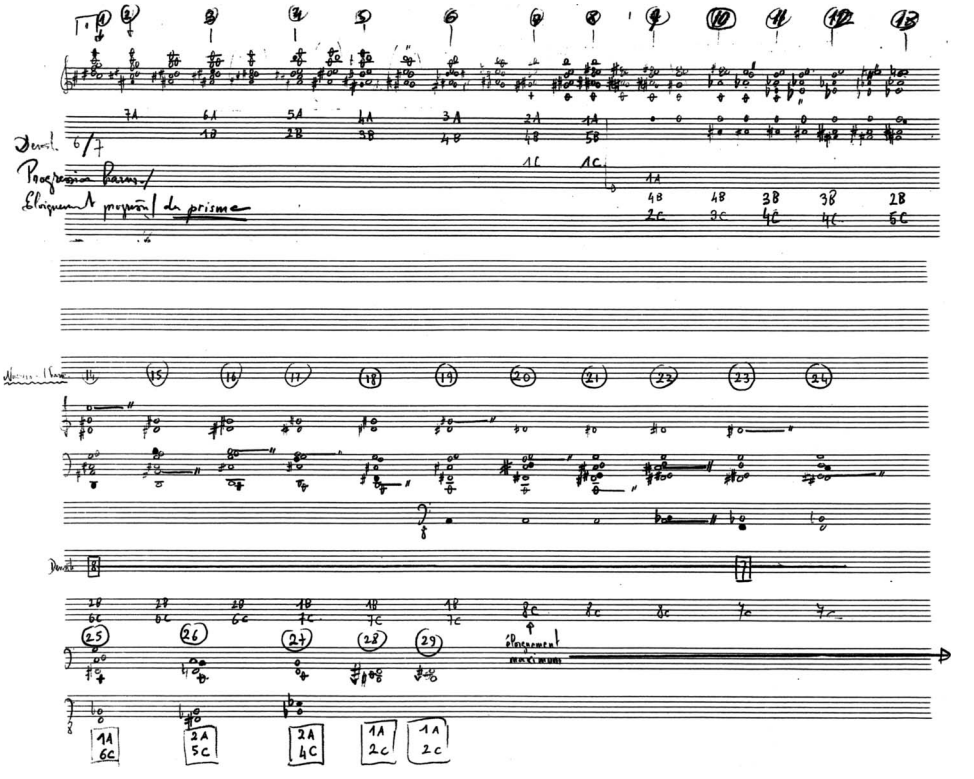

Figure 5 Harmonic progression of *Périodes*' fourth respiratory cycle. Gérard Grisey Collection—*Périodes* used with the permission of Paul Sacher Foundation, Basel, Switzerland.

S_p, i.e. components 1, 2, 3, 5, 7, 9, 11, 13, 15, 17, 19 and 21 of the fundamental E1's harmonic spectrum. Aggregate B is made up of components drawn from the spectrum but not included in S_p, those that Grisey referred to as the complementary spectrum. Finally, aggregate C includes only notes that do not belong to the harmonic spectrum, thereby representing a sort of anti-spectrum. Therefore, this harmonic conception is similar to that previously employed by Grisey in *Dérives*.

The starting point of this progression is the chord in rest section 3, which is made up of the original spectrum's last five harmonics, notes C$\frac{1}{4}$5, D$\sharp$5, F5, G5 and A$\frac{1}{4}$5. In addition to these five notes, rounded up to equal temperament (C$\frac{1}{4}$5→C$\sharp$5 and A$\frac{1}{4}$5→A5), the draft's first chord (1) includes harmonic 25 (C6). As an odd harmonic, the latter was deemed belonging to the original spectrum. Step by step, Grisey then modifies the chord, adding a note written systematically in black and removing one or more other notes.

In the beginning of the process, the composer specifies the intermediate chords from which a note was removed (un-numbered chord). Later, from chord 14, Grisey simply indicates the deleted note with a dash '— //', only to forego any mention from

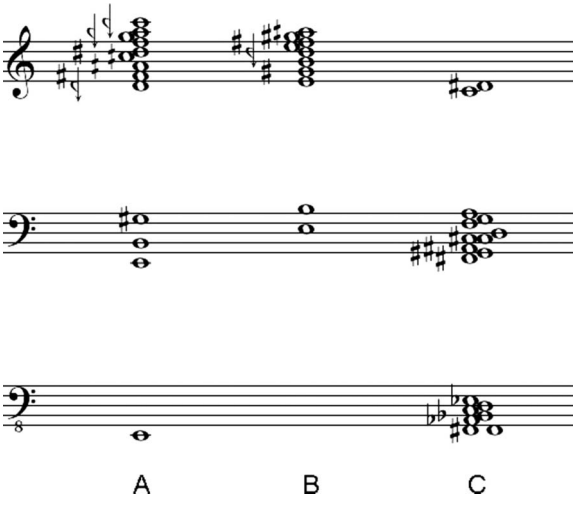

Figure 6 Reconstruction of aggregates A, B and C from which Grisey completed the harmonic evolution of *Périodes*' fourth respiratory cycle.

chord 25 onwards. The density (i.e. number of notes per each chord) is set at 7 at the very beginning of the progression (chords 2–13). It then gradually decreases towards the end (chords 23–29). Below each numbered chord, Grisey indicates the number of notes belonging respectively to aggregates A, B and C. This allows one to follow the evolution in the degree of harmonicity, without reading the chords (in fact, this was probably done prior to the chords being written). Chords 20–24, which include only notes belonging to aggregate C, are farthest removed from the harmonic spectrum. Hence Grisey's indication, below chord 20, that this is the point of maximum distance from the original prism. The choice of each chord's notes is done within aggregates A, B and C. As the evolution progresses, Grisey selects lower notes in order to obtain a gradual and global descent in the tessitura—which is shown as intended from the onset in evidence from the piece's formal outline (Figure 3).

This outline reflects the harmonic progression of *Périodes*' fourth cycle as a whole. It also perfectly illustrates the notion of transformative process—quite dear to the composer. Though slight variations exist between the chords, as they appear on this document, and those included in the final score, Grisey is rigorously faithful to this harmonic planification. Let us now focus specifically on the implementation of the inspiration whose harmonic evolution is restricted itself to the first system (chords 1–13).

Périodes' *Fourth 'Inspiration': From Planning to Conception*

The general idea of this 56-second long section is to generate a series of '*mélodies tissées*' (woven melodies)—tangled melodic lines—that lead to a trilled chord (PSF-GGC, *Périodes*). Among documents used to prepare this section, we chose to reproduce the one that reveals a new facet of the composer's '*atelier*' (Figure 7).

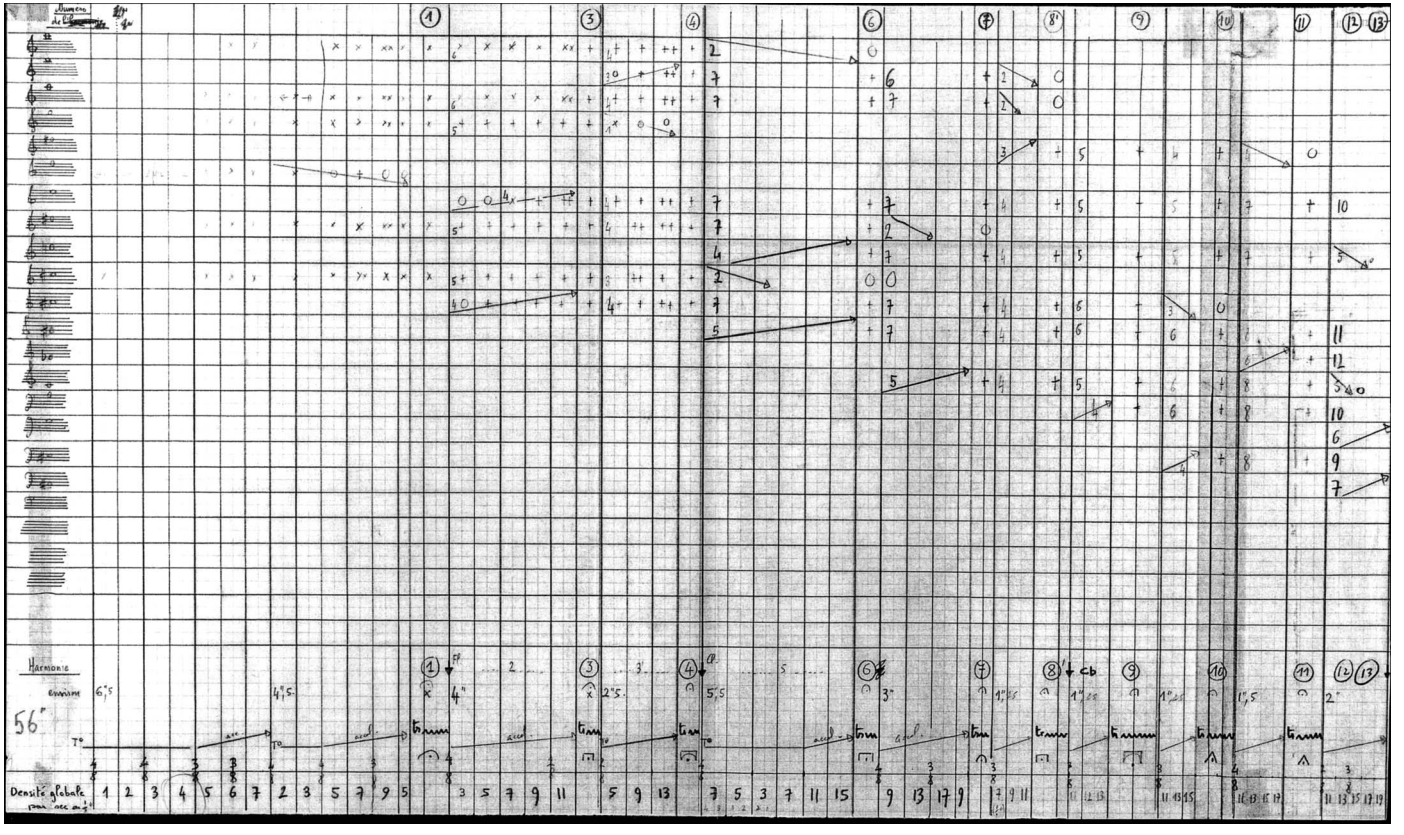

Figure 7 Musical organisation of *Périodes*' inspiration 4. Gérard Grisey Collection—*Périodes*, used with the permission of Paul Sacher Foundation, Basel, Switzerland.

Written on grid paper with only a few musical notes, it is nonetheless extremely rich and precise. Once deciphered, it becomes possible to rewrite almost the entire score (including cues 16–19). Once again, Grisey's highly structured compositional approach is confirmed; as is the original spectrum's importance in organising sub-sections, from the construction of woven melodies to the choices in tempi.

Time is shown in abscissa on a 1 cm (2 squares)=1 second scale according to a tempo of quarter note=120. Several elements appear on the *y*-axis: the '*numéros des ~~harmonies~~*' (~~chords~~' numbers) (line 1); a pool of notes, from high to low (lines 2–25); the '*Harmonie*' (chord) again, the timing of sub-sections, the tempo's progress and metric (line 26, which includes 10 vertical squares); and finally, the '*densité globale par sec. ou ½*' (global density per second or ½'') (last line). Grisey clearly indicates (line 26) the presence of nine trills; however, inspiration 4 contains 11 sub-sections whose tempo systematically accelerates towards the end (ascending diagonal arrows at line 26). Each sub-section becomes a sonorous wave consisting in several intertwined melodies that lead to a trill. The beginning and the end are an exception to the rule with two successive waves for the former and a wave leading to an expiration phase in the latter. We shall now explain how Grisey uses the three series, drawn from the original spectrum to coordinate all compositional procedures.

Let us begin by analyzing how Grisey assigned tempi and durations to the 11 sub-sections that make up this 56-second section. The number of sub-sections, and each one's relative duration, are the result of extremely rigorous procedures entirely conditioned by S_i. In this section, there are 11 sub-sections, which is equal to the number of elements in S_i. A sketch, not reproduced here, illustrates how the composer began by defining the durations—the sum of which must be 56 seconds—in order to apply the most appropriate metric structure. Grisey defined equivalences between the values contained in S_i (22, 14, 18, 12, 8, 7, 6, 5, 4, 4, 4), the duration of sub-sections and the metric, keeping in mind the accelerations he wished to achieve consistently for each wave. We reproduced this document as a chart, specifying the sub-sections to which each value refers (Table 4).

The lack of a systematic, mathematical approach makes it difficult to understand how these equivalences were obtained. They appear to shift, voluntarily, around a constant, which is perhaps another demonstration of the notion of blurred periodicity dear to the composer. Let us consider the example of the value 4, which appears three times in S_i. Grisey combines it with a 3/8 measure, which is subject to acceleration in tempo and therefore becomes equivalent in duration to 2.5 eighth notes instead of 3. Yet, the base tempo is set at quarter note=120, implying that the eighth note lasts 0.5 seconds. Consequently, 2.5 eighth notes should equal 1.25 seconds. This timing is then assigned to three sub-sections (18c, 19a and 19b) given that the value 4 appears three times in S_i. The ratio between S_i values and the approximate timing of each wave seems to hover around 1/3.

The order of the sub-sections and the durations of the fermatas (very long, long, medium, short), indicated underneath each trill 'tr$_{\wedge\wedge\wedge\wedge}$' (Figure 7) in the main manuscript and carried forward onto the score were not chosen arbitrarily as

Table 4 Durations and tempi established according to S_i

S_i	Metric	Duration (seconds)	Sub-section
4	$3/8_a$	1.25	18c, 19a, 19b
5	$4/8_a$	1.5	19c
6	$5/8_a$	2	19d
7	$6/8_a$	2.5	17b
8	$7/8_a$	3	18b
12	$10/8_a$	4	17a
14	$12/8_a$ or $11/8_a$ ($4+7_a$)	4.5	16b
18	$15/8_a$ or $12/8_a$ ($8+4_a$)	5.5	18a
22	$18/8_a$ or $14/8_a$ ($8+6_a$)	6.5	16a

Various values of S_i are shown in column 1. The metric indications and durations calculated according to the tempo quarter note=120 are those inscribed by Grisey on one of his sketches (the index *a* indicates an acceleration in tempo that was drawn as an ascending diagonal arrow in the original document). In the last column, we have carried forward the relevant sub-sections (for ease of the various sub-sections' description, we have added indexes to the score's cues).

demonstrated by the composer's decision to group them in order to obtain four 14-second sections ($4 \times 14'' = 56''$). Each is then combined with a new cue on the score:

Cue 16: 6.5''+4.5'' (+long trill)
Cue 17: 4'' (+medium trill) +2.5'' (+very long trill)
Cue 18: 5.5'' (+medium trill) +3'' (+long trill) +1.25'' (+medium trill)
Cue 19: 1.25'' (+very long trill) +1.25'' (+short trill), +1.5 (+short trill) +2''

This system of periods enables one to know the theoretical values (unspecified by the composer) of the various fermatas: 0.562'' (short), 0.625'' (medium), 3'' (long) and 6.875'' (very long).

Thus, S_i essentially determines the temporal structure of inspiration 4. The pool of pitches, located vertically on the left of the document, was designed according to the previously studied harmonic progression: the notes are a compilation of the first 13 chords (system 1 in Figure 5). The chord numbers, shown circled at the top of the document, are also recorded at the bottom—above the trills ('tr$_{\wedge\wedge\wedge\wedge\wedge}$') combined with fermatas. As time is represented in abscissa (2 squares=1 second), Grisey is able to precisely plan for the presence of these notes—adding an X or numbers to different squares. The number of marks within a square determines the number of times the note must appear during an allotted lapse of time. When a number N appears, often combined with an arrow encroaching on several squares, this indicates that the note must appear N number of times during said time range. If it is a downward arrow, the notes appear most at the beginning of the time range, and the opposite is true if it is an upward arrow. At a glance, the distribution of crosses and numbers from lines 2 to 25 reveals the transition towards low tessitura, as established by the composer through his harmonic progression. The numbers gradually increase and, as they become higher and closer together, the woven melodies grow denser. In the final 2-second sub-section (last column built around chords 12 and 13), Grisey plans on

Table 5 Progression of rhythmic density in the 11 sub-sections of *Périodes*' inspiration 4

Temporal cue	0''		14''				
Sub-section	16a	16b	17a	17b			
Waves' duration (in seconds)	6.5	4.5	4	2.5			
Density (/second)	1-2-3-**4**-5-6-7	2-3-5-7-9-5	3-5-7-9-11	5-9-13			
(/½ second)							
Temporal cue	28''			42''			
Sub-section	18a	18b	18c	19a	19b	19c	19d
Waves' duration (in seconds)	5.5	3	1.25	1.25	1.25	1.5	2
Density (/second)	7-5-3-7-11-15	9-13-17-					
(/½ second)		-9	7-9-11	11-**12**-13	11-13-15	11-13-15-17	11-13-15-17-19

using nine distinct pitches ($A_{\sharp}2$, $C_{\sharp}3$, G3, A3, C4, $E_{\flat}4$, $G_{\sharp}4$, D5 and E5) that respectively appear 7, 9, 6, 10, 5, 12, 11, 5 and 10 times. Thus, 75 notes are to be interpreted in two seconds by the ensemble's seven musicians, thereby resulting in a very dense sound texture. Though the pitch selection is determined through harmonic progression, what governs the densification process of each sub-section?

The series of numbers entered on the document's last line expresses the notes' overall density. That is to say, the number of unsynchronised notes contained inside a single time cell: 1 second (two squares) and 0.5 seconds (one square). Aside from a few exceptions shown in bold in Table 5, the sequence is entirely defined using S_n. On the whole, densities within each sub-section increase gradually. This procedure concretely illustrates the composer's remarks when, in the score's guidelines, he describes the numbers in his series of harmonics as used 'for rhythmic density' (Grisey, 1974a).

The score excerpt below (Figure 8) fully reflects the rich and precise information this sketch contains (Figure 7). The excerpt, which we have annotated, represents sub-section 18a. The clarinet then comes into play, adding an extra line to the woven

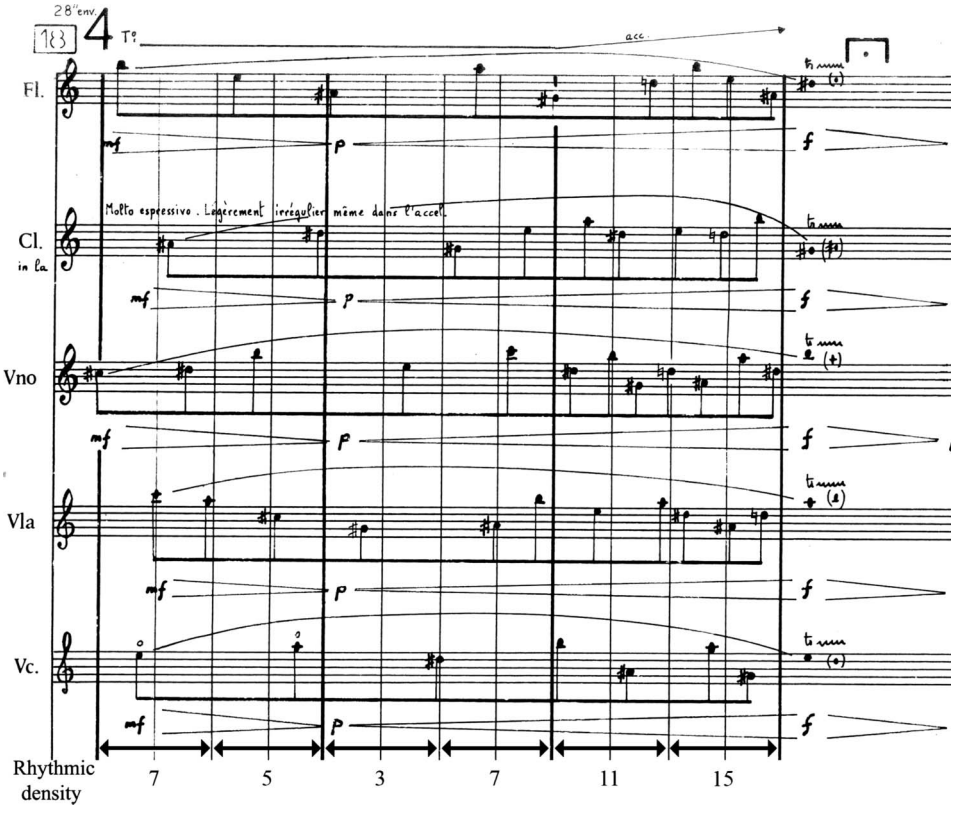

Figure 8 Gérard Grisey, *Périodes*, Ricordi 132243 (p. 36). The numerical values we have added to the bottom part of the score represent the rhythmic density per second and are drawn exclusively from S_n.

melody. Each vertical bar is equivalent to a small square in the outline, or a half-second at steady tempo. We have also added the rhythmic density per second at the bottom of the score. The total number of notes included in this melodic fabric is equal to 7+5+3+7+11+15=48. We also obtain the same result upon adding together the vertical series of numbers (2+7+7+7+7+4+2+7+5=48) associated with pitches C6, B5, A5, E5, $D_{\sharp}5$, D5, $C_{\sharp}5$, $A_{\sharp}4$ and $G_{\sharp}4$. As dictated by the harmonic progression, the trill—led to by the woven melody—includes chord 6 and contains three pitches from the original spectrum (A5, $D_{\sharp}5$, $A_{\sharp}4$) and four from the complementary spectrum (B5, E5, D5, $G_{\sharp}4$).

The sketch presented above is of great precision and clearly demonstrates how the construction of inspiration 4 is entirely dependent upon data drawn from the original spectrum: from the harmonic path articulated around S_p, to the structure of durations and tempi as determined by S_i, in addition to the rhythmic density of notes as defined by S_n. Hence, the original spectrum is a pre-compositional model that acts upon the piece as a whole, in addition to the individual structure of different sections and sub-sections. The manner in which Grisey designs this section of *Périodes*, using only data—both abstract and objective—drawn from the original spectrum, becomes an essential constant in his compositional '*atelier*' that is to be found in all pieces belonging to the cycle *Les espaces acoustiques*.

Conclusion

For the first time, in *Dérives* (1973–74) and *Périodes* (1974), Gérard Grisey uses harmonic spectra as pre-compositional models to articulate and structure his musical thought. In *Dérives*, the spectral model does not yet seek to transcribe a sound's harmonicity, it behaves instead like an organisational and combinatory thought process. Indeed, Grisey seeks to arrange the 12 chromatic notes such that they coincide with fundamental $E_{\flat}1$'s harmonic spectrum. The note is therefore adjusted in order most closely to resemble the frequency, without truly seeking to transcribe objective acoustic data. In *Dérives*, Grisey develops an approach that might be described as spectral atonalism—or spectral dodecaphonism. The prism is both a theoretical model and a central component in the compositional '*atelier*'. The composer calls upon it to imagine and develop a number of compositional procedures that are decisive on both a macro and a micro level. This characteristic is later present in *Périodes* as well as the other pieces of the cycle *Les espaces acoustiques*.

In *Périodes*, Grisey leaves behind equal temperament to focus on the physical structure of harmonic sounds: the frequency as a starting point in the choice of the note. The new model contains 12 pitches equivalent to the harmonics 1, 2, 3, 5, 7, 9, 11, 13, 15, 17, 19 and 21 belonging to fundamental E1's harmonic spectrum. Contrary to common belief, we do not believe that the latter is the result of the literal transcription of a specific sound. It is instead the translation of an essential characteristic of musical sound: harmonicity. As with *Dérives*, the model is not simply used as a pool of notes: the ranking of harmonics, and the intervals that separate

them (expressed in quarter tones or savart) govern a number of compositional procedures thus minimising all arbitrary choice.

In his article/manifesto dedicated to spectral music, Dufourt lists the main points opposing serial and spectral music. He states that 'in concealing its inherent logic, the former imparts a latent unity upon the works progression' while 'the latter exposes its internal organisation, thereby rendering its unity manifest' (Dufourt, 1979, pp. 293–294). Our philological analysis helped clarify a number of the key components belonging to Grisey's first spectral pieces. In light of our results, we feel that Dufourt's proclaimed opposition is no longer as obvious as it may have first appeared. Behind such 'manifest unity', Grisey's work conceals an unyielding organisational logic. The Gérard Grisey Collection at the Paul Sacher Foundation is an essential source in documenting this logic and understanding the origins and the emancipation of the spectral aesthetic in the 1970s.

Grisey's pre-compositional spectral models offered him the ability to fashion his musical thought according to objective sound data. Through the construction of these models, Grisey could broadly outline the main features (overall length, distribution of sections) of his musical path. In order to do so, the composer would establish the piece's formal outline, a sort of synopsis in which time is represented in abscissa, while drawings, charts and notes (both textual and musical) are used to depict the sound-in-making. Once this conceptual phase completed, the writing would truly begin section by section. New, more precise and elaborate outlines were then established, featuring the detailed sound parameters (see Féron 2010a, for the description of one of these outlines).

In the early 1970s, the spectral model becomes an essential component in Gérard Grisey's '*atelier*'. The harmonic spectrum of fundamental E1 as elaborated for *Périodes* became the anchor for the cycle *Les espaces acoustiques*, yet Grisey continually changes his manner of calling upon it (adjunction of higher odd harmonics, sub-harmonic spectra, transpositions, spectrogram transcriptions ...). Such constant evolution and enhancement underscores the dynamic nature of the creative process and the importance of sound's decomposition in Grisey's artistic project.

Translated from French by Karen Brunel-Lafargue

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Note

[1] Started in 1974 and completed in 1985, the cycle *Les espaces acoustiques*, lasts approximately 90 minutes and is made up of six instrumental pieces: *Prologue* (1976) for solo viola, *Périodes*

(1974) for 7 musicians, *Partiels* (1975) for 16 or 18 musicians, *Modulations* (1976–77) for 33 musicians, *Transitoires* (1980–81) for a large orchestra, *Épilogue* (1985) for 4 solo horns and large orchestra.

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