DOCTOR OF PHILOSOPHY

Energy and Vector in Composition
A Portfolio of Compositions

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Energy and Vector in Composition

A Portfolio of Compositions

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Portfolio of Musical Works

Stereo Acousmatic Works

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Instrumental works

8. *Mandalas* (2020) 14’42”

   Piano

Audio link: https://soundcloud.com/hu-yu-949505089

[Total running time of the portfolio: 96’37”]

Declaration

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. All other sources are acknowledged by bibliographic references. This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree unless, as agreed by the University, for approved dual awards.

I confirm that I am submitting this work with the agreement of my Supervisor(s).

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Yr wyf drwy hyn yn datgan mai canlyniad fy ymchwil fy hun yw'r thesis hwn, ac eithrio lle nodir yn wahanol. Caiff ffynonellau eraill eu cydnabod gan droednodiadau yn rhoi cyfeiriadau eglur. Nid yw sylwedd y gwaith hwn wedi cael ei dderbyn o'r blaen ar gyfer unrhyw radd, ac nid yw'n cael ei gyflwyno ar yr un pryd mewn ymgeisiaeth am unrhyw radd oni bai ei fod, fel y cytunwyd gan y Brifysgol, am gymwysterau deuol cymeradwy.

Rwy'n cadarnhau fy mod yn cyflwyno'r gwaith hwn gyda chytundeb fy Ngoruchwyliwr (Goruchwylwyr)

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I am especially grateful to Professor Andrew Lewis for his patient guidance. He provided considerable support and inspiration in composition and many opportunities for practical experience in concerts and music festivals. In addition, his character and attitude towards life have influenced me, letting me know how to face music and life with the correct perspective. During my studies, I was also instructed by the composer Dr Guto Puw on pitch composition, which also inspired a lot of my instrumental work. Thanks also to Dr John Cunningham for guiding my music theory studies. The help of other composers and friends has also been a source of encouragement and motivation for me. Finally, my family has provided great help during my studies.

Thanks again to Professor Andrew Lewis.

Abstract

This write-up mainly investigates how the idea of musical kinetic energy and the concept of vectors in physics can be used to extend and analyse principles in music composition, especially in acousmatic music. According to this concept, the methodology for researching the rationale and technology of acousmatic music composition is derived from the concepts of energy and vector, which together provide the foundation of my compositional process.

Seven of the submitted works in the portfolio are acousmatic music. They are *戲 (Xì), Tapping*, *Cricket*, *Microwave*, *If the train goes to Lhasa*, *Tulpa* and *Undo*. These pieces focus on the intrinsic characteristics of sounds and their extrinsic cultural associations. Because of the properties of different sound samples, each work emphasizes a different type of vector. Three aspects of energy in music composition are expressed in each work: point, line and space. During the development of these works, other music genres have become sources of inspiration for me. These genres have helped develop my methodology and my own unique style of acousmatic music composition.

The submitted work in the portfolio – *Mandalas* – is instrumental. Compared with acousmatic music, the energy and vectors of instrumental works may be distributed differently in terms of pitch and harmony. Nevertheless, the concepts of energy and vector remain valid for such compositions.

In this write-up, I will first introduce the theory of kinetic energy in the field of music. Then, I will discuss the expression of energy in music composition from the three aspects of point, line and space. Directivity and quantity are central to the movement and change of energy in the musical flow, and these concepts are best understood in terms of vectors. Finally, I will discuss seven different types of vectors – gesture, texture-gesture, density, dynamic, frequency, spatial, and meaning, with analysis and examples corresponding to the submitted portfolio.

Research questions

The following issues will also be discussed in the analysis of the pieces:

1. Which concepts and vocabulary can be borrowed from the field of physics to help compose and analyse music from a new perspective?
2. What is the influence of the concept of energy in composition?
3. What is the relationship between energy and vector?
4. What kinds of common vectors occur in acousmatic music?
5. How do such vector concepts influence composition?

1 Introduction

Each work in the portfolio builds on the development of the concepts of kinetic, energy and vector and expands the methods and experiences of previous works, gradually increasing the complexity and innovation of the work. The methodology begins in the stereo pieces, in which the continuity of the energy in the movement of the music space emphasises the sound's smooth transition between the abstract and the concrete. Based on this foundation, the multichannel pieces expand the design of the logical movement of the music space. They use narrative methods to correspond to the transmission of sound energy in different spatial locations. The instrumental pieces extend the previous ideas, but the concept of the vector is embodied in various compositional techniques. These include the translation of the symmetrical structure of the scale.

1.1 Musical Literature Review

Bernard Parmegiani (1927–2013): *De Natura Sonorum* (created 3 June 1975, Paris)

First series: *I. Incidences/Résonances.* This piece uses a long note, sustained throughout the entire first section, which serves as a reference line. The deformation of the long note as the piece develops represents a deviation from the reference line leading to a process of energy diffusion and return. I borrowed this idea in *Undo* and *Cricket* by employing a sustained note as a reference line throughout both pieces.

Second series: *III. Ondes Croisées.* Here, the composer employs a sustained note through the entirety of the section as well. However, in this piece, the sustained long note develops only through a crescendo, increasing in energy as it reaches the end of the piece. I borrowed this idea from Parmegiani for the last part of *Tupla* to accumulate energy and strengthen the final climax.

Wen Bihe (1991–): *Regression* (2016)

The sound in *Regression* comes entirely from the *udu*, an African clay instrument that originated as a food and water vessel, but also has ritual functions. This piece emphasises the vector of gesture, which might also be understood as inertia in the development of music. This piece also utilises pointillism to combine trivial sound material into a gesture. I borrowed these ideas in the composition of certain phrases in *Tupla, Undo,* and *Microwave* through centrifugal force, centripetal force, gravity and parabolic motion.

François Bayle (1932–): *Tremblement de terre très doux* (1978)

François Bayle divides the work into eleven movements which are further divided into three series interpolated with one another: “Climats”, “Transits” and “Paysages”. The series maintain this juxtaposed structure with relatively little development, creating a dramatic unity. There is a hint of trance-like African elements in the work which then alter to suggest Asia before they reach a state of equilibrium. At the same time, they are juxtaposed with the sound of footsteps in high heels on a stony surface, which maintains a sense of both unity and separation. The transitions between the two states can be understood as vectors of meaning. I borrowed these ideas and applied them to *戲 (Xì), Cricket* and *If the train goes to Lhasa*.

Andrew Lewis (1963–): *LEXICON* (2012)

This piece primarily emphasises the phonological processing and deformation of letters and words. After processing, the speech can be converted into sounds similar to those of flies, books or ocean waves. Through change and development, the gesture of the original sound material is converted into texture, which can be understood as a texture-gesture vector (formal vector/structural vector). I borrowed this idea and applied it to *Tapping, Cricket* and *Microwave*.

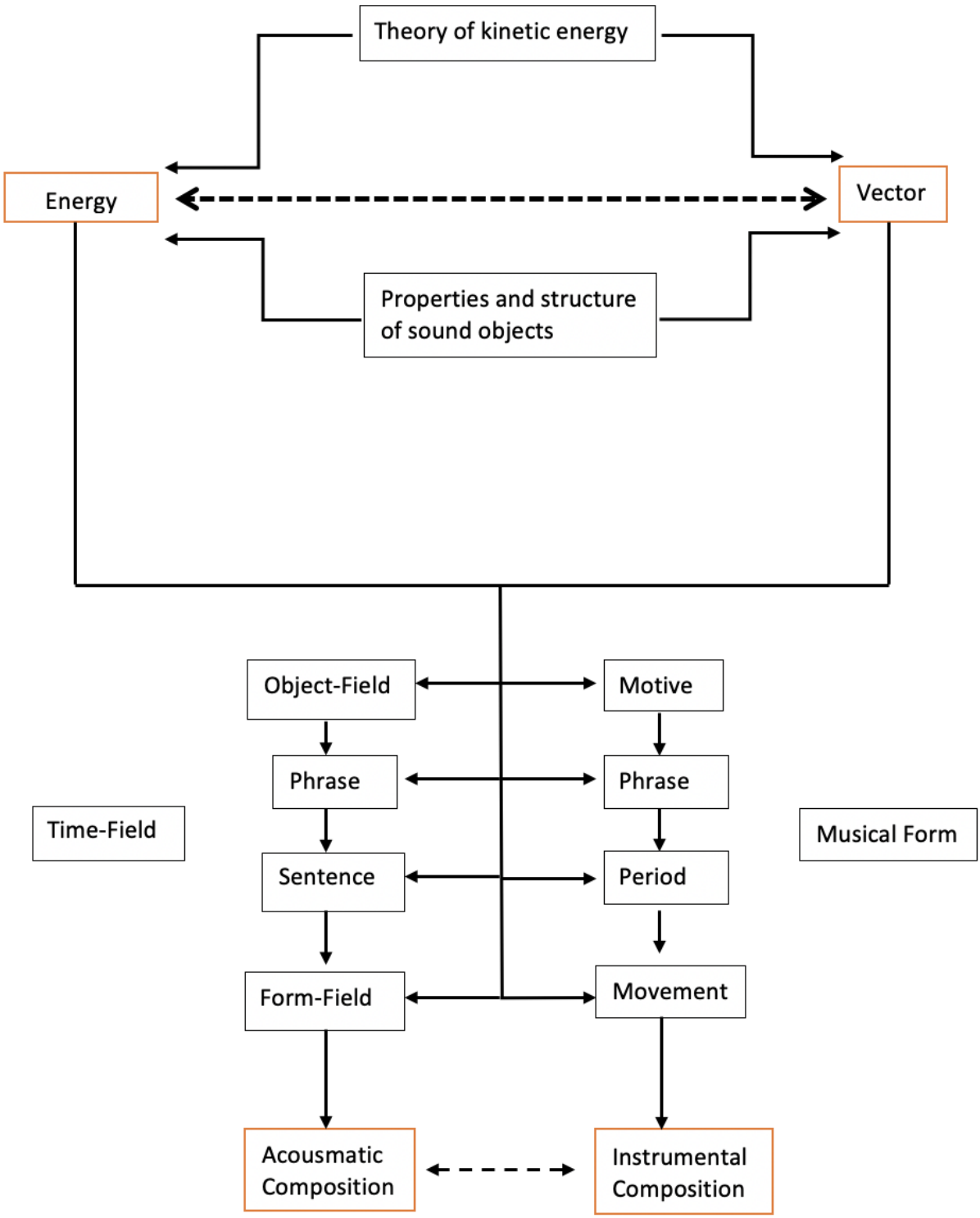
Many clues about energy and vectors can be found in works by other composers: *N’vi’ah* (João Pedro Oliveira, Portugal, 1959–), *Baoding* (David Berezan, Canada, 1967–), *Goodnight, Tin Hau* (Adam Stanovic, UK, 1981–), *Remember Japan* (Hans Tutschku,

Germany, 1966–), *Music for Guitar, E-Bass and Electronics* (Constantin Popp, Germany, (1980–) and *TOKYO District 7 for piano and electronics* (Hibiki Mukai, Japan, 1993–). These pieces sparked my reflections about common vectors in composition and how one might realise a composition using these concepts.

1.2 Methodology and Contents of the Commentary

The section on specific works (Section 5) mainly explains the source of inspiration and musical structure of the pieces in portfolio, that refers to questions answered in the context of the experimental and research stages of the study. The structure of the commentary is summarised in the following diagram (Figure 1). The pieces are arranged in chronological order.

Figure 1: **Map of the logical relationship between the textual commentary and portfolio of compositions**



I will discuss the concept and development of energy theory in detail in Section 2. Building on that, the write-up will comment on the portfolio from the perspective of energy and vector and summarize seven common vector concepts. The methodology mainly borrows from the concepts of energy and vector. These theories provide different perspectives and arguments for the projection of a sound object and the language organisation of music, space, narrative and aesthetics.

1.3 Energy and Vector

Kinetic energy theory is a field of theoretical research on the dynamics of music. The term 'energetics' (*die Energetik*) was first coined by the historian Rudolf Schäfke in a lecture entitled '*Musikästhetik und musikalischer Einführungsunterricht*'.[1] He used it to describe the ideas of 20th century theorists such as August Halm (1869–1929), Heinrich Schenker (1868–1935), Ernst Kurth (1886–1946), Arnold Schering (1877–1941), Hans Mersmann (1891–1971) and Kurt Westphal (1904–1978),who commented on musical analysis through the rhetoric of force and energy.[2] It focuses on the perceptual practical experience of music and supports a certain isomorphic relationship with the listener's psychological activities. This theory explores the development of music in time and space from the perspective of energy by analysing the overall relaxation and fluctuation of sound dynamics, the comprehensive interactions of multiple musical elements from the inside to the outside and the development of music in time and space.

The concept of energy in music borrows from the concept of energy in physics. The concept is used as a metaphor to drive the flow of music, causing music to have a fluctuating shape. The energy of music can be seen as a continuous dynamic of the music as a whole. From the perspective of time, it is a structure that is linear and continuous.

[1] Rudolf Schäfke, *Geschichte der Musikästhetik in Umrissen,* (revised edition; Berlin-Schöneberg, 1982), pp. 393-450.
[2] Lee Rothfarb, 'Energetics' in Thomas Christensen (ed.), *The Cambridge History of Western Music Theory*, (Cambridge: Cambridge University Press, 2008), p. 927.

Vector is a basic concept in mathematics and physics. In general, a geometric object that satisfies both quantity and directionality can be regarded as a vector. In physics, displacement, velocity, force, momentum, magnetic moment and current density are all vectors. Those concepts can be borrowed from physics to influence the structure of acousmatic music. In this context, vectors are constructed based on multiple elements such as frequency, dynamics, texture, space, rhythm and density, and their interrelationships and logical methods are intentionally designed. Throughout this research I have found that the concept of vectors provides a rational composition perspective from both a microscopic point of view, which involves the processing of sound materials and the organisation of structures, and the macroscopic point of view, which concerns the overall structure of music.

2 Theory of Musical Kinetic Energy

Musical kinetic energy theory is a research theory on the aspects of musical movement and dynamic properties that emphasises the perceptual experience of listening to music. It forms an isomorphic relationship between the attributes of movement in music and the psychological activities of the audience.

Historian Rudolf Schäfke termed 'energetics' (*die Energetik*) in 1934 to describe a group of 20th century theorists who commented on musical analysis through the rhetoric of force and energy.[3] Schäfke notes that while the Pythagoreans first established the concept of 'music as motion', and while 'tension' and 'force' are inherent in writings from antiquity, such figurative language lay dormant 'under the cover of other dominant views.'[4] Only in the 20th century did theories of music reliant on metaphors of force and motion attain currency, such as August Halm, Heinrich Schenker, Ernst Kurth, Arnold Schering, Hans Mersmann and Kurt Westphal. According to Austin Patty, these theorists

> conceive of music as possessing energy that is manifest in processes of tension and release. For instance, Kurth uses the concept of *Kraftwelle*, or force-wave, in his analysis of form in Bruckner. Local waves accumulate energy until a *Gipfelwelle* (an 'apex wave') discharges the accumulated tension.[5]

The kinetic energy theory of music gradually became systematised in the late 20th century. For example, Paul Hindemith (1895–1963) proposed harmonic fluctuation based on the level of chord tension and the continuous progress of sound (tonal and non-tonal) and classified the content of different colour chords and intervals.[6] Steven Larson proposed musical gravity,

[3] Rudolf Schäfke, *Geschichte der Musikästhetik in Umrissen* (revised edition; Berlin-Schöneberg: Dr. Hans Schneider Verlag, 1982), pp. 393-450.
[4] Michael Rofe, *Dimensions of Energy in Shostakovich's Symphonies* (1st edition; London: Routledge 2012), pp. 3–20.
[5] T. Austin Patty, 'Pacing Scenarios: How Harmonic Rhythm and Melodic Pacing Influence Our Experience of Musical Climax.' *Music Theory Spectrum* 31:2 (2009), 328.
[6] Paul Hindemith, *The Craft of Musical Composition* (revised edition; London: Schott Music, 1945), Vi, p. 223.

musical magnetism and musical inertia and established an algorithm to quantify the interaction of musical power.[7]

These concepts provide a very rich perspective from which to analyse and compose music, as they achieve a balance between perception and rationality and between science and aesthetics. At the same time, the field of music research has become a comprehensive discipline, as a result of its expansion into areas connecting to the physics of sound (such as acoustics), psycho-acoustics, the phenomenology of sound and cybernetics.

[7] Steve Larson and Leigh Vanhandel, 'Measuring Musical Forces'. *Music Perception: An Interdisciplinary Journal,* 23:2, (2005), 119.

3 Energy in Composition

Through inner listening and practical auditory experience, the energy of music can be regarded as a continuous and dynamic collection of musical fragments. It is often the case that the dominant development of music is not only the development of motivation and the transition and connection of sounds, but also involves the accumulation of many discontinuous points to form a continuous dynamic whole. This can be simplified into three parameters: point, line (time) and space.

In this three-dimensional space, the meaning of energy representation is varied. For example, in a three-dimensional space, a point in energy can be understood as the aggregation and collection of time and space. In contrast, in a two-dimensional plane, a point in energy can be understood abstractly as the amount and size of energy, including the starting point, high point and end point. These notions influence the understanding of energy's shape and internal structure, and the concept of energy affect the core logic of music development and composers' musical styles.

3.1 The Basic Shape of Energy

Borrowing the concept of the Time Envelope in sonic art allows a comparison of the three states of energy in music: energy accumulation, storage and release. These states are similar to Denis Smalley's description of the three stages of sound: onset, continuant and termination.[8] This theory will be discussed in detail in section 4.1, below. The three states of energy constitute the most basic form of energy development in music which are crucial to composition and sound design. The explosion of energy is generally a very concentrated state, and energy storage and release can be achieved through the joint action of a variety of musical elements. For example, in instrumental composition, the musical energies can be embodied as changes in melody, harmony, expression, tonality, speed, rhythm, texture, counterpoint, timbre, velocity or pitch. In acousmatic music composition, the musical

[8] Denis Smalley, 'Spectromorphology: Explaining sound-shapes.' *Organised Sound*, 2:2 (1997), 112.

energies can be reflected in the texture, gesture, quality, space, volume, frequency, density, loudness, timbre or cultural content of sound.

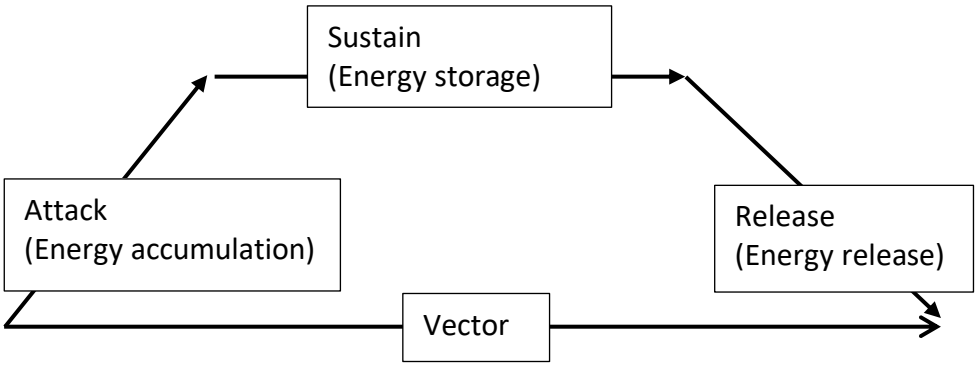


Figure 2: The three states of energy in music

3.2 Points in Energy

The concept of points in energy can be divided into three aspects. First, it can be understood as an acoustic sound concept that is temporally instantaneous. Second, it can be appreciated as the vertical structure of musical lines. Finally, it can be interpreted as a fragment of music, such as a phrase or a motive.

The function of points is mainly used to divide the structure of musical events, which can consist of a microstructure or a macrostructure in the time dimension. Alternatively, points of energy can be used as a composite music event divided into spatial dimensions. In a single musical event, there is a starting point, an explosion (or burst) point and an end point, each of which serves different structural functions. The starting point is the process of energy accumulation, the explosion point is the effect of energy burst and connection, and the end point is the process of attenuation. The function of points is relative and is related to the musical attributes discussed.

Relative to energy, the number, density, rate and frequency of points all affect the perceived speed, dynamic and static state of music. These factors also affect the spatial distance, which

can be far or near, deep or shallow in space. The greater the density, the faster the rate of the points and the greater the perceived energy. However, less energy is felt when too many points exist in a single music event and time. This leads to an extreme phenomenon: the separate points become a collection of points as a new point, and the music changes from an extremely fast dynamic to a static one. These experiences are all related to human auditory psychology.[9]

In the concept of compositional technique, a point can also function as a central point or point of focus. Generally speaking, the composer will continuously transform, repeat, surround, iterate and accumulate around the central point to harness energy to emphasise certain elements in music. For example, the design of the piece *Mandalas* is spread, repeated and transformed around the E♭ pitch as the central point.

Material of *Mandalas*

I. B C E♭-E G A♭ (symmetry from E♭ E)

II. B C E♭-F A♭ A (symmetry from E♭ F)

III. C D E♭ F G♭ A♭ A B (whole-half scale)

IV. C D E G♭ A♭ B♭ (whole scale). It can be seen as the descending scale (B♭, C, D) of the minor second below and the ascending scale (E, G♭, A♭) of the minor second above with E♭ as the central point.

V. 6-note scales form transposition I first scale

3 chords form interleaving of each 6-note scale

E♭ G B/D F♯ B♭/C♯ F A

[9] Dane L. Harwood 'Universals in Music: A Perspective from Cognitive Psychology.' *Ethnomusicology*, 20:3 (1976), 521–533.

VI. Messiaen Mode III 9-note scale forms interleaving of 3 chords

B C D E♭ E F♯ G A♭ B♭

Motive of *Mandalas*

Minor second/sextuplet/single tone repeat (E♭, E)/ E A♭ G

3.3 Lines in Energy

When analysing lines of music horizontally, the source of energy predominantly originates from the emphasis on the deviation from the central point and the reference line. The concept of a reference line is similar to the concept of the central points and can represent all musical components. For example, in acousmatic music composition, a complete phrase can be restored to a specific sound texture, which can be regarded as a reference line. Energy changes in music can also develop when sound texture is transformed. In pitch composition, a complete horizontal melody line can further restore a scale, which can be regarded as a reference line. Lengthening, shortening, or adding extra-tuned pitches will cause the reference line to deviate, change its energy and affect the direction of the music. The separation and reunion of the reference line is one of the important causes of energy changes in music. For example: In *Undo,* there is a pitch that is seen as a reference line throughout the music (See Figure 26). Separating and returning to the pitch will switch the dynamic and static of the music so that a change in energy is achieved.

According to Gestalt theory, human psychology always tends to understand the complex diversity of art as the simplest possible balanced structure and tries to find logical relationships.[10] Therefore, an audience easily enters into a form of inertia while listening to music. When music deviates from this inertia according to a certain logical relationship, a dramatic conflict occurs. This conflict accumulates energy, explodes and resolves. The linear

[10] Rudolf Arnheim, *New Essays on the Psychology of Art*, (Berkeley: University of California Press, 1986), pp.31–38.

structure in energy also includes horizontal and vertical directions, static and dynamic states and perhaps some lines that are similar or equivalent to the concept of points. This structure depends on the composer's music design and arrangement and the audience's listening angle. In actual auditory cognition, sound is three-dimensional and includes not only the vertical and horizontal aspects of music in the temporal dimension but also in the spatial dimension.

3.4 Energy in the Sound Space

According to Philip Alperson, music is the art of time, and time is the primacy of music.[11] Its dimensions are embodied in the horizontal and vertical logical organisational structure. But the concepts of energy and vector push music to a third dimension, which is space. In a two-dimensional space, energy is embodied as the amplitude of movement up, down, left and right. In a three-dimensional space, energy is embodied as front/back, far/near, deep/shallow, which are related to the perception of the audience. From the perspective of the real world, sound can be distributed in any direction. The concepts of sound elevation, sound panorama and vectorial space[12] are part of this thinking. Space will be discussed more fully in section 4.2.6. From the perspective of psychological perception, the audience can perceive energy as a spatial volume (i.e. large, small or thick), as having weight and shape and as reflecting the quality of the sound, thus realising the music as an objective entity. This notion will be discussed in detail in section 4.1.

[11] Philip Alperson, ‘‘Musical Time’ and Music as an ‘Art of Time.’’, *The Journal of Aesthetics and Art Criticism*, 38:4, (1980), 407–417.
[12] Denis Smalley, ‘Space-Form and the Acousmatic Image’, *Organised sound,* 12:1 (2007), 35–58.

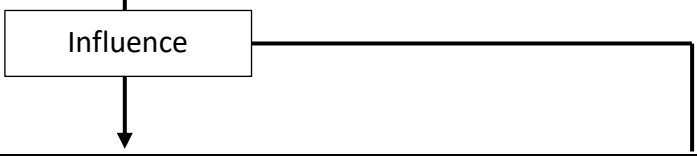
4 Vectors in Composition

Vectors can be perceived in a variety of ways due to their various physical and psychological characteristics. Therefore, composers should take vectors into account when conceiving new works regardless of whether the result of vector motion matches the audience's perceived expectation and psychological tendency.

4.1 Properties and Structure of Sound Objects

The spread of sound waves through the air involves a variety of physical properties that related to human auditory imagination and perception. Classifying and summarising the objective traits, physical attributes and subjective feelings of sound objects is the goal for studying energy and vectors in music.

Sound properties								
Pitch	Loudness	Intensity	Timbre	Sound length	Density	Rate	Space	Envelope



Subjective feelings	Objective physical properties
Big / Small	Frequency
Wide / Narrow	Width of frequency
Thick / Thin	Frequency range
Light / Heavy	Frequency range
Up / Down	The position of the spectrum
Left / Right	The location of the space
Front / Behind	The location of the space
Far / Near	The location of the space
Dense / Sparse	Density

Empty / Full	Texture
Smooth / Rough	Sound resolution and texture
Fast / Slow	Speed, rate, tempo
Soft / Hard	Envelope
Dry / Wet	Reverberation
Harmony / Discord	Frequency, overtone
Long / Short	Duration
Simple / Complex	Quantity

Figure 3: Basic properties of sound

Subjective feelings and objective descriptions are interdependent. Focusing on the characteristics and attributes of sound helps the composer to create expressive music.

According to the different attributes of a sound object, composer and electronic music pioneer Pierre Schaeffer divided the shape of sound into three basic types: sustained, impulse and iterated.[13] Sustained sounds have long-lasting, stable, soothing properties, and the sound attack is not obvious. After the sound gradually changes shape to the holding stage, it continues to move for a certain period without obvious fluctuations, contributing to a certain narrative. Impulse sounds have a shorter, faster, more obvious attack, and often take on a pointed shape. These sounds tend to constitute rhythmic material with a greater, instantaneous explosive power, which can increase the musical tension and drama. Compared with impulse sounds, iterated sounds have repeatability and order. Iterated sounds are usually short units that are looped according to a specified rule and rate that can be represented with shaped dots and lines. On this basis, Norwegian composer Lasse Thoresen discussed the properties of sound and the structure of music in more depth and visualised the sound objects through images.[14] These graphics and symbols also indicate the directionality of energy and vectors.

[13] Pierre Schaeffer, *Treatise on Musical Objects: An Essay across Disciplines* (California: University of California Press, 2017), p. 366.

[14] Lasse Thoresen, 'Spectromorphological analysis of sound objects. An adaptation of Pierre Schaeffer's typomorphology.' *Organised Sound*, 12:2, (2007), 129–141.

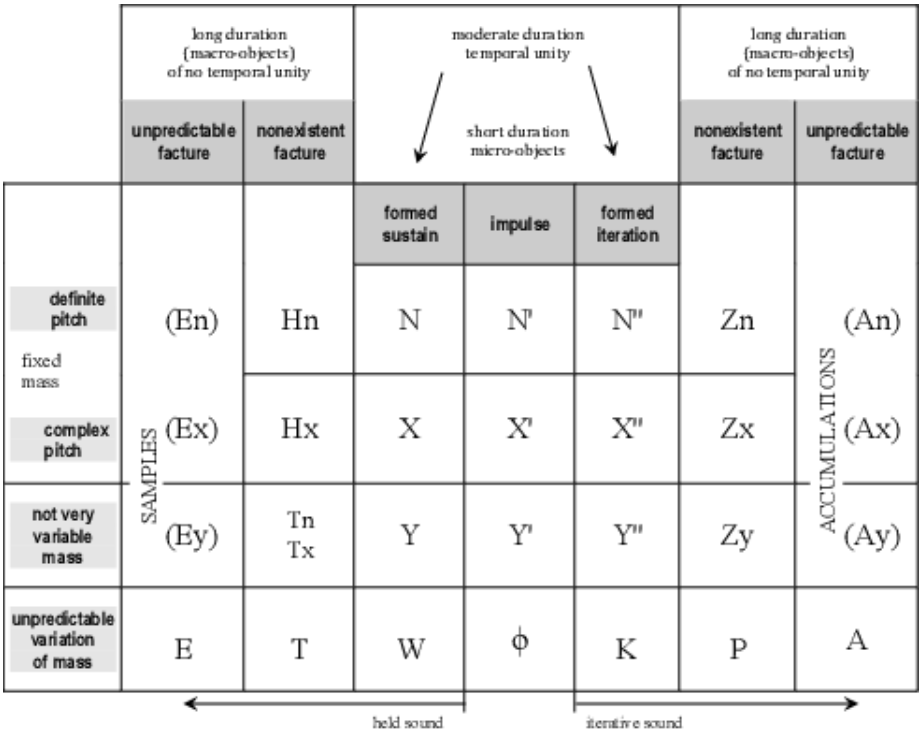


Figure 4: Schaeffer's sound form classification table[15]

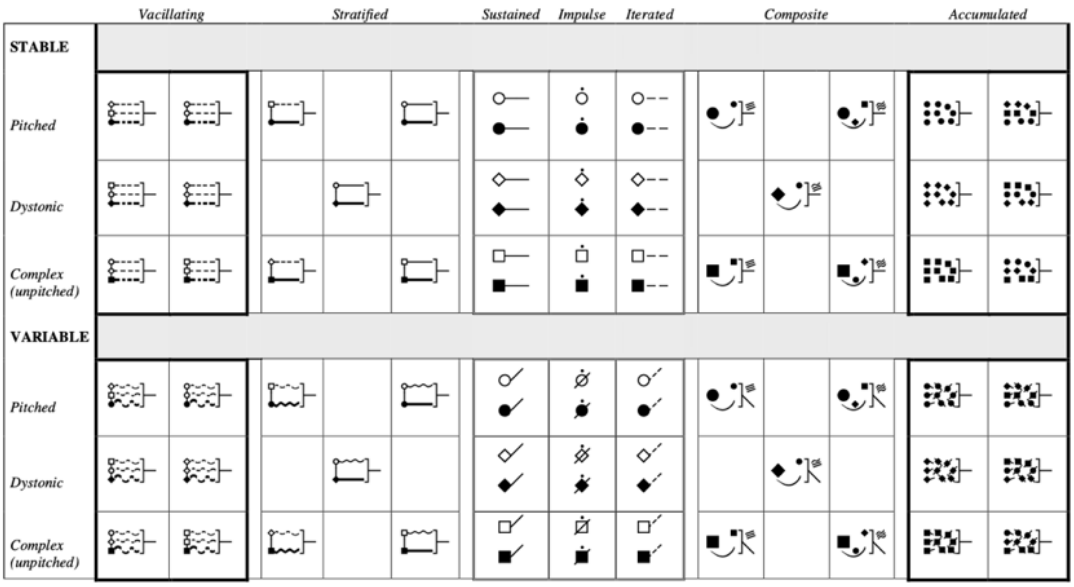


Figure 5: A graphic of Schaefer's 'typomorphology' designed by Lasse Thoresen[16]

[15] Pierre Schaeffer, *Treatise on Musical Objects: An Essay across Disciplines* (Oakland: University of California Press, 2017), p. 366.

[16] Lasse Thoresen, 'Spectromorphological analysis of sound objects. An adaptation of Pierre Schaeffer's typomorphology.' *Organised Sound*, 12:2, (2007), 134.

The sound unit constitutes the smallest unit of composition in the composition process when organising musical language. According to Denis Smalley's spectromorphology theory, sound objects can be divided into three stages: onset, continuant and termination.[17] Smalley's theory further corresponds to the previous energy concept – that of the three states of energy in music (See Figure 2). The most basic direction of the vector in the sound object is presented by synthesising all of these aspects.

Onsets	Continuants	Terminations
Departure	Passage	Arrival
Emergence	Transition	Disappearance
Anacrusis	Prolongation	Closure
Attack	Maintenance	Release
Upbeat	Statement	Resolution
Downbeat		Plane

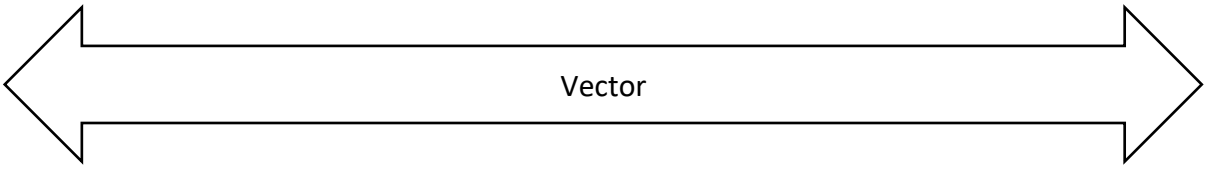


Figure 6: Smalley's three stages of sound objects: onsets, continuants and terminations

If the sound unit is the smallest unit in the musical form of the composition, then the sound gesture is the basic material in the music structure and the method of organising the musical language.

4.2 Vector

The directionality of a vector is not limited to two- or three-dimensional space. Sometimes, its direction can also reflect meaningful, perceptual, cognitive, cultural or other factors. The following will discuss some conventional vectors in acousmatic music composition, including

[17] Denis Smalley, 'Spectromorphology: Explaining sound-shapes.' *Organised Sound*, 2:2, (1997), 115.

gesture vector, texture-gesture vector (formal vector/structural vector), density vector, dynamic vector, frequency vector, spatial vector, vector of meaning.

The types of common vectors in composition mentioned in this chapter are based on Smalley's 'structural functions' theory,[18] Lasse Thoresen's 'Form-building patterns' theory,[19] and Stéphane Roy's '*grille fonctionnelle*' theory.[20]

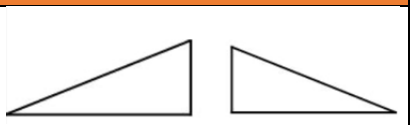
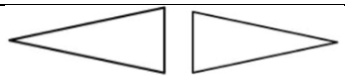
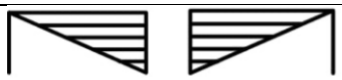
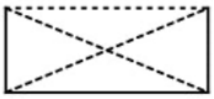
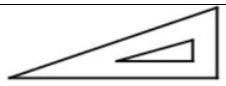
Shape of Vector	Applicable vector type	Graph
Ascent/Descent, Rise/Fall	Dynamic and Frequency	
Increase/Decrease, Acceleration/Deceleration	Density and Space	
Aggregate/Discrete, Agglomeration/Dissipation	Frequency, Space and Density	
Expansion/Contraction	Frequency, Space and Density	
Focus/Valley, Focusing /Hollowing	Density, Dynamics and Frequency	
Fluctuation	Dynamics, Frequency, Density, Texture and Space	
Nested Increasing type	Gesture, Texture and Meaning	
Nested descending type	Gesture, Texture and Meaning	

Figure 7: Common vector types

[18] *Ibid*., pp. 114-117.
[19] Lasse Thoresen, 'Form-building patterns and metaphorical meaning', *Organised Sound*, 15:2, (2010), 82–95.
[20] Stéphane Roy, *L'analyse des musiques électroacoustiques: modèles et propositions*, (Paris: Harmattan, 2003), pp. 344–350.

4.2.1 Gesture Vector

Gestures originate from the physical actions of human behaviour. They are related to the cause and result of an action and affect the action's direction of development, which means that a clear direction is generated from one goal to another. Gestures are used in the description of sound, emphasising the direction and purpose of sound movement. Moreover, as Smalley notes, gesture is a form of 'energy–motion trajectory' that can make a sound object reach a state of excitement, thereby generating spectral life.[21] Sound objects with the gesture attribute provide the nature of sound movement, making it the most valuable attribute of sound. In other words, in acousmatic music composition, emphasis is given to using gesture-based sounds to select appropriate sound materials and create 'personal' sounds.

Smalley pointed out that 'the morphologies are not just isolated objects. They may be linked or merged in strings to create hybrids.'[22] These may be of a single morphological type ('monomorphological') or a mixture of several different types ('polymorphological'). [23] Gestures can be divided into three categories: single-layer, multi-continuous and multi-layer composite. Single-layer gestures are composed of a single sound or combinations of several different sounds into one gesture; multi-continuous gestures are a mixture of multiple continuous gestures that constitute a longer, continuous gesture chain; and multi-layer compound gestures refer to several single-layer gestures or multiple continuous gestures constituting a multi-layered, compound mixture of gestures stemming from the vertical structure.

At the same time, the sounds of three gestures can also represent the three stages of the smallest sound unit. In other words, a minimum sound unit contains three gesture vectors. Sound units can be composed of emergence, transition and release or of upbeat, statement

[21] Denis Smalley, 'Spectromorphology: Explaining sound-shapes.' *Organised Sound*, 2:2 (1997), 113.
[22] Denis Smalley, 'Spectro-morphology and Structuring Processes', in Simon Emmerson (ed.), *The Language of Electroacoustic Music.* (London: Palgrave Macmillan press, 1986), p. 71.
[23] *Ibid.,* p. 77.

and disappearance. Various combinations also lead to the sound unit's uniqueness, which depends entirely on the composer's choice and design.

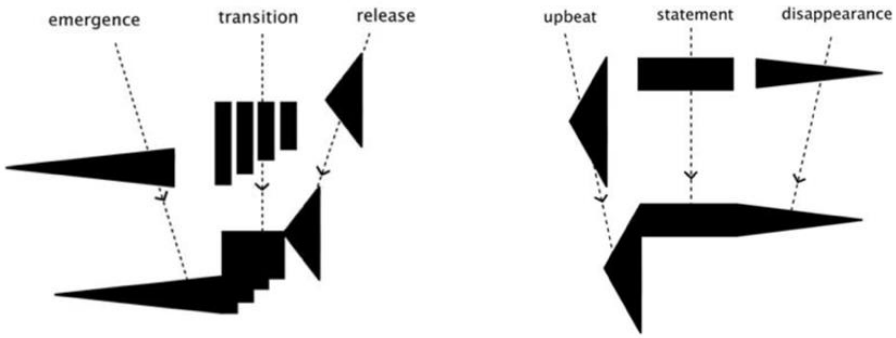


Figure 8: Sound units constituted by different gestures in three structural stages[24]

Manuella Blackburn has observed that sound units can be connected to form a longer phrase.[25] In this expansion process, some sound stages can have dual functions. The directionality of a gesture moving to the next target gesture forms a multi-level, multi-form and linear structure that is the trajectory of the movement of various forms of energy. From a microscopic point of view, the gesture vector can be either the three directions of the three stages of the smallest sound unit or the trend of a phrase or section; from a macroscopic perspective, it can be the outline of the entire piece of music.

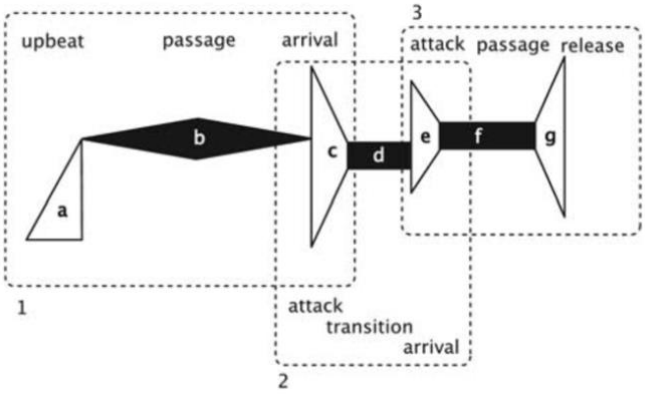


Figure 9: Multiple gestures for dual-function sound combination[26]

[24] Manuella Blackburn, 'The visual sound-shapes of spectromorphology: An illustrative guide to composition.' *Organised Sound*, 16:1, (2011), 7.
[25] *Ibid.*
[26] *Ibid.*

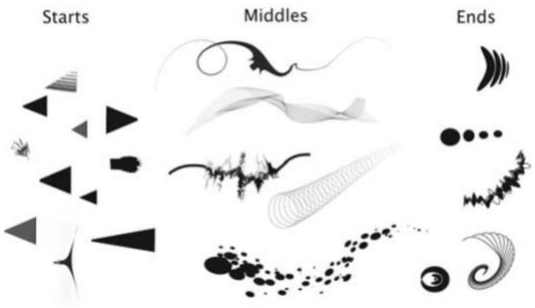


Figure 10: The different forms of the three stages[27]

It is often the case that vectors are present in natural phenomena such as centripetal force, centrifugal force, inertia, gravity and breathing. If music expresses human nature, natural attributes make music more fluent and comfortable to human auditory perception.

For example, in the 4:43–5:15 passage of *Tulpa*, the phrase moves from a granular, dense, and dynamic clustered sound group through rising and falling pitch and the accumulation of energy, finally ending in a static gesture. This gesture consists of two parts connected to one another: one is a completely static, lengthy sound pad, while the other is an impulse-shaped sound. The trajectory of the first gesture is like gravity, moving downward in a parabola. The end of the second gesture deviates from the original trajectory like centrifugal force. The third gesture resembles inertia, buffering the energy of the musical movement with an impulse sound. This can be seen in the following diagram. (The graphics used here are based on the idea of the spectromorphological sound-shape as a visual guide for acousmatic music composition introduced by Blackburn.)

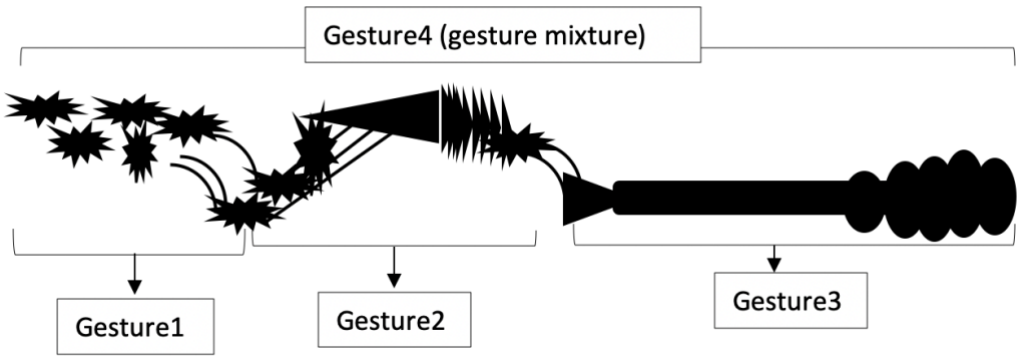


Figure 11: The 4:43–5:15 passage of *Tulpa*

[27] *Ibid.*

4.2.2 Texture-Gesture Vector (Formal Vector/Structural Vector)

The word 'texture' has two meanings in acousmatic music composition. The first is similar to timbre, while the second is similar to musical structure or musical organisation.

Timbre is a very important part of acousmatic music composition, sometimes. The sound materials of acousmatic music include specific timbres in nature and electronic synthetic timbres artificially synthesised. Since the emergence of Arnold Schoenberg's concept of *Klangfarbenmelodie*,[28] timbre has become an important structural element in modern music. With the development of melody timbre, pitch has been transformed into a carrier of timbre. Often in acousmatic music, the pitch relationships are ignored and a sense of melodic pitch flow is lacking, thus creating more room for the flow of timbre. Timbres generated by different materials, shapes, vocal techniques, synthesis methods and triggering methods are organised and laid out according to structural elements such as frequency, rhythm, density and strength. These timbres will be discussed in the section 4.2.5, while the discussion of texture in this chapter focuses on musical organisation.

The traditional texture concept is suitable for the standards of 'voice', such as melody and pitch, but not for timbre-based acousmatic music. Regardless of whether it is used in pitch composition or acousmatic composition, the essence of texture is the same. According to Smalley's theory, textures can be divided into four categories according to the type of movement in acousmatic music: streaming, flocking, convolution and turbulence.[29] In 2003, Stéphane Roy put forth the theory of *grille fonctionnelle,* which divided the relationship between music events into five categories: direction (*orientation*), stratification (*stratification*), processing (*processus*), relational rhetoric (*phénomène de relationnels*) and rupture rhetoric (*phénomène de rupture*).[30] Combining the two theories provides a basis for research on texture vectors.

[28] Alfred Cramer, 'Schoenberg's Klangfarbenmelodie: A Principle of Early Atonal Harmony', *Music Theory Spectrum*, 24:1, (2002), 1–34.
[29] Denis Smalley, 'Spectromorphology: Explaining sound-shapes.' *Organised Sound*, 2:2, (1997), 115.
[30] Stéphane Roy, *L'analyse des musiques électroacoustiques: modèles et propositions*, (Paris: Harmattan, 2003), pp. 344–350.

From the perspective of the structure and vectors of acousmatic music, texture and gestures are the main means of composition design. Some structures are dominated by texture, which provides a core framework. Others are dominated by gesture. If gesture is extended over a long period, its forward direction becomes unclear and its power is not strong. It becomes more like a texture. Then, shorter gestures may be included in the texture to assist the movement. In structures dominated by gestures, the texture is contained within the gesture and the motion of the gesture constitutes the texture.[31] However, most structures are a mixture of gestures and textures. Gestures may gradually accumulate into textures, and textures may gradually disappear into gestures. In this mutual conversion, a vector is formed in the process of movement.

For example, in the 13:53–14:20 section of *Tapping*, the sound is made by old-fashioned telephone is similar to the texture of wood. When the sound is always in motion, this texture itself becomes a musical gesture to promote the music's development.

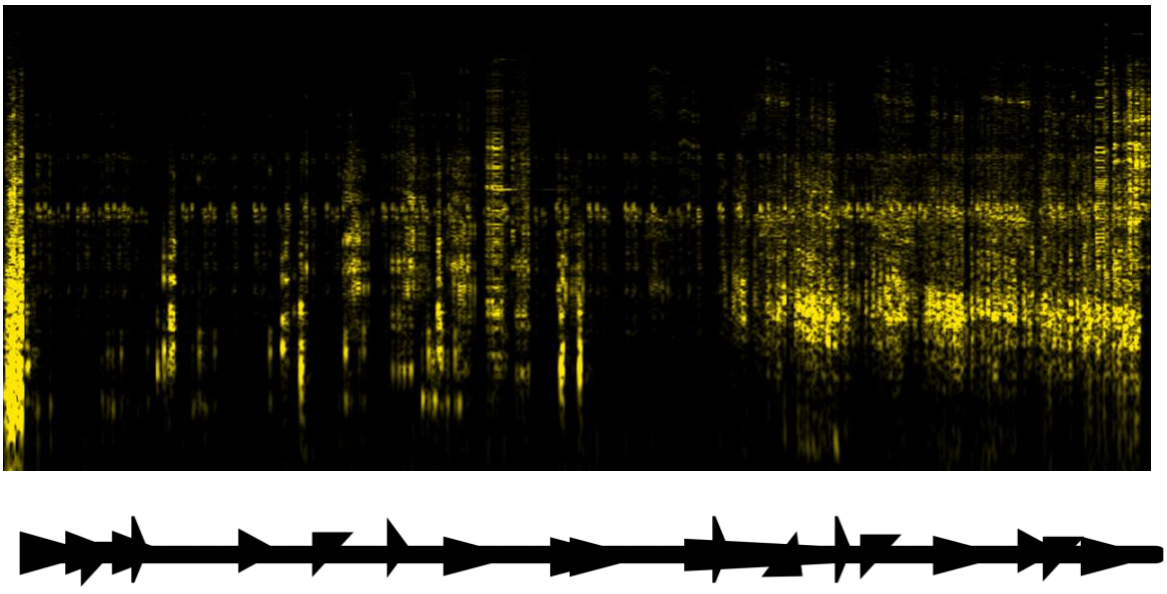


Figure 12: The 13:53–14:20 section of *Tapping*

[31] Denis Smalley, 'Spectromorphology: Explaining sound-shapes.' *Organised Sound*, 2:2 (1997), 115.

In summary, both gestures and textures are important for the structure of acousmatic music, sometimes. This leads to a discussion of how dynamic contours and energy development in composition occur through the joint forces of frequency, density, dynamics, space and culture.

4.2.3 Density Vector

In acousmatic music, development in rhythmic movement is often expressed in terms of increasing or decreasing speed, reflecting the fast, slow, dynamic and static natures of sound. The rhythmic movement of sound material mainly involves impulse type, point type and iterative type. Density is the accumulation of sounds through which a sound object appears within a certain time domain, ranging from sparse to dense and reflecting the number of sounds per unit of time and the rate of movement. Therefore, the change in density is mainly reflected in the transition from point, linear, granular and continuous sound shapes. Density vectors include four main categories: agglomeration/dissipation, acceleration/deceleration, focus (sparse–dense–sparse)/valley (dense–sparse–dense) and fluctuation.

For example, in the 3:32–3:58 passage of *Undo*, there is the sound of a telephone being dialled. A long tone persists and gradually turns into an intermittent point-like sound form, gathering into a denser version of itself before finally spreading out to connect to the next phrase.

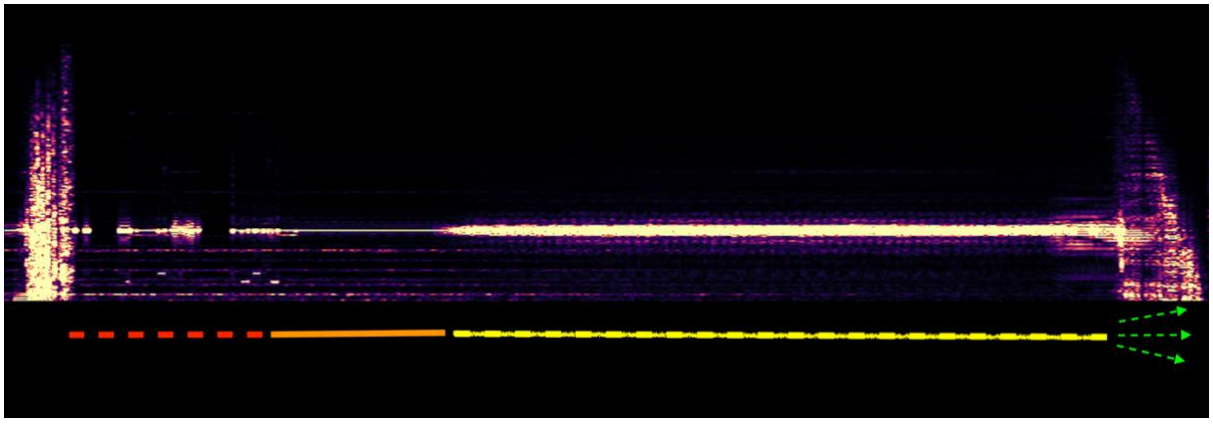


Figure 13: The 3:32–3:58 passage of *Undo*

4.2.4 Dynamic Vector

Intensity refers to a physical and measurable entity such as the size of a sound, while loudness refers to a perceptual entity that can only be measured through the response of a human observer.[32] The human perception of contrasting energy levels in music constitutes a dynamic vector. The dynamic contour of sound is closely related to its energy. Energy can be tracked through general dynamics (from weak to strong), speed (the density of events within a certain period) and musical elements such as range, lightness, performance and block density (the number of chords).[33] The change in strength in the dynamic range is the main parameter that constitutes the energy. The dynamic vector can be summarised as rise/fall, focus/valley and fluctuation.

An example of such a vector occurs in the 1:41–2:09 passage of *Microwave*. There are three sound patterns in which the accumulated energy finally explodes. Whenever the energy accumulation process is relatively static, the volume is low and stable. When the energy accumulation reaches the final stage, the bursts and releases are dynamic, and the volume is high and uneven.

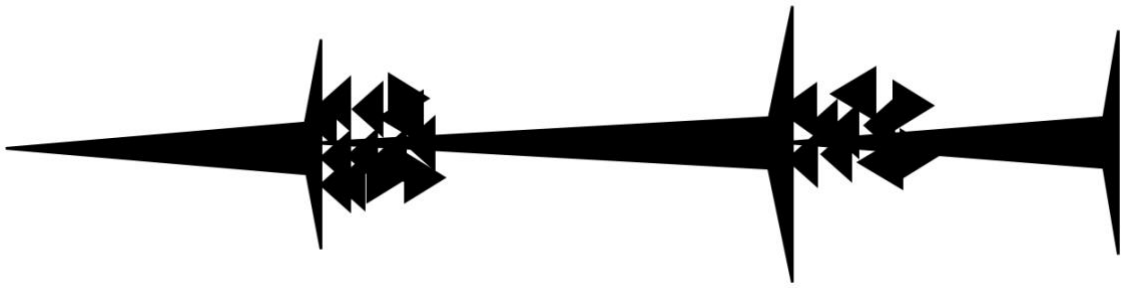


Figure 14: The 1:41–2:09 passage of *Microwave*

4.2.5 Frequency Vector

The pitch composition is based on the use of a clear pitch, and timbre and pitch are independent concepts. Once timbre and pitch are no longer regarded as the main carriers of

[32] Alexander Lerch, *An Introduction to Audio Content Analysis* (Wiley-IEEE Press, 2012), iv, p. 71.
[33] Thoresen Lasse, 'Form-building patterns and metaphorical meaning', *Organised Sound*, 15:2, (2010), 82–95.

musical information, any sound can become the main body of a composition, and pitch and timbre can coexist in the spectrum.[34] In spectromorphology, timbre contains the attribute of pitch, and pitch is one of the potential attributes of timbre; they are inseparable constructs. Frequency vectors can be classified as rising/falling, expansion/contraction, hollowing/ focusing and fluctuation.

For example, in section 1:41–2:09 of *戲 (Xì),* the original sound material is a Welsh monologue. After the sound material is sliced and processed, it is transformed into what is perceived as a sound with a continuous grainy quality. In the process of development, the pitch moves through the frequency vector classifications of rising/falling, expanding/contracting, hollowing/focusing and fluctuation before finally connecting to the second half of the original Welsh sound material and forms a phrase dominated by frequency vectors.

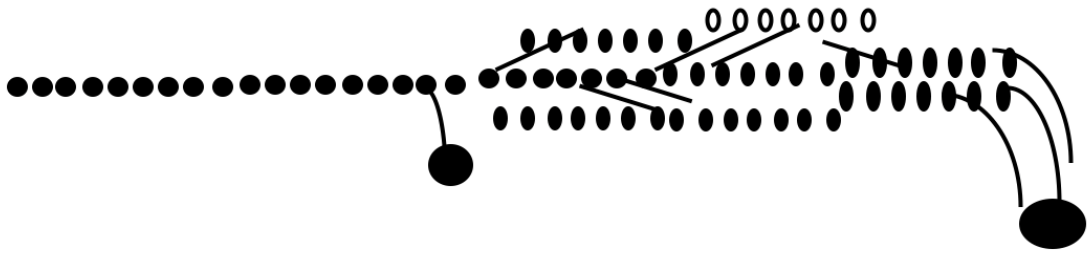


Figure 15: The 1:41–2:09 passage of *戲 (Xì)*

4.2.6 Spatial Vector

The spatial design of acousmatic music is not limited to real space. The design of spatial movement is mainly embodied in different sound gestures, frequencies, trajectories, methods and speeds of different textures in space to show the depth and breadth of different environments. From the perspective of the motion state, space can be divided into static and dynamic sound spaces. Moreover, there are two types of space control: pre-set and real-time. In real-time space control, someone diffuses the piece in real time on an acousmonium (the fixed movements on the stereo become larger movements in the concert). In pre-set space

[34] Denis Smalley. 'Defining Timbre—Refining Timbre' *Contemporary Music Review*, 10:2, (1994), 35.

control, the composer fixes the spatial movements on the multichannel piece, and this is the space that is heard in concert. The motion design of dynamic space mainly includes trajectory, speed, form, density, structure and motion gestures, which are all inter-related. The spatial design of acousmatic music is mainly based on two-channel, four-channel, 5.1-channel, 7.1-channel, eight-channel, and as many as dozens or even hundreds of speaker combinations. The portfolio pieces submitted with this thesis are composed for stereo and the Main Eight speaker configuration proposed by Jonty Harrison and BEAST.[35]

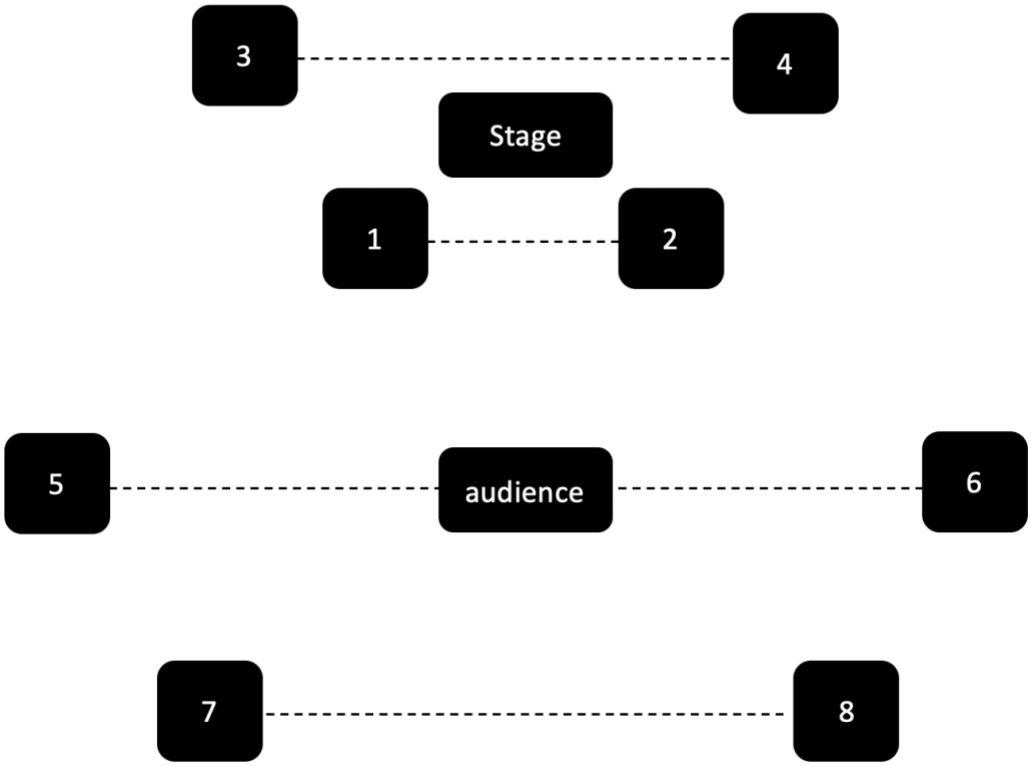


Figure 16: The Main Eight speaker configuration proposed by BEAST

In 2002, Belgian composer Annette Vande Gorne published 'L'interprétation spatiale. Essai de formalisation méthodologique', which discusses the various forms of spatial movement in stereo sound.[36]

[35] BEAST (Birminghan Electro-acoustic Sound Theatre); the 'Main Eight' was proposed by the British composer Jonty Harrison in 'Sound, space, sculpture: some thoughts on the 'what', 'how' and 'why' of sound diffusion' *Organised Sound,* 3:2, (1998), 121.

[36] Annette Vande Gorne, 'L'interprétation spatiale. Essai de formalisation méthodologique', *Revue DEMéter Université de Lille-3*, (2002), 9-11.

1) Crossfade (*Lefonduenchaîné*)

2) Unmasking (*Ledémasquage*)

3) Accentuation (*L'accentuation*)

4) Flickering (*Lescintiller*)

5) Oscillation (*L'oscillation*)

6) Balancement (*Déséquilibre*)

7) Vague (*Lavague*)

8) Rotation (*Larotation*)

9) Spiral (*Laspirale*)

10) Rebound (*Le rebond*)

11) Insertion/Rupture (*L'insertion/rupture*)

12) Appearance/Disappearance (*L'apparition/disparition*)

13) Explosion (*L'explosion*)

14) Accumulation (*L'accumulation*)

15) Envahissement (*L'envahissement*)

According to Vande Gorne's theory, these spatial forms can be classified as four spatial vectors, which are vectors of growth/decrease, expansion/contraction, aggregation/discretion and fluctuation.

As an example, in *Microwave*, section 2:51–3:19 uses sounds similar to raindrops that are triggered in eight channels in sequence and then follow a diagonal movement trajectory, which forms a vector of growth and expansion. At the same time, the rhythmic bass is surrounded by eight channels in a counter-clockwise motion track, which formed a vector of counter-clockwise fluctuation. 'Because left-right/front-back cues are much more reliable than distance cues, circular motion is most easily recognised when it passes right around the head of the listener (central circular motion).' [37] The trajectory of this section can be understood as a 'cyclical and oscillatory motion'/ 'frame motion' formed by the diagonal

[37] Wishart, Trevor, and Emmerson, Simon, *On Sonic Art*. (revised edition; Abingdon, Oxon: Routledge, 2002), X, p. 207.

‘direct motion’/ ‘double motion’ of the raindrop and the ‘central motion’ of the rhythm bass, which is also the ‘counterpoint of spatial motion’.

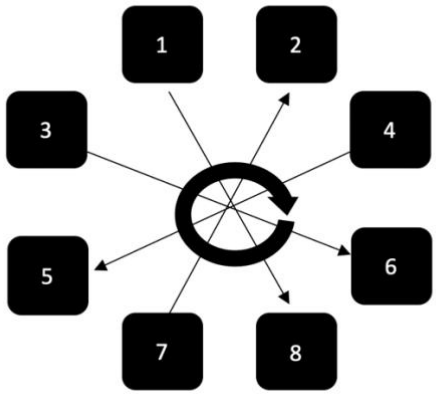


Figure 17: The 2:51–3:19 passage of *Microwave*

4.2.7 Vector of Meaning

Music is a method of expression, and this expression is meaningful. Different sounds will affect listeners' associations with the physical attributes of the natural world. Moreover, different physical attributes have their own meanings, including cultural meanings. In the development of music, sounds with different attributes undergo transitions, connections and overlaps. These processes constitute the vector of meaning.

1. Vector of cultural symbol types: For example, *戲 (Xì)* emphasises vectors of two different cultural attributes – the Peking Opera in China and Welsh fairy tales – and connects the two cultural symbols through a certain commonality of music and sound. *If the train goes to Lhasa* emphasises three different types of sound texture vectors. The first is a female voice, the second is a train, and the third is a piano; these vectors encompass the human voice, ambient noise and instrumental music. The cultural attributes of these three sounds are transformed into each other and overlap each other, thus forming a vector of meaning.

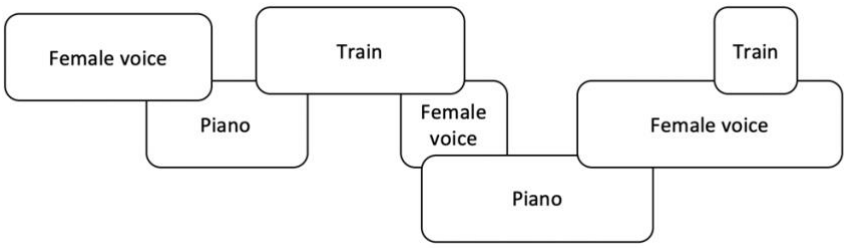


Figure 18: The 0:00–12:23 passage of *If the train goes to Lhasa*

2. Vector of the meaning of objective physical properties: For example, the metal-textured sound, wood-textured sound and dial sound in *Tapping.* There is no metal texture sound in the original sound material, and the metal texture is imitated by the processing of the dial sound. By emphasizing the sound of metal texture to highlight the contrast with the texture of wood sound. As the music develops, the two sounds contrast and merge with each other, resulting in a synthetic sound texture that connects to each other. If the dial sound is the initial connection point, and the new synthesized sound is the new connection point of the two textures to form a new vector of meaning (See Figure 3).

3. Vector of the meaning of subjective feelings: For example, the section of 7'39"-8'10" in *Undo*, contrast of round, elastic, heavy bass and serrated, inflexible, light mid-high frequency (See Figure 3).

4.3 Conclusion

I have summarised seven common vector types above. However, I have considered neither the time vector nor the counterpoint vector derived from the composite of multiple vector patterns. Further innovations in technology, allowing us to analyse and control various parameters more comprehensively, will make increasingly accurate control of sound objects possible. While we can expect this analysis to expand and improve as reproduction hardware facilities develop, it is not yet complete. The concept and application of vectors warrant further exploration in electroacoustic music.

5 Commentaries on Works

5.1 *戲 (Xì)*

5.1.1 Program notes

The word *戲 (Xì)* in Chinese refers to both opera and drama but also to a specific kind of attitude toward life. The name of this work mainly refers to the sound elements of the Peking Opera and the sound materials of Welsh fairy tales. The sounds of two different cultures mesh, overlap and connect with each other during the development process, forming a vector of meaning. At the same time, the work includes many other musical instruments and natural sound samples, all of which are fragmented and embellish the development of the entire work. This piece was performed at the Welsh-Chinese Cultural Two Dragon Concert in 2019.

5.1.2 Structure

The piece is 8’50” in length and can be divided into three parts: the faintly visible motive (0:00–1:50), the appearance and development of the motive (1’50”–7’07”) and the slow disappearance of the fragments of the motive (7’07”–8’50”). The second part is divided into three stages. The first (1’50”–2’16”) introduces the theme of Welsh fairy tales, the second (2’16”–3’16”) introduces the theme of the Peking Opera and the third (3’16”–7’07”) includes the process of interweaving, transforming and developing the two themes. The third part (7’07”–8’50”) reverses a lot of the sound material that was presented before, but the long lines of the static pad remain the same as the first part. Two symbols of different cultures form a meaningful vector through the connection and design of these sound objects. If the cultural attributes of the original sound material are ignored, the energy of the two types of sound is transmitted to the climax of the piece.

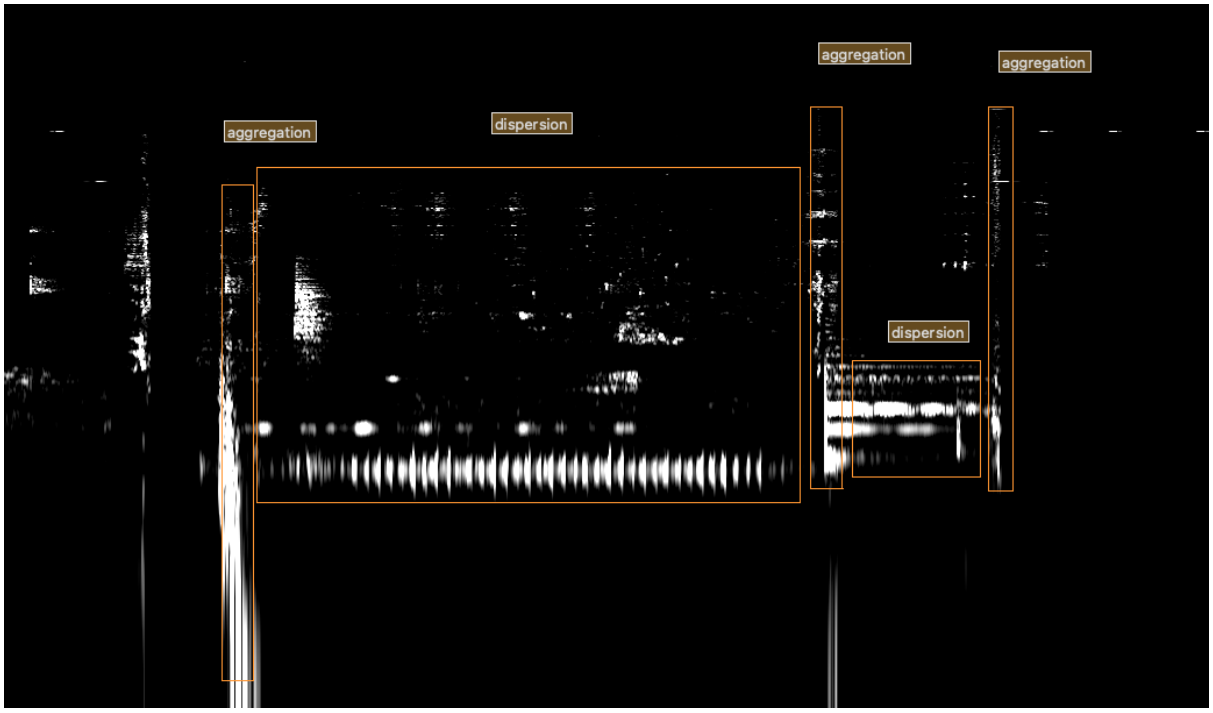


Figure 19: Sonogram of *戲 (Xì)* (2’16”–3’16”)

In terms of energy design, as in the second stage of the second part, energy can also be decomposed into aggregation——>dispersion——>aggregation. The scattered energy forms can be understood as polyphonic (see Figure 20), and the layered energies at different time points are also intertwined and triggered.

5.2 *Tapping*

5.2.1 Program notes

The main sound samples of the piece involve sounds of a telephone being dialled and a keyboard being typed. In the real world, people’s daily life is full of various sounds that connect their daily lives through a collection of fragments. When people are quiet, they often fantasise in the form of pictures and stories, but they rarely fantasise about the sounds that they remember around them. In a company, everyone is busy at work, where many sounds – such those of telephone calls and typing on keyboards – are present. If this time is imagined as another world of sound, the experience becomes a wonderful fantasy. Every detail of life is felt, and we can imagine another parallel universe amidst the reflection of this world.

5.2.2 Structure

The length of *Tapping* is 20’00”. The first part (0’00”–6’13”) is divided into six phrases, each of which (after the first) repeats, transforms and expands the previous one. The second part (6’13”–8’21”) is a quiet and lengthy section that can also be interpreted as the elongation of the theme's motive. The third part (8’21”–10’20”) introduces a more intensive rhythm, and the sounds are mostly impulse-shaped. In terms of density, this section maintains a high-energy state. The fourth part (10’20”–19’33”) transforms and expands the third part. Each phrase starts with the quiet motive of the long line in the second part and then uses the high-density motive of the third part to release energy. The fifth part (19’33”–20’00”) is the conclusion, returning to the original material and motive.

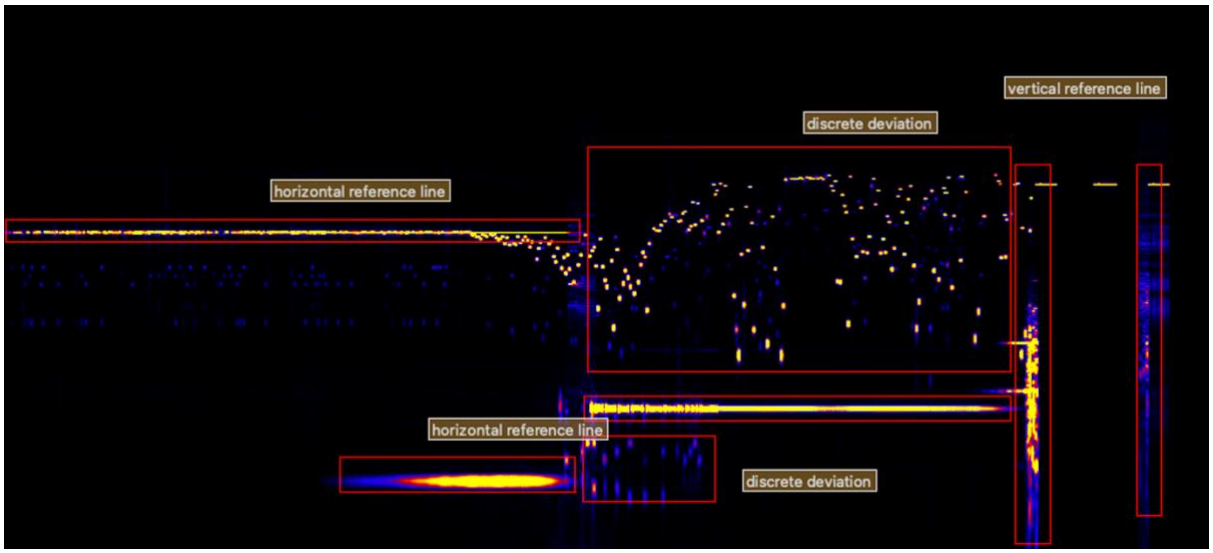


Figure 20: Sonogram of *Tapping* (0’57”–1’38”)

From an energy design perspective, the deviation from the base line is a means of gathering energy for this work. The deviation of the vertical base line can also be understood as the deviation of the point. The discrete deviation in the middle connects the vertical and horizontal dimensions (see Figure 21).

5.3 *Cricket*

5.3.1 Program notes

Humans perpetually express their views of the world, desiring that others listen and empathise. In nature, every creature has its own language and is also expressing themself. Although humans cannot fully understand nature's language, they can learn to listen and feel. The sound of crickets is like Morse code – long and short pulses, combined according to specific rules. At the same time, it is very similar to the impulse-type sound shape in acousmatic music. Every summer, cricket calls overwhelm the grass and fields and express various rhythms and frequencies. At a specific moment and from a certain angle, the voices of crickets may also be heard as the protagonist in a story. Although I do not understand the language of crickets, I try to listen, understand and feel their language when recording them. In this work, crickets are the protagonists.

5.3.2 Structure

This experimental work is 12'30" in duration, and it is reminiscent of a rondo in structure. However, dividing the specific parts is difficult because some of the repeated phrases are short, fragmented and interspersed throughout the work. The entire composition process is a gradual transformation from one paragraph to another, and it is difficult to distinguish where one paragraph end and another begins. It can be seen as the 'Wishart' structure.[38] The energy of the entire piece is evenly distributed, and strong contrasts or dramatic conflicts do not exist. Every repetition of the theme is in the process of subtly adjusting and transforming. The rising/falling, expansion/contraction, hollowing/focusing and fluctuation of the frequency vector constitute the main part of this work. For example, the 11'55"-12'20" section of *Cricket* forms a falling frequency vector in a parabola shape (see Figure 22).

[38] Trevor Wishart, *Sound Composition* (revised edition; Orpheus The Pantomime Ltd., 2012), p. 103.

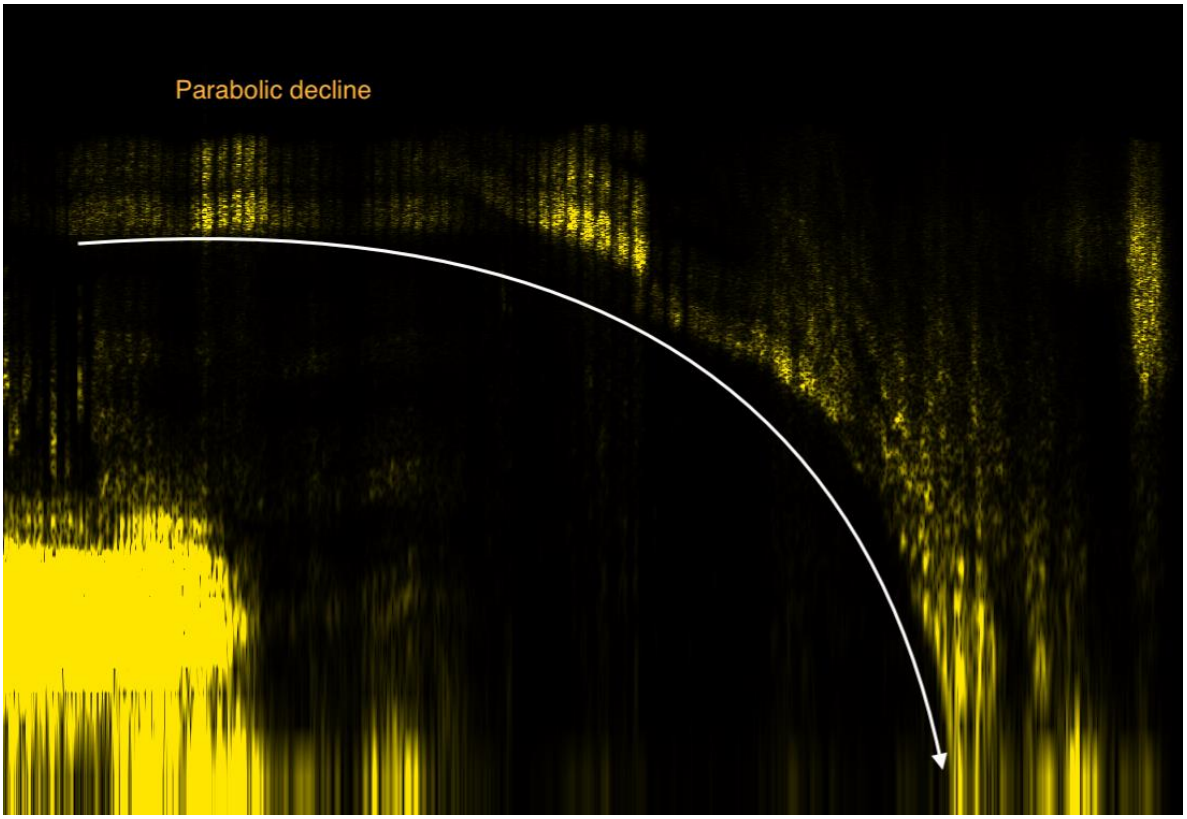


Figure 21: Sonogram of *Cricket* (11’55”–12’20”)

5.4 *Microwave*

5.4.1 Program notes

Microwave ovens are relatively common daily necessities. Most people use microwave ovens every day. After closing the door of a microwave oven, a person sets the time and waits patiently. At the moment when the microwave oven starts to operate, the energy of the electric current injects new vitality into the world inside the door. From a microscopic point of view, the world inside begins to change. For this limited time, the world in the microwave is a fantasy to me. However, everything returns to normal when the final ‘ding’ sounds.

5.4.2 Structure

The duration of this piece is 8’10”, and its structure is similar to that of a sonata. The first part (0’00”–2’50”) is the exposition section, which presents two comparative themes. The second

(2’50”–5’32”) is the development section, and the second theme is the connecting phrase to enter this section. This section introduces a large number of regular rhythms. Compared to the high-density first section, the second section is also high-density but has a more regular distribution, and the music develops progressively in three stages until reaching the climax. The third part (5’32”–8’10”) is the recapitulation section, which also reproduces the two themes and transforms them. From the perspective of energy storage, the 3’30”–8’00” part of *Microwave* can also be seen as four stages. The energy of each stage is superimposed on the basis of the energy of the previous stage (see Figure 23).

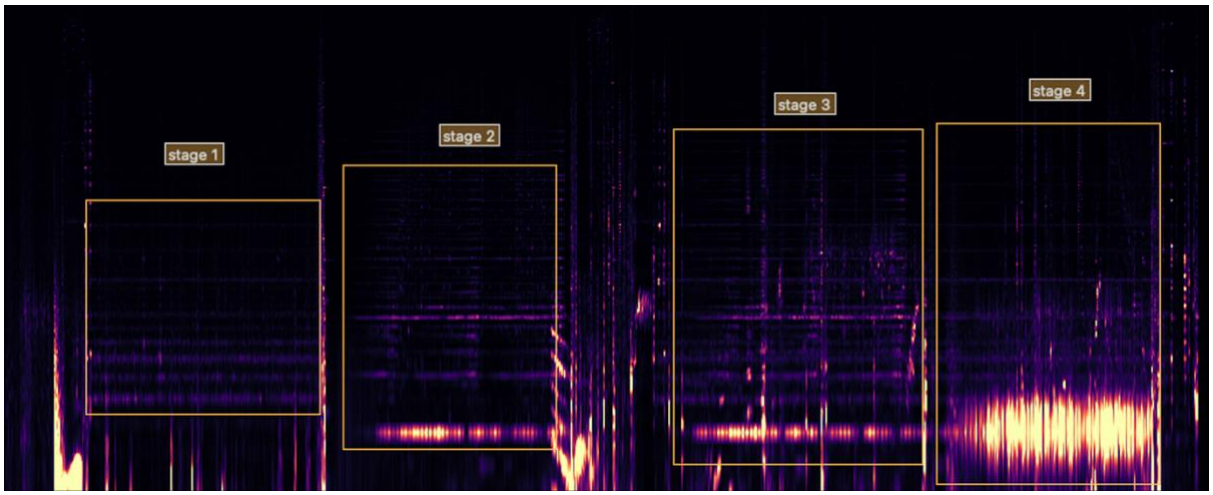


Figure 22: Sonogram of *Microwave* (3’30”–8’00”)

5.5 *If the train goes to Lhasa*

5.5.1 Program notes

Lhasa, which is in Tibet, China, is a place of pilgrimage for many people, and the subway is an underground network of trains and rails connected to the modern city. Most people live in a hurry, constantly changing subway trains to reach different places for work and entertainment. Is there a track that can lead busy people to Lhasa and let hurried souls slow down and calmly feel the world? Lhasa and the subway are two completely unrelated places: one represents the helplessness of life, and the other embodies spiritual freedom. They are intertwined with each other, communicate with each other, and overlap with each other to form a meaningful vector.

5.5.2 Structure

The duration of this piece is 15’30”. The first part (0’00”–4’03”) utilises female voice materials as the theme. The second (4’03”–7’12”) adds the sound materials of a piano and train. Each phrase is based on its own sound material to highlight the attributes of the different sounds. The first stage is the piano part, the second is the train sound, and the third is the female voice. The third part (7’12”–10’50”) highlights the sound of the train as a long pad in order to prepare for the fourth part. Finally, the fourth part (10’50”–15’30”) breaks up the three different sound materials in a forward and reverse manner, re-assembling and combining the materials to invoke a feeling of simultaneous backward and forward musical flow.

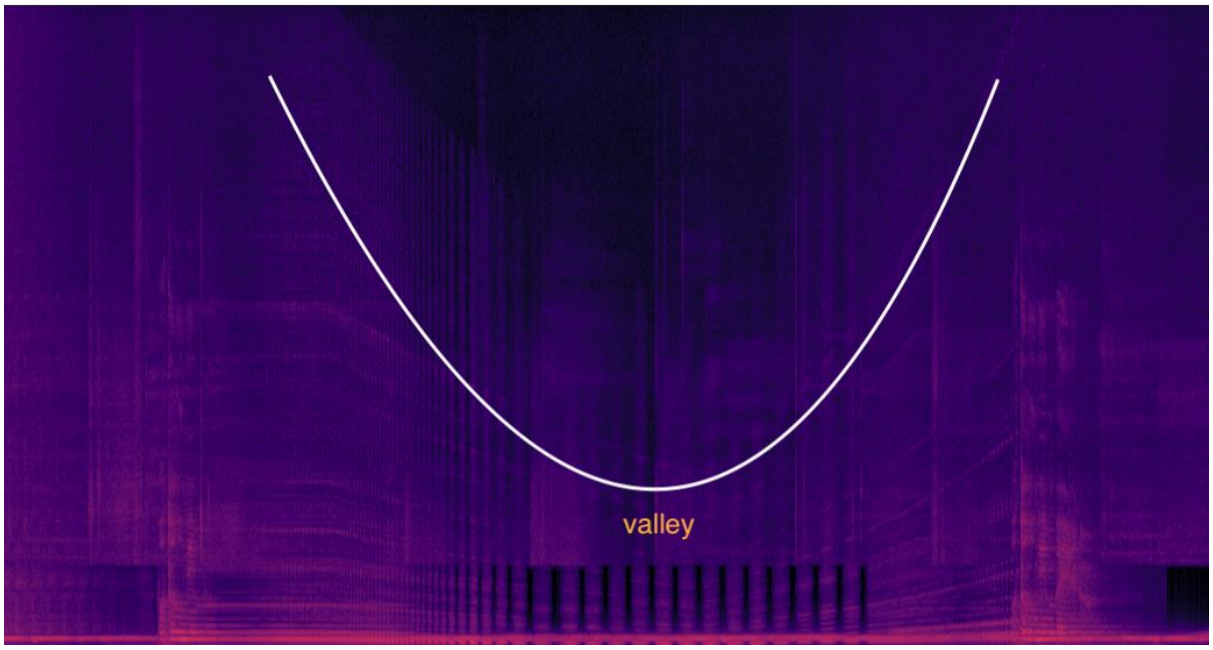


Figure 23: Sonogram of *If the train goes to Lhasa* (0’09”–0’25”)

This sonogram shows the flow of energy in this work can be observed in a state of fluctuation through Sonogram, (0'09"–0'25") The frequency in this section falling and rises, and the density and sparseness of the density vector form a valley state of centripetal energy .

5.6 *Tulpa*

5.6.1 Program notes

The word *tulpa* comes from Buddhism and means an imaginary spiritual companion or guide. It can also be a way of thinking about meditation. This piece does not record or use any obvious Buddhist sound materials, but it uses some traditional percussion and non-instrumental impact sounds. In any case, similarities and connections can always be found in various sound materials. The repeated and evolving percussive sound in the piece is intended as an allusion to – rather than a literal depiction of – the bells used in Buddhist ceremonies. The original source sounds are gradually developed through repeated transformation until they reach the polar opposite of their starting point. Other musical contrasts employed in the piece include high and low frequency, near and far, dynamic and static and loud and quiet. Some suggested spiritual contrasts include order and chaos, peace and anxiety and light and dark. The piece was performed in the electroacoustic concert at the Centennial Celebration of the Bangor University School of Music.

5.6.2 Structure

The duration of *Tulpa* is 8’25”. It can be divided into three parts, with the first part (0’00”–2’22”) acting as the exposition of the first motive, the second (2:22–5:00) comparing the second motive and the first motive and the third (5‘00”–8’25”) establishing the development of two new motives and the return of the first motivation. Each part is a process from the beginning of energy storage to the release of energy, and the parts are mutually embedded and overlap with one another. The energy of each part is also the expansion, iteration and upgrade of the energy of the previous part, leading all of the energy to reach a climactic peak by the end of the piece. The process precisely resembles waves on the beach, with each wave pushing the previous wave forward. Finally, the waves hit the reef as the end point of this wave-driving process, concluding with their sudden termination and the end of the energy transfer. From the perspective of density vector, this part can be understood as the process of agglomeration ↔ dissipation, acceleration ↔ deceleration, density ↔ sparse. For example, the 6'10"-7'08" section of *Tulpa* can be understood as an accelerated density vector from sparse to dense (see Figure 25).

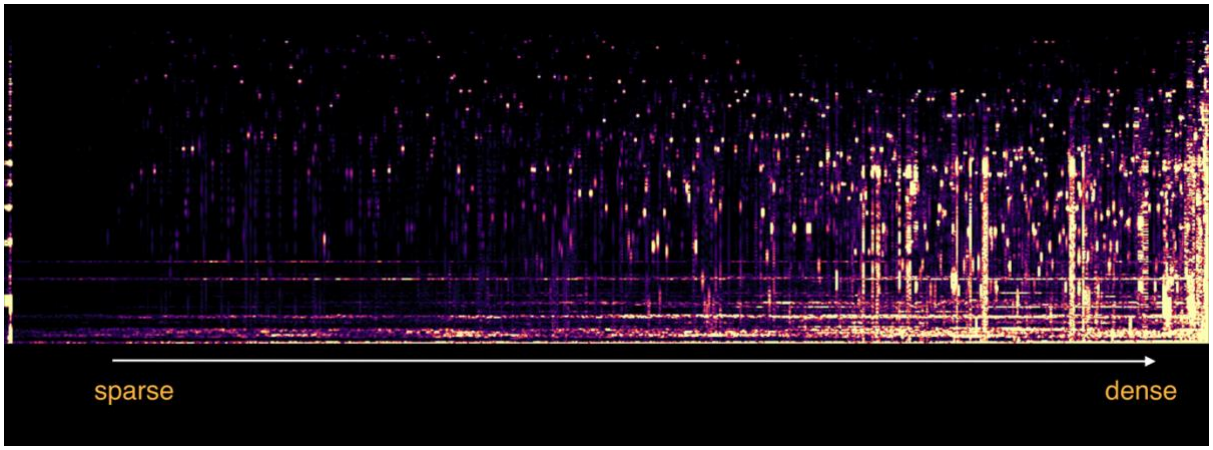


Figure 24: Sonogram of *Tulpa* (6’10”–7’08”)

5.7 *Undo*

5.7.1 Program notes

Buddhism includes the concept of six reincarnations, and Taoism has the concepts of *tai chi*, *yin* and *yang* and the five elements. In *Undo*, these concepts are iterated repeatedly and regularly. The sound material of this work is the same as in *Tapping*. However, *Tapping* is more like a free collage of fragments, while the sound of dialling in this work runs through the entire piece of music. As this takes place, the process perpetually deforms, develops, iterates and repeats the sound. The process goes back and forth, symbolising law in chaos and disorder in order.

5.7.2 Structure

The length of this piece is 8’30”, and the structure resembles a sonata form. The first part is the exposition (0’00”–3’07”), the second is the development (3’07”–6’20”) and the third is the recapitulation (6’20”–8’30”). From a horizontal point of view, the density of the overall music is just that – dense – so the energy contrast of each part is shown in the vertical structure. In the first part, the texture is mainly single-layer, and the development of the sound is triggered and transmitted through one line. In the second and third parts, the trigger and transmission of energy are shuttled in different parallel lines. Because of the overlap of different types of sounds, the frequency becomes wider, and the texture of phrases becomes

more layered. In this work the vector of density remains abruptly static and abruptly dynamic (see Figure 26), thus creating a contrast between strong and weak energy.

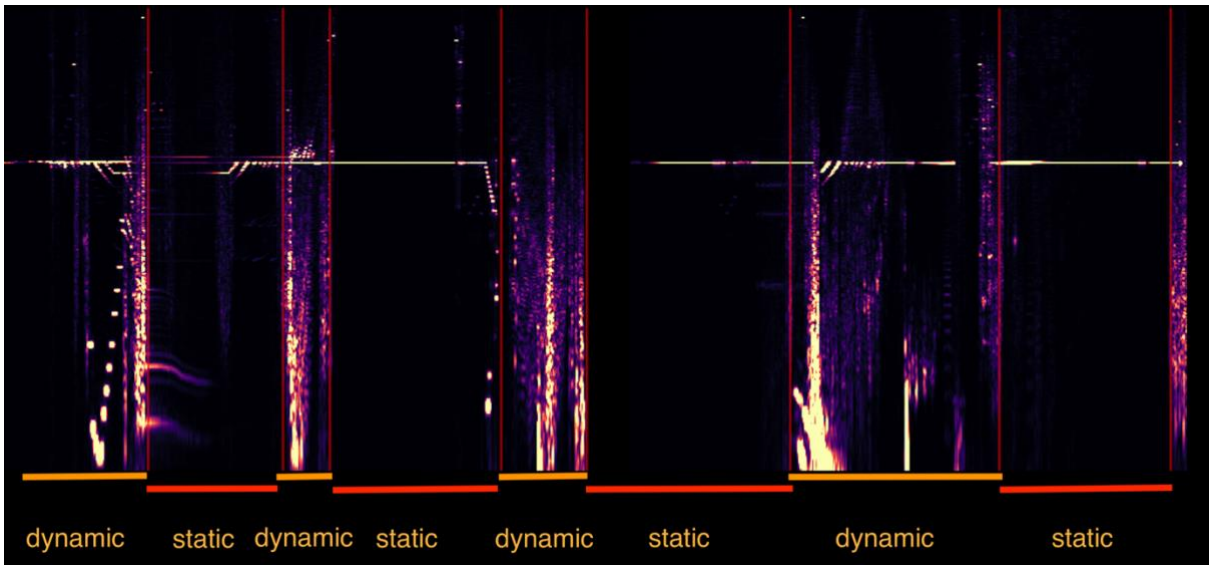


Figure 25: Sonogram of *Undo* (0’28”–1’25”)

From a macro perspective, the entire composition is maintained throughout by using C sharp as a reference line. The development of music at different pitches forms the deviation and regression of the reference line, which makes the energy in an unstable state of accumulation and release.

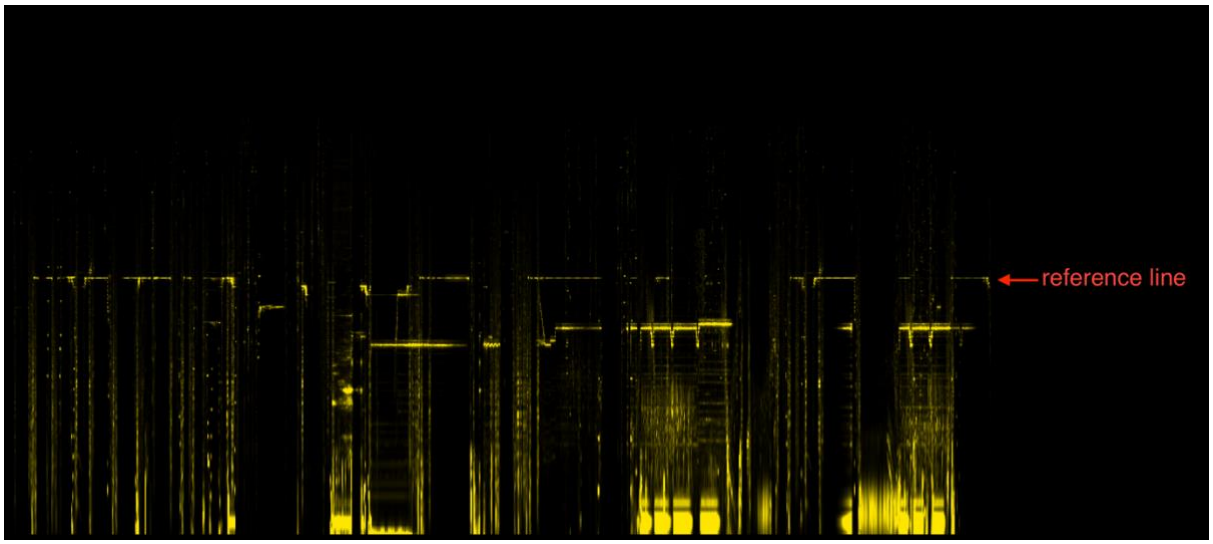


Figure 26: Sonogram of *Undo* (0’00”–8’30”)

5.8 *Mandalas*

5.8.1 Program notes

The word *mandala* is derived from Sanskrit and means ‘circle’. It is a symbol of Hinduism and Buddhism and represents the universe and its energy. Some psychologists have discovered that the mandala has special significance for the mind and self-realisation of modern people. With the mandala, one can calm chaotic thoughts, relieve stress, release negative energy and relax and calm the body and mind. It is also a method of meditation and can improve concentration. This work is an interactive piano piece influenced by Japanese composer Toru Takemitsu (1930-1996). The duration of the piece is 14’42”. The equipment required for the live performance is one computer with Max/Msp, one piano, one keyboard, two contact condenser microphones (cardioid), one audio mixer and four loudspeakers. When performing live, the audios are mapped to the Ableton Live, corresponding to different keys of the keyboard, and played in real time according to the score information. The submitted recording is from a Disklavier. The speaker distribution diagram for a live performance is as shown in Figure 27.

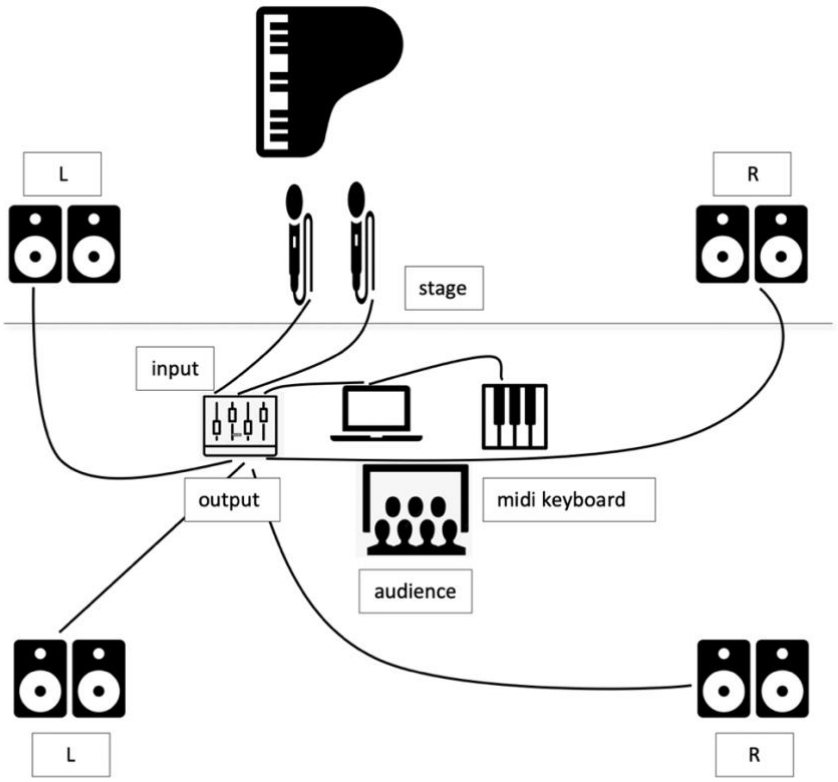


Figure 27: Equipment distribution map during live during live performances of *Mandalas*

Material

I.

C E♭ E G A♭ B (symmetry from E♭ E)

II.

C E♭ F A♭ A B (symmetry from E♭ F)

III.

C D E♭ F G♭ A♭ A B (half whole scale)

IV.

C D E G♭ A♭ B♭ (whole scale)

V.

6 notes scales form transposition I first scale

3 chords form interleaving of each 6 notes scales

E♭ G B/D F♯ B♭/C♯ F A

VI.

Messiaen Mode III 9 notes scale form interleaving of 3 chords

B C D E♭ E F♯ G A♭ B♭

Motive

Minor second/Sextuplet/ Single tone repeat (E♭, E)/ E A♭ G

Form

(Trilogy Form)

Exposition:

Intro: 1–7 /A: 8–12 / B: 13–22 / A1: 23–28 / Bridge: 29–33

Development:

Intro: 34–35 / A2: 36–42 / C: 43–54 / C2: 55–66 / B1: 67–78 / C3: 79–88

Recapitulation:

C4: 89–95 / A3: 96–104 / C5: 105–113 / Bridge: 114–120 / C5: 121–129 / B2: 130–146

Ending: 147–149

Tempo

The performer does not need to strictly follow the rhythm and speed of the score.
When playing, the performer requires more rubato, and enters a new section according to the cue point of the electronic music.

Notes

The main scale is the I symmetry scale, and the main idea is to build on the contrast between atonality and tonality. The piece is primarily atonal, and some symmetrical harmonies floating above the atonal foundation imply slight tonality.

The rhythm fluctuates between regular and illogical. In the design of pitch and rhythm, the music was not composed strictly according to the algorithm to reflect more humanity.

The supplemental electronic part emphasises the gestures of the piano part. In mixed music works, I believe that the aesthetics of different styles are compatible and complement each other.

6 Conclusion

Based on the above analysis and summary, the terms of physics are borrowed in this write-up: growth, decrease, expansion, contraction, aggregation, discretion, fluctuation, displacement, velocity, force, momentum, magnetic moment, current density, centrifugal force, centripetal force, inertia, parabolic decline, force, reference line, the energy and vector concepts of physics. The use of terms vector and energy are applicable to the music in this write-up and form part of a personal reflection on the music and literature used.

In this write-up, the two concepts of energy and vector are proposed based on physics, and the purpose is to distinguish the physical quantity with/without direction in a narrow sense. Energy is a scalar quantity, emphasizing the concept of "quantity". Vector refers specifically to two-dimensional or multi-dimensional vectors, emphasizing that each component changes (In this article, the main emphasis is on the "direction"). The definition of energy includes the concept of a vector, and the definition of a vector cannot include the concept of energy.

Borrowing the concepts of energy and vectors in physics is a new field of music analysis and research. This field emphasises perceptual knowledge in music and reflects the psychological activities of the audience in the process of musical movement. The concepts of energy and vector not only provide a new perspective for the production and analysis of acousmatic music, but also bring more creative thinking to the composition of instrumental music.

In the interior of the musical structure, when several elements are emphasised by vector behaviour and constitute a deterministic system, other structural elements do not need to be emphasised. This constitutes an uncertain system, allowing deterministic behaviour and uncertain behaviour to logically organise together. Such organisation causes the music to alternatively move centripetally, eccentrically and in a balanced way.

Order and disorder, inevitability and contingency, rational control and random control, certainty and uncertainty, and periodicity and aperiodicity are all important considerations for music design. This write-up principally proposes the shapes of vectors, such as rising/falling, aggregation/discretion, expansion/contraction and fluctuation, that are used to

deconstruct the gesture, texture, density, dynamic, frequency, space and other meaningful musical elements of acousmastic music. These vectors are also often the result of synergy between several musical structural elements. Therefore, in the process of composing and analysing my portfolio, emphasis – both intentional and unintentional – is placed on the effect of multiple vectors. Through the internal connection between a variety of sound materials and the vector relationship (excitation, suspension) controlled by multiple structural elements, the auditory expectations of the listeners can be met or subverted. At the same time, vector control also brings new ideas to instrumental composition.

To summarise, the vector is the driving force that guides, stimulates and promotes the thinking activities of the audience. The vector also affects the design of various angles in acousmatic music composition and even provides new theoretical perspectives and creative thinking for the composition of tonal music. There are many more vector models that can be produced on the basis of energetics theory, many types of vectors that I have not mentioned, such as narrative vectors. The system of energetics needs to be supplemented by theorists. Based on the experience of my doctoral study for three years, this article summarizes some of the viewpoints of energy theory, and proposes the concept of seven kinds of vectors, and it is hoped that future scholars can expand and supplement on this basis.

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HuYu（Lori）

Mandalas

for piano and electronics

1 Computer with Ableton Live and MAX/MSP

1 Piano

1 MIDI Keyboard

2 Contact Condenser Microphones
(Super-Cardioid)

1 Mixer

4 Lound Speakers

Duration 14 mins

Technical Set-up

Equipment required:

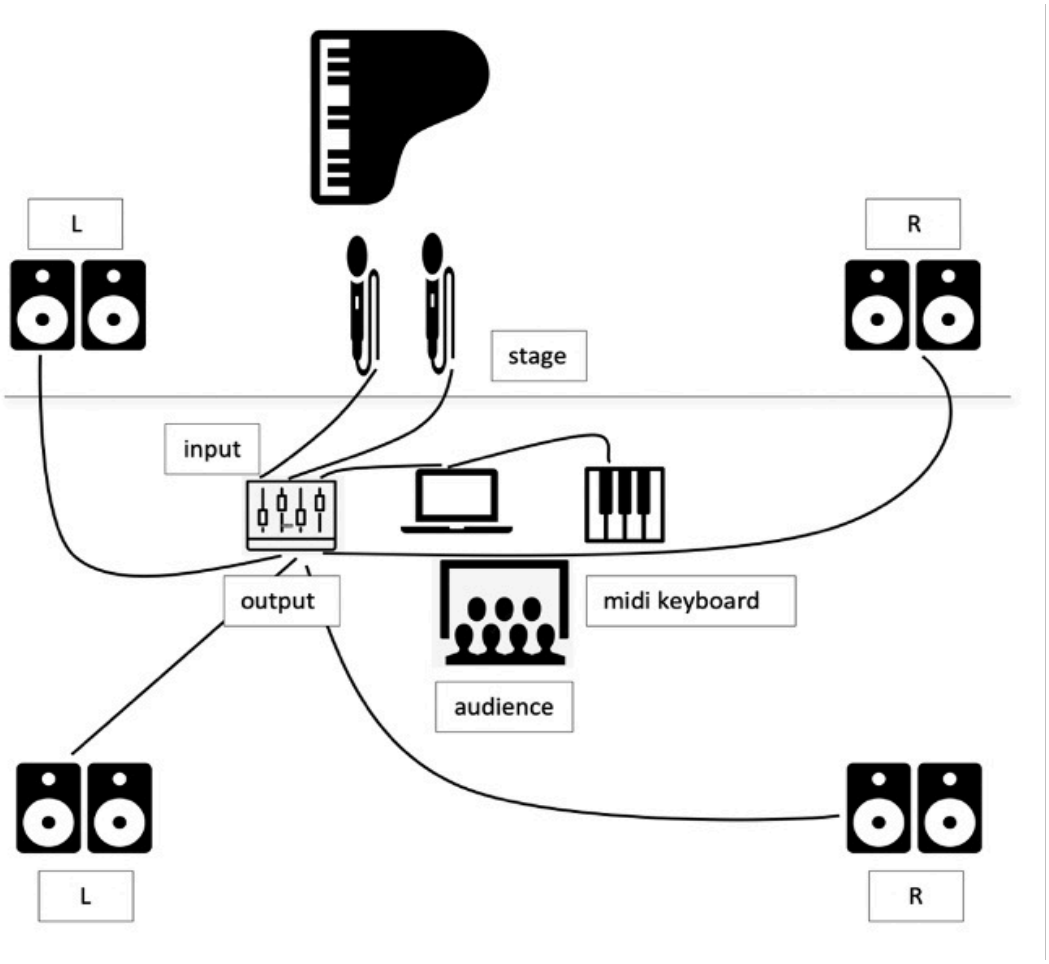
4 loudspeakers; mixing desk; computer; MIDI keyboard (48 keys).

Piano is picked up with microphones and fed via the mixing desk.

The computer runs the Max which transforms the sounds and sends 4 outputs to the mixing desk.

The computer takes input from a MIDI keyboard, played by the pianist, which triggers different settings in the Ableton Live .

The configuration of the 4 speakers is shown in the diagram.



NOTES

Main scale is I symmetry scale. The main idea is to build on the contrast between atonality and tonality. The whole piece is mainly atonality, and there are some symmetrical harmony floating on the basis of atonality, which implied tonal slightly.

The rhythm goes between regular and illogical. In the design of pitch and rhythm, the reason for not composing music strictly according to the algorithm is to reflect more humanity.

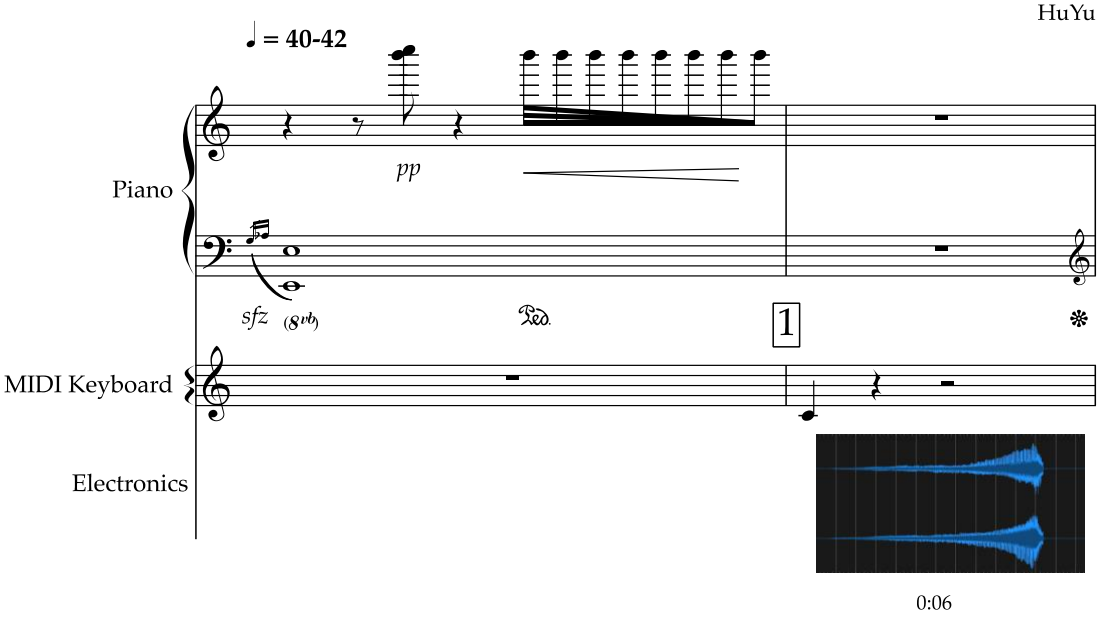
The supplement of electronic part emphasizes the gestures of the piano part more. In mixed music works, I think that the aesthetics of different styles are compatible and complement each other.

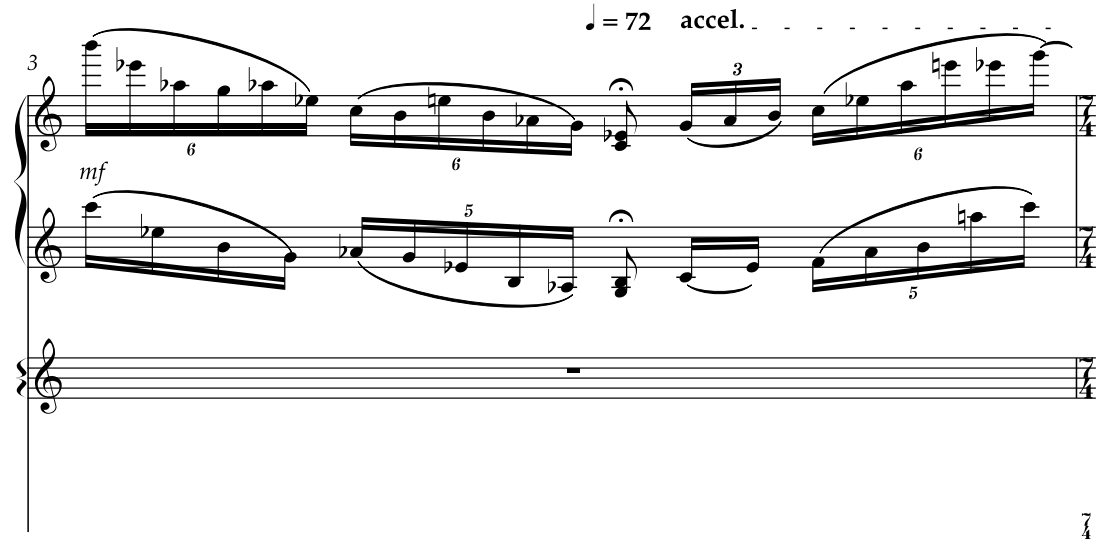
Tempo

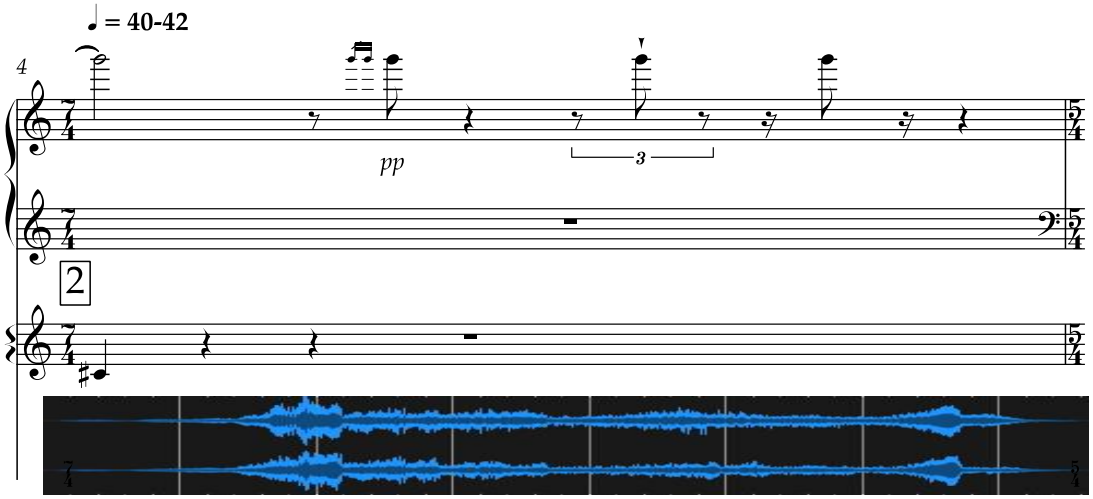
The performer does not need to strictly follow the rhythm and speed of the score.
When playing, performer need more Rubato, and enter a new section according to the Cue point of electronic music.

Mandalas

HuYu



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3
2
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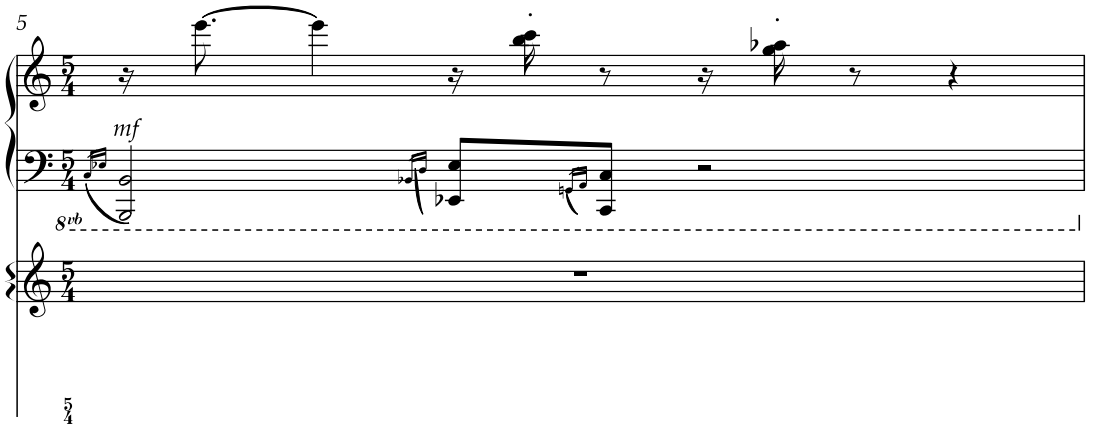
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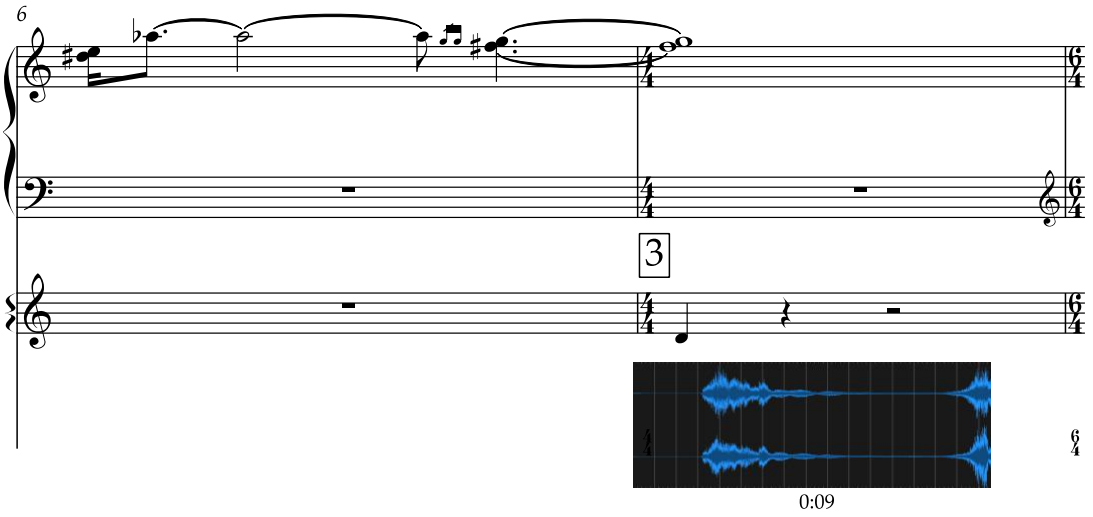
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3
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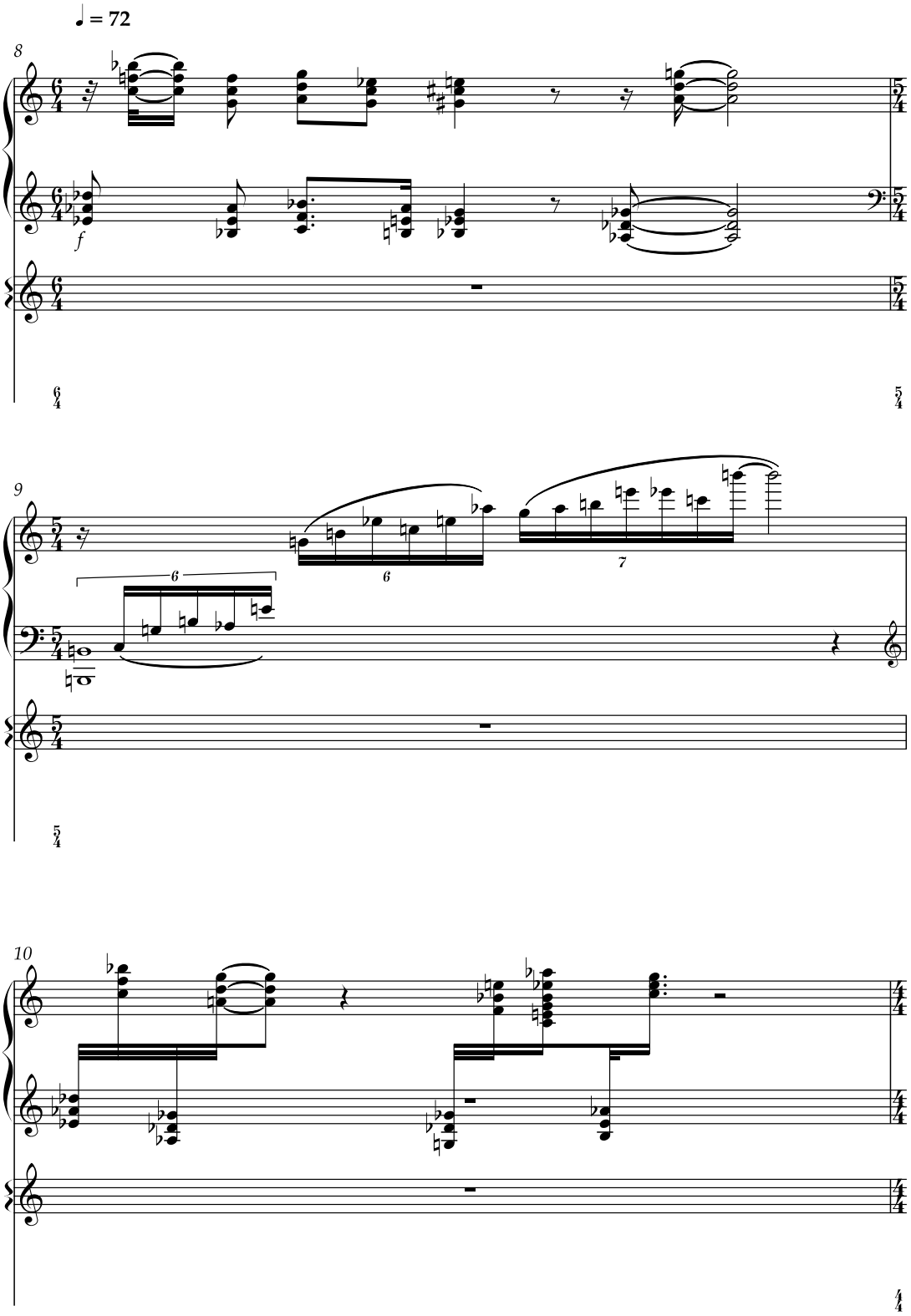
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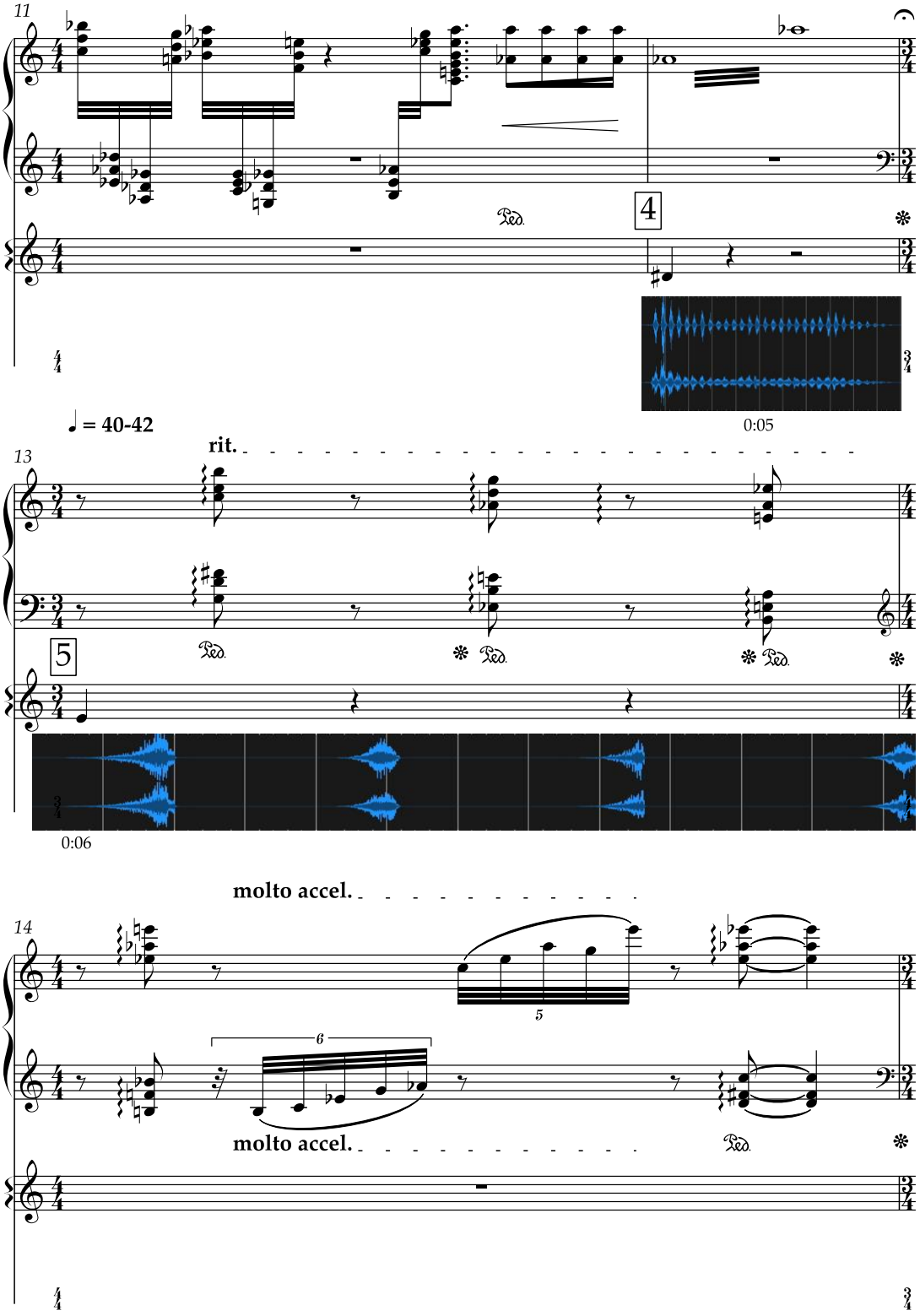
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0:05
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13
5
0:06
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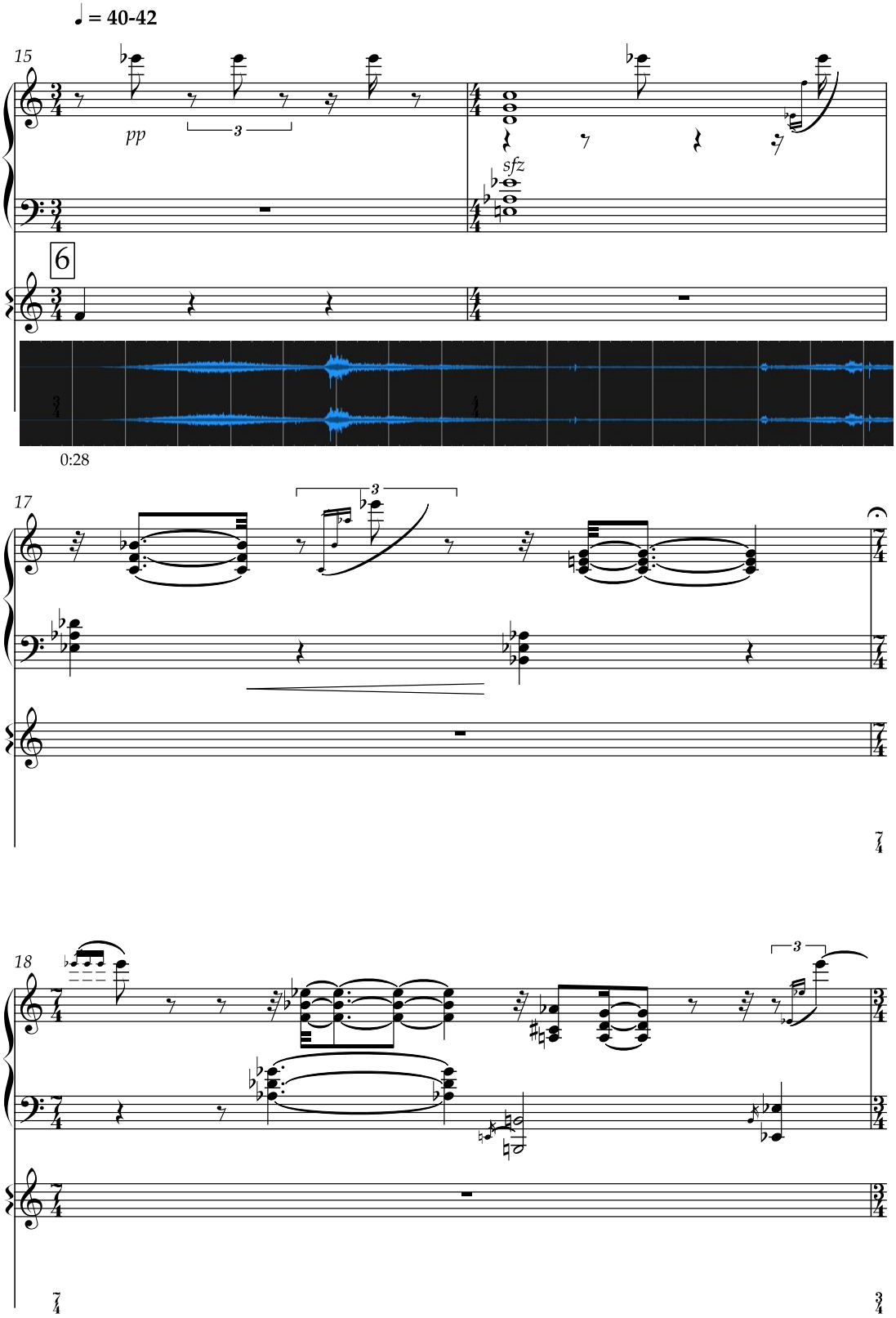
14
molto accel.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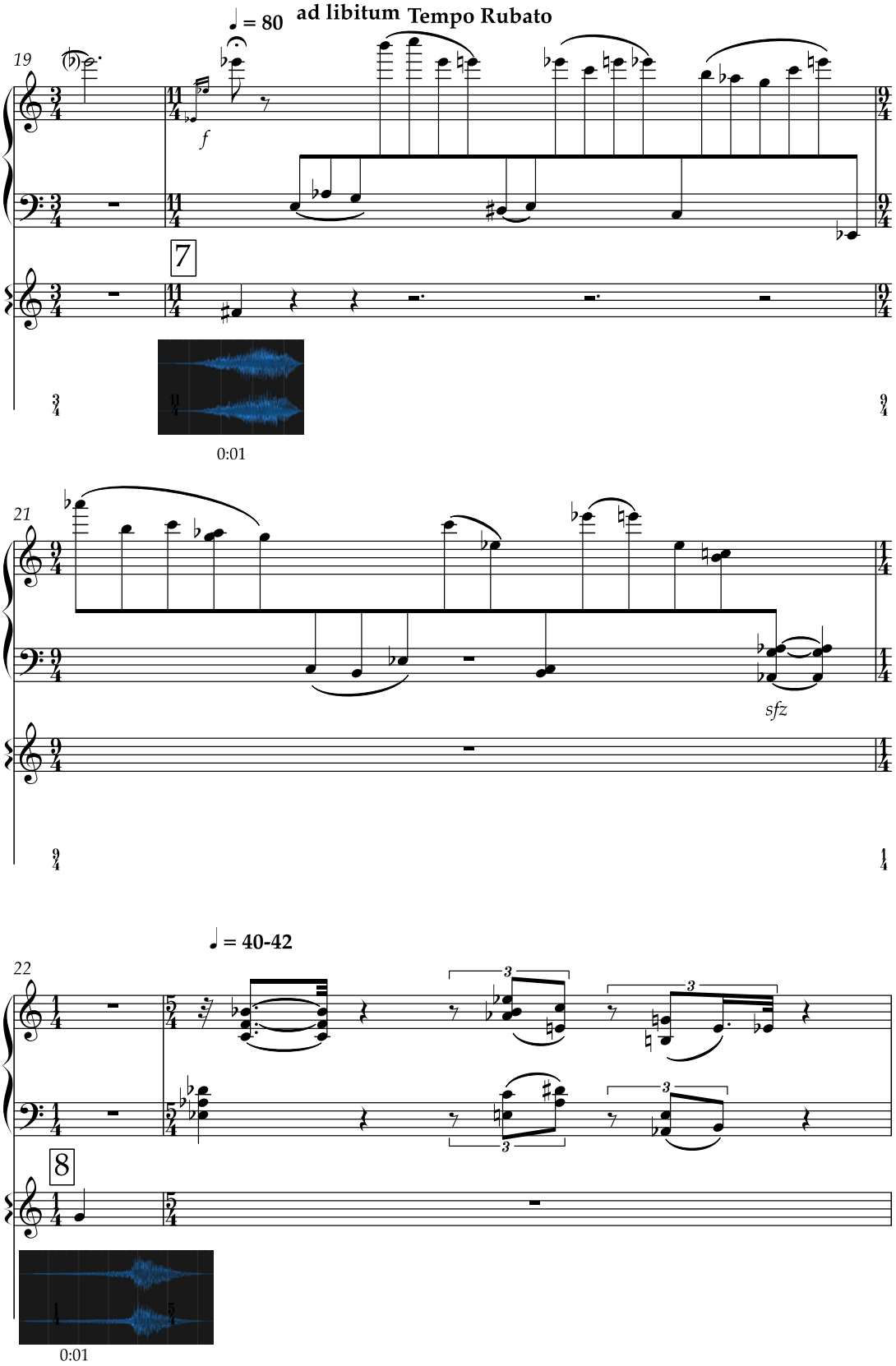
3
18
3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ad libitum
Tempo Rubato
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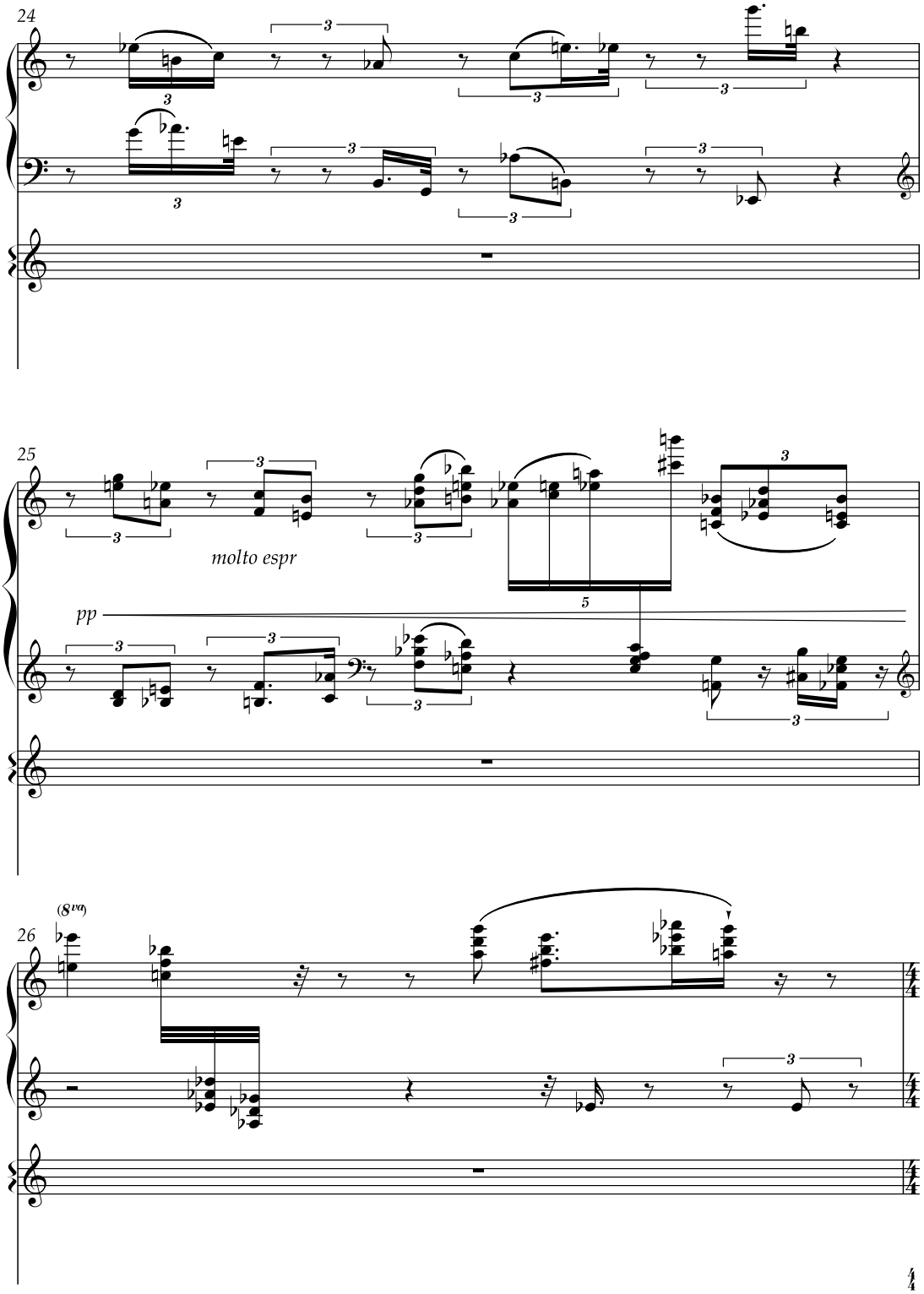
f
7
0:01
21
sfz
♩ = 40-42
22
8
0:01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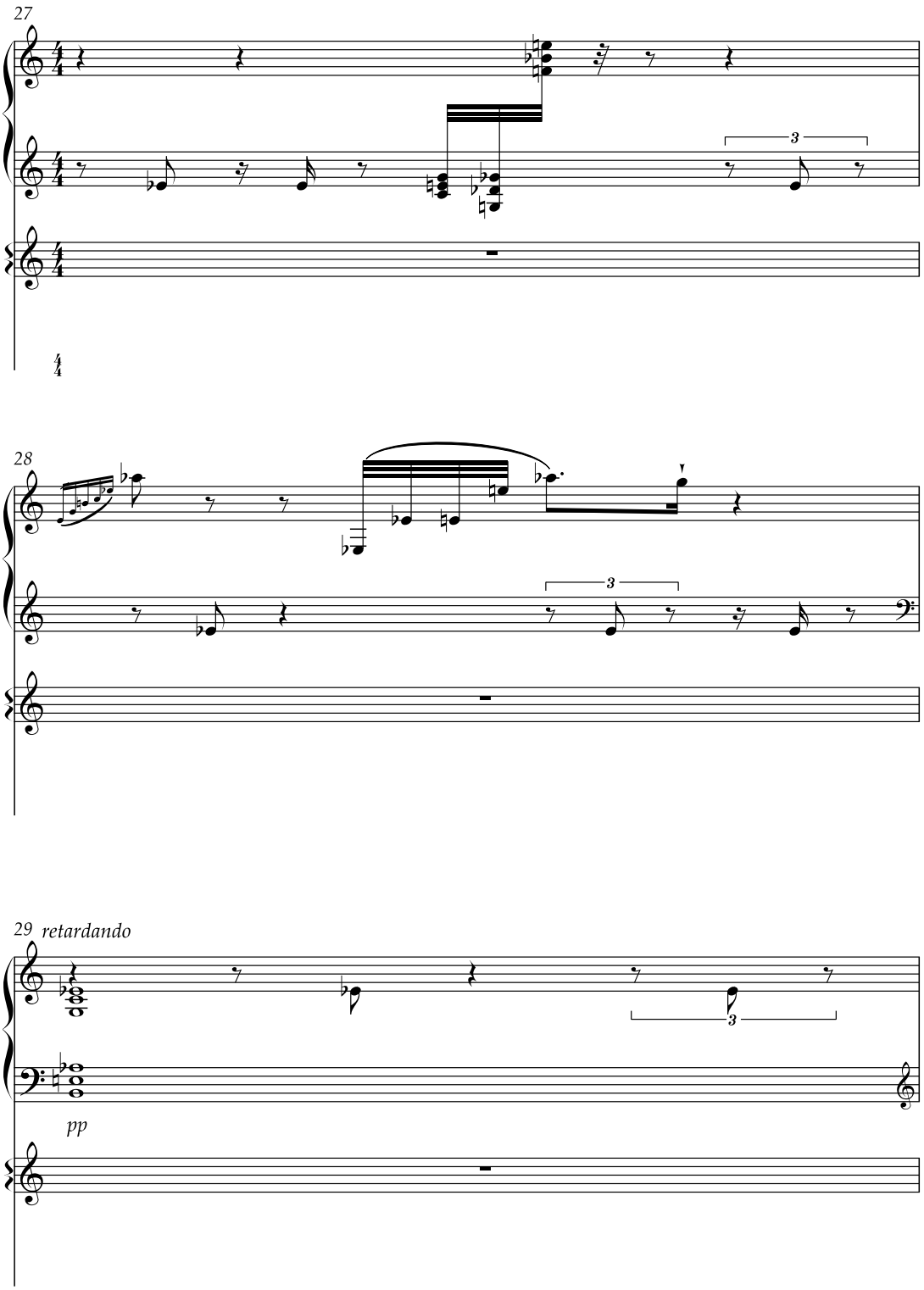
26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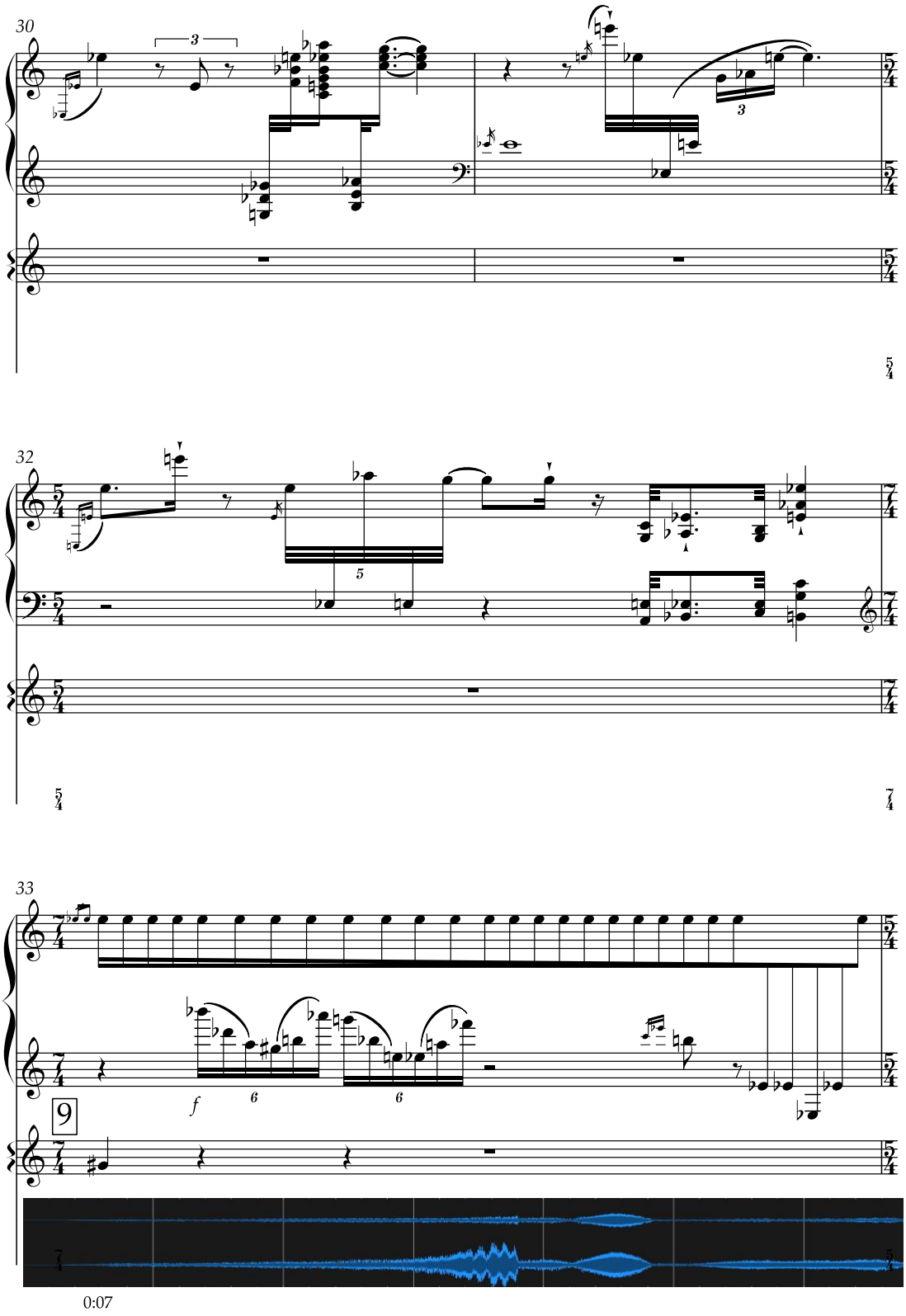
pp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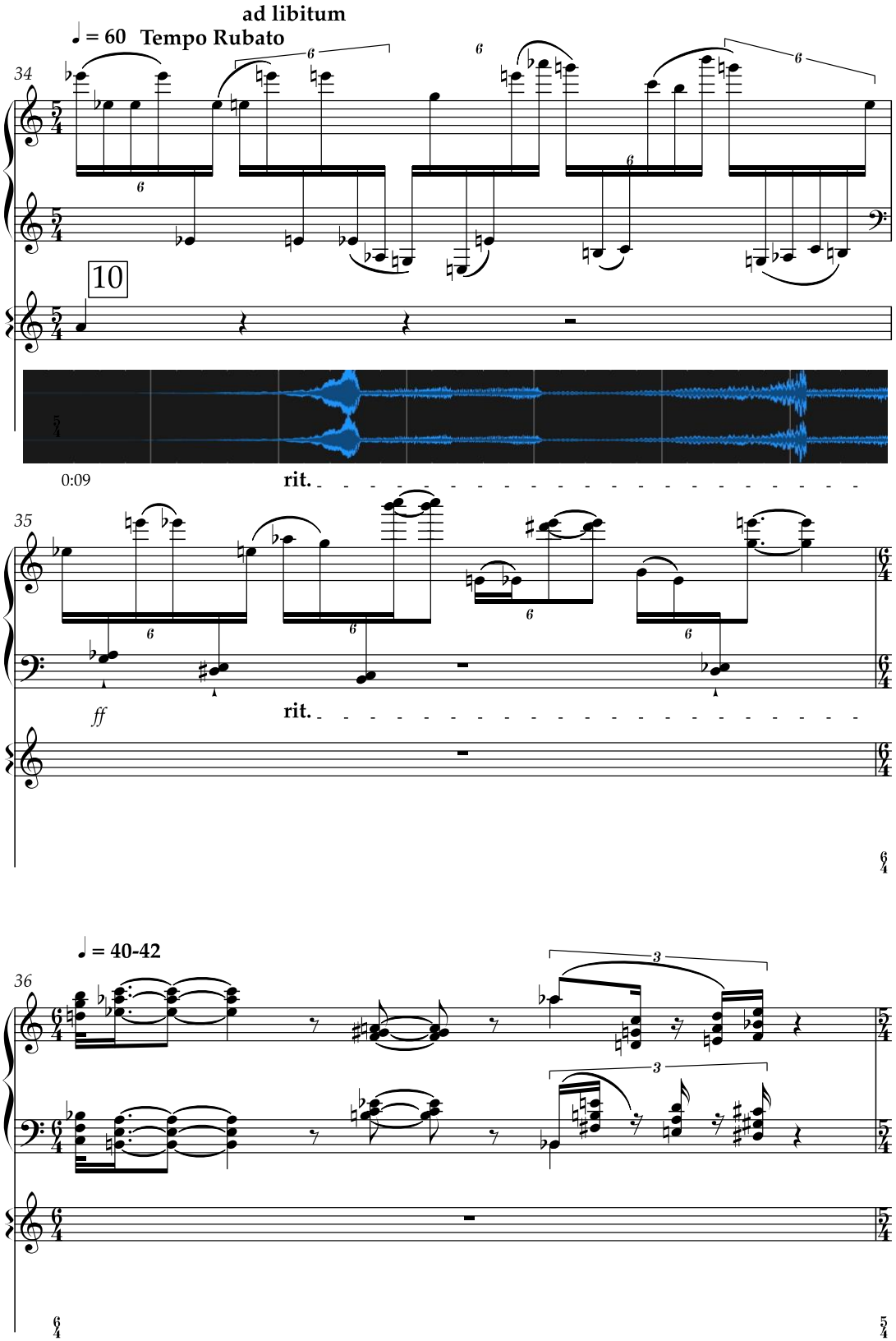
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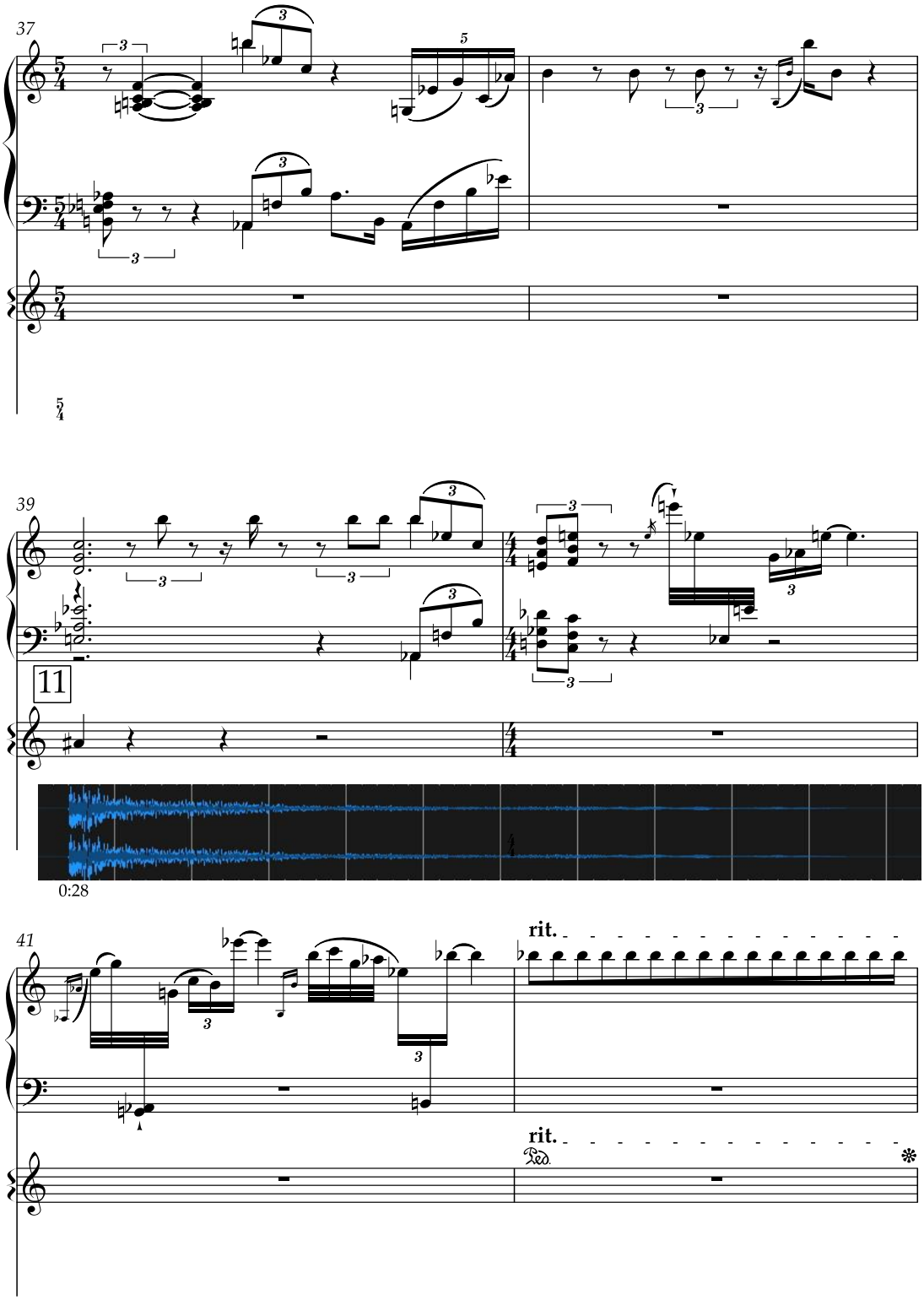
10
0:09
rit.
35
ff
rit.
♩ = 40-42
36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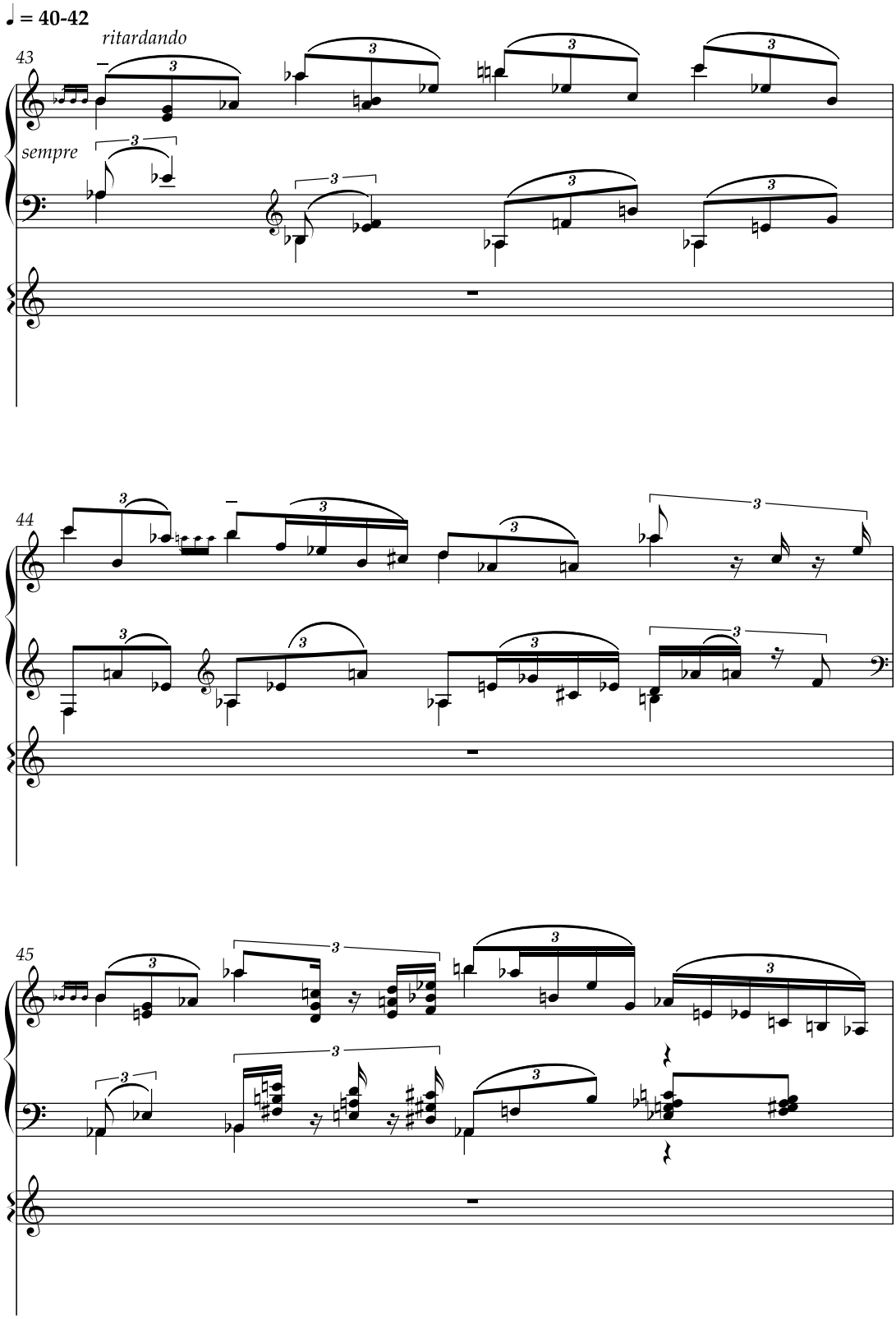
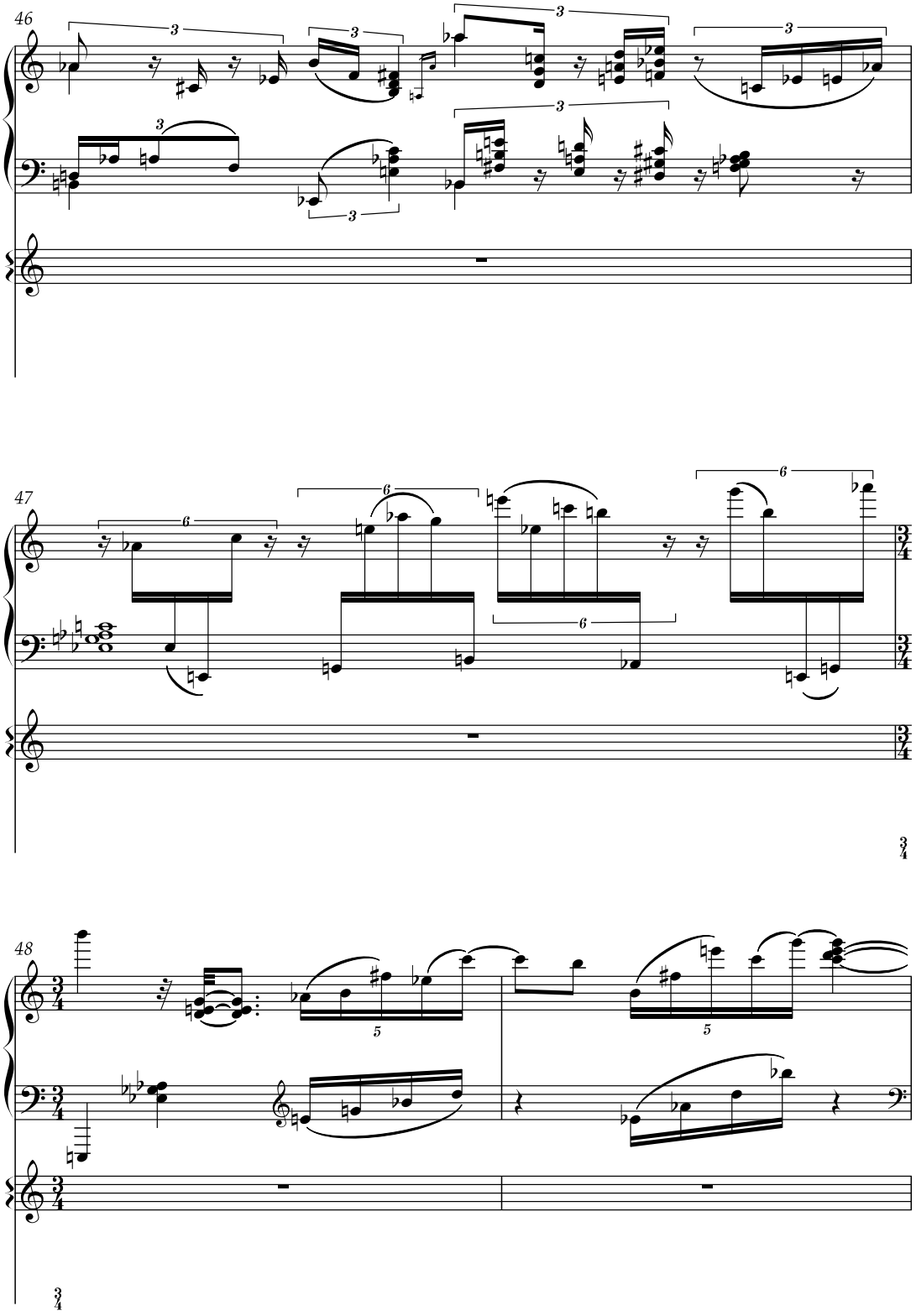
39
11
0:28
41
rit.
rit.
Ped.


♩ = 40-42
ritardando
43
sempre
44
45

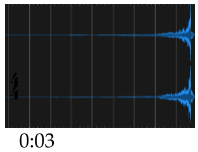

46
47
48

50

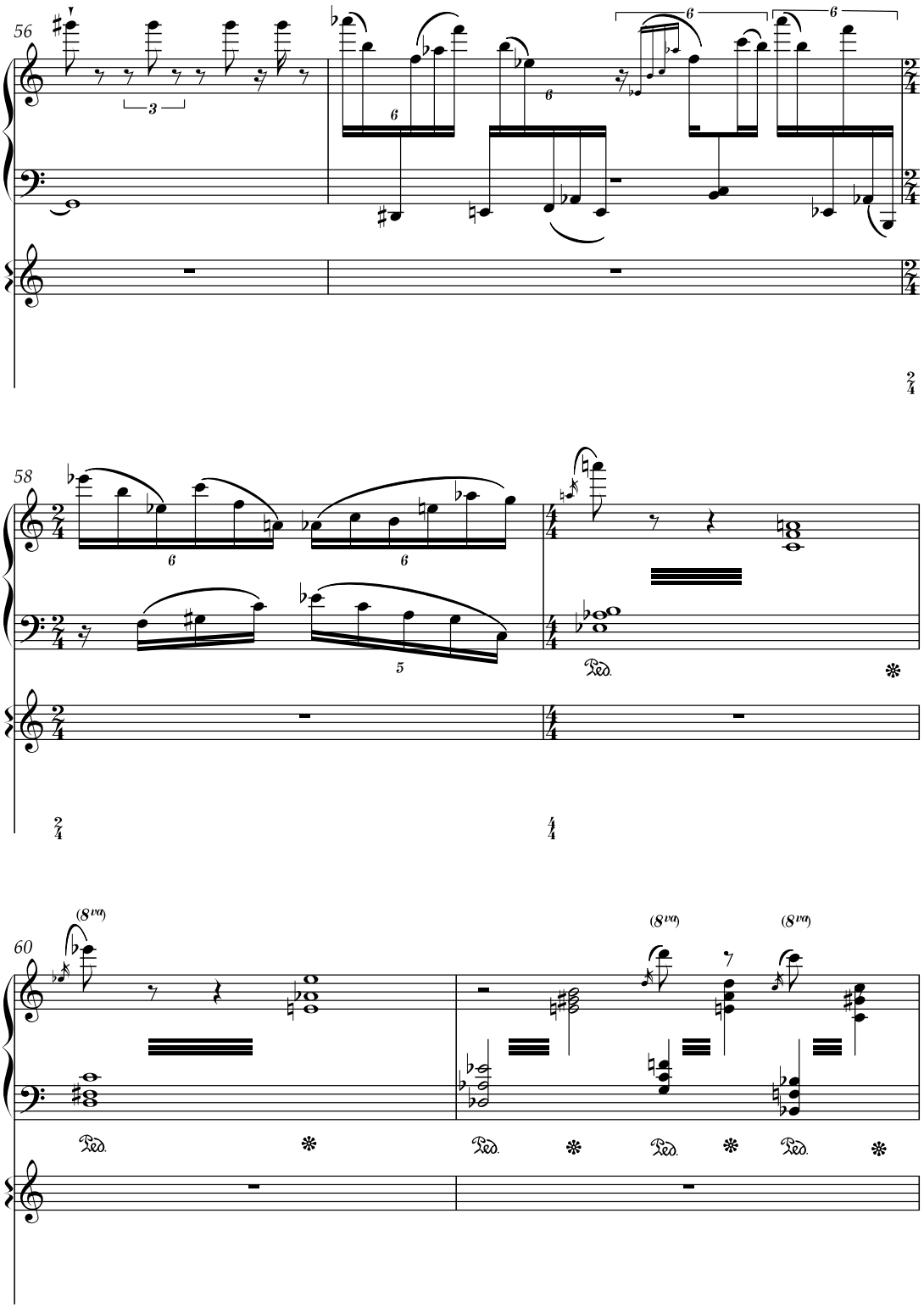
52

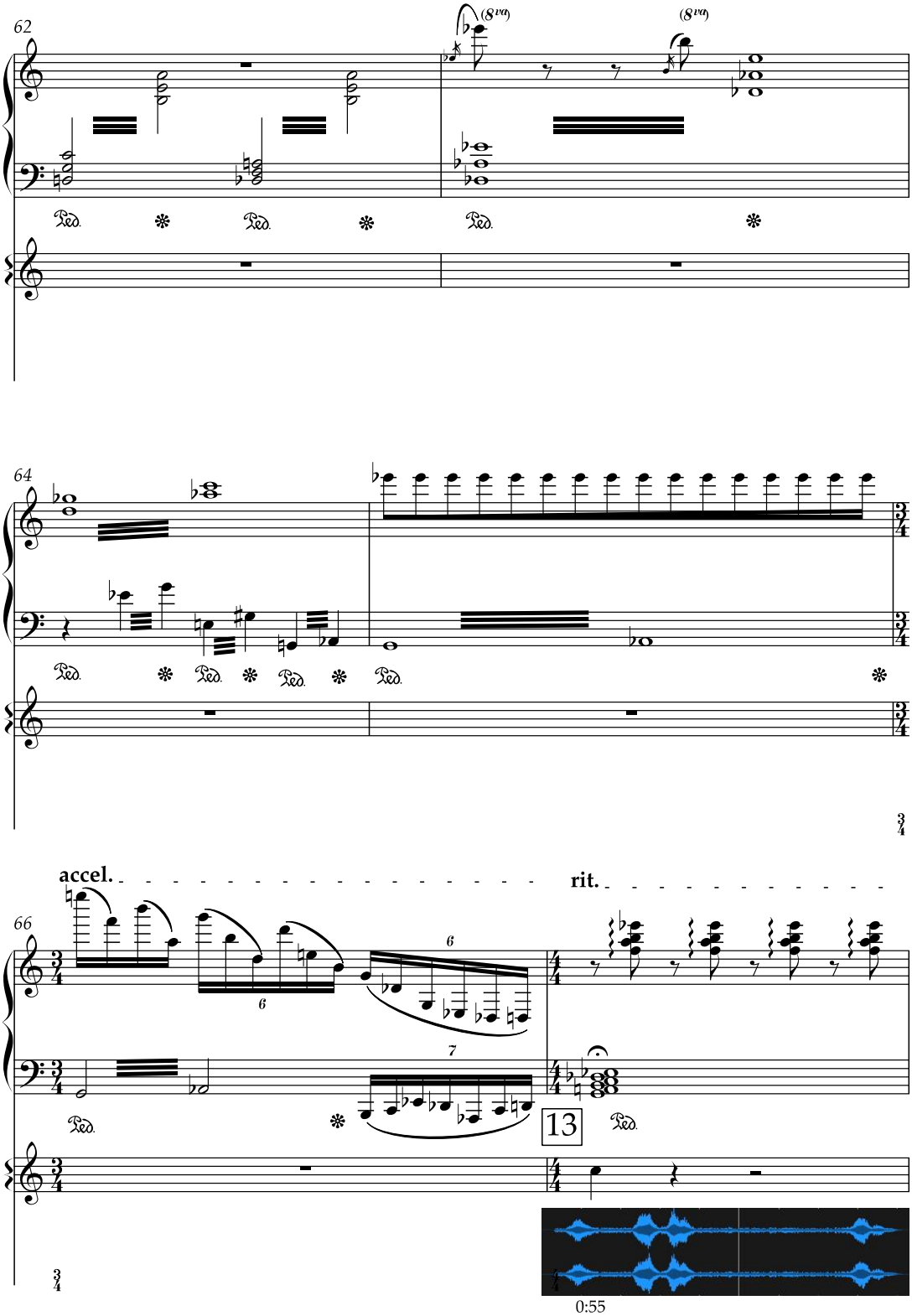
54

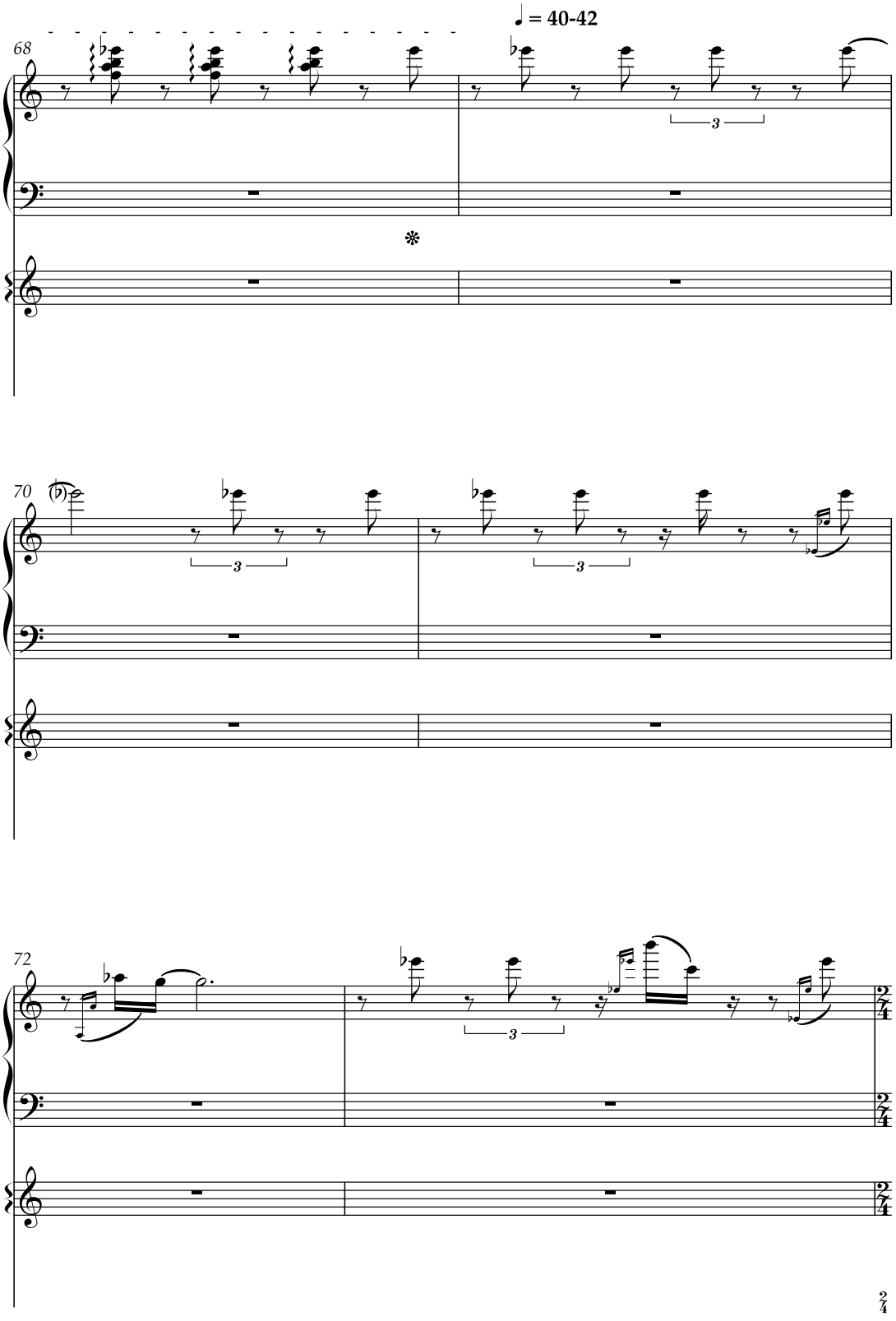
12

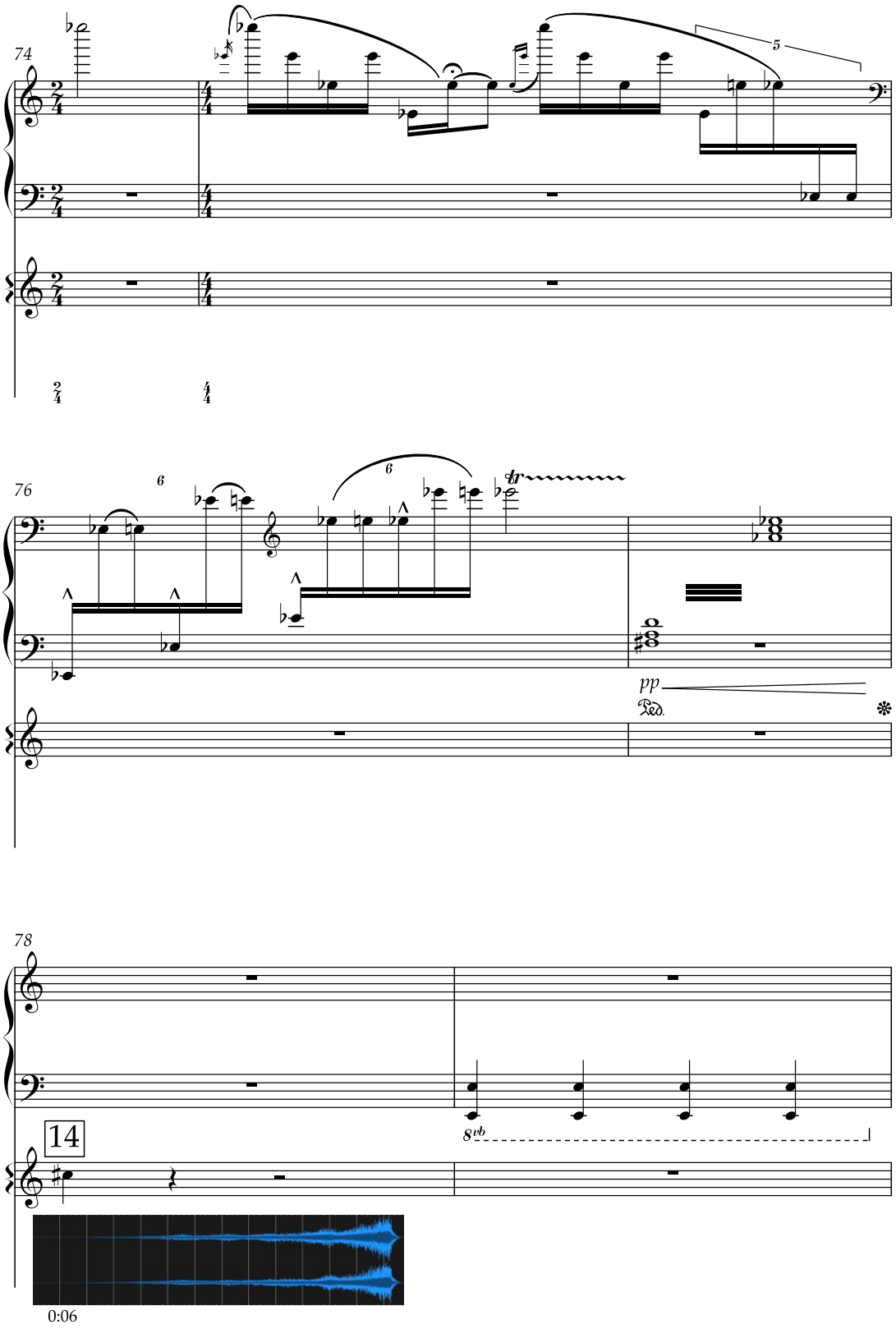


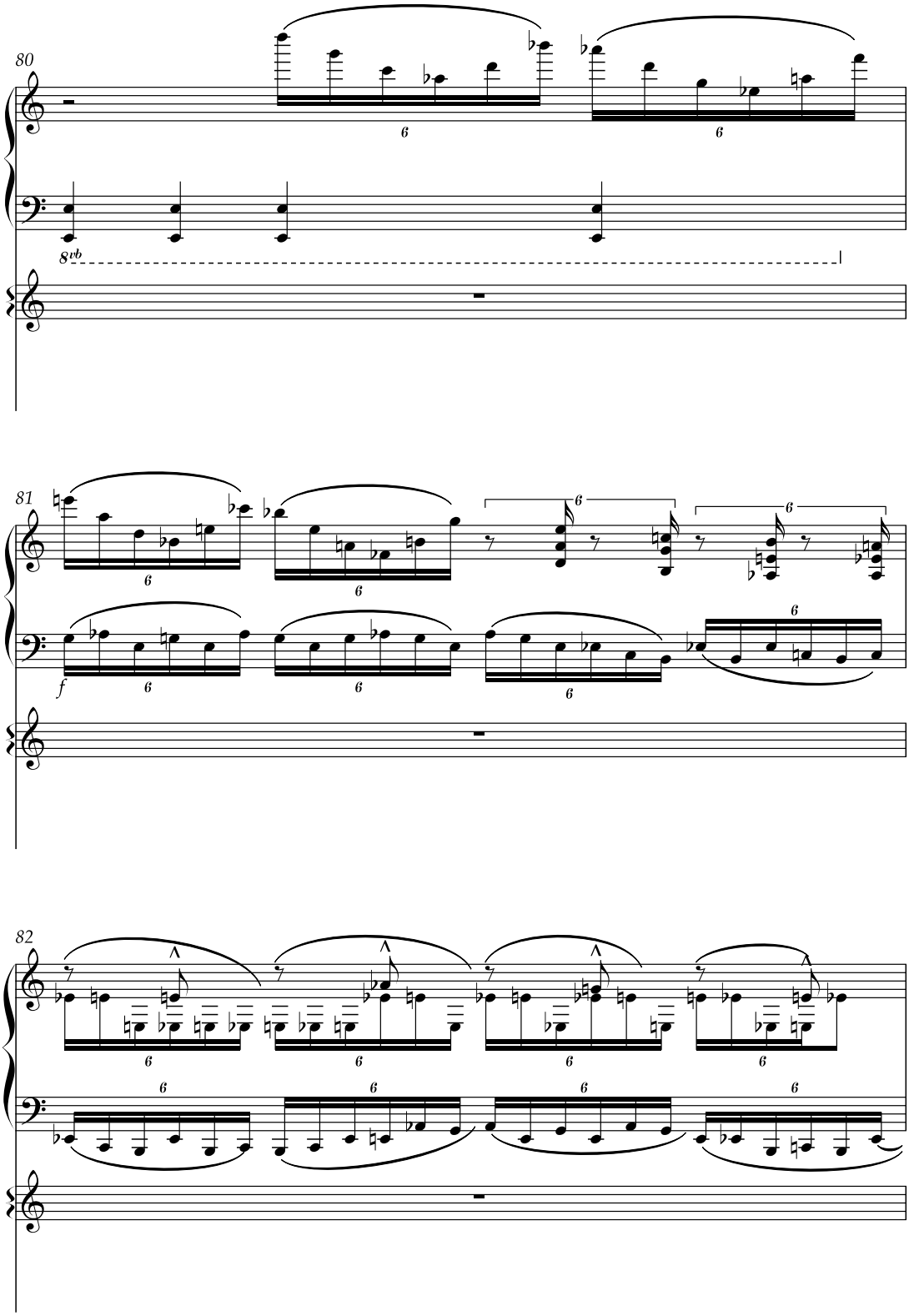
0:03

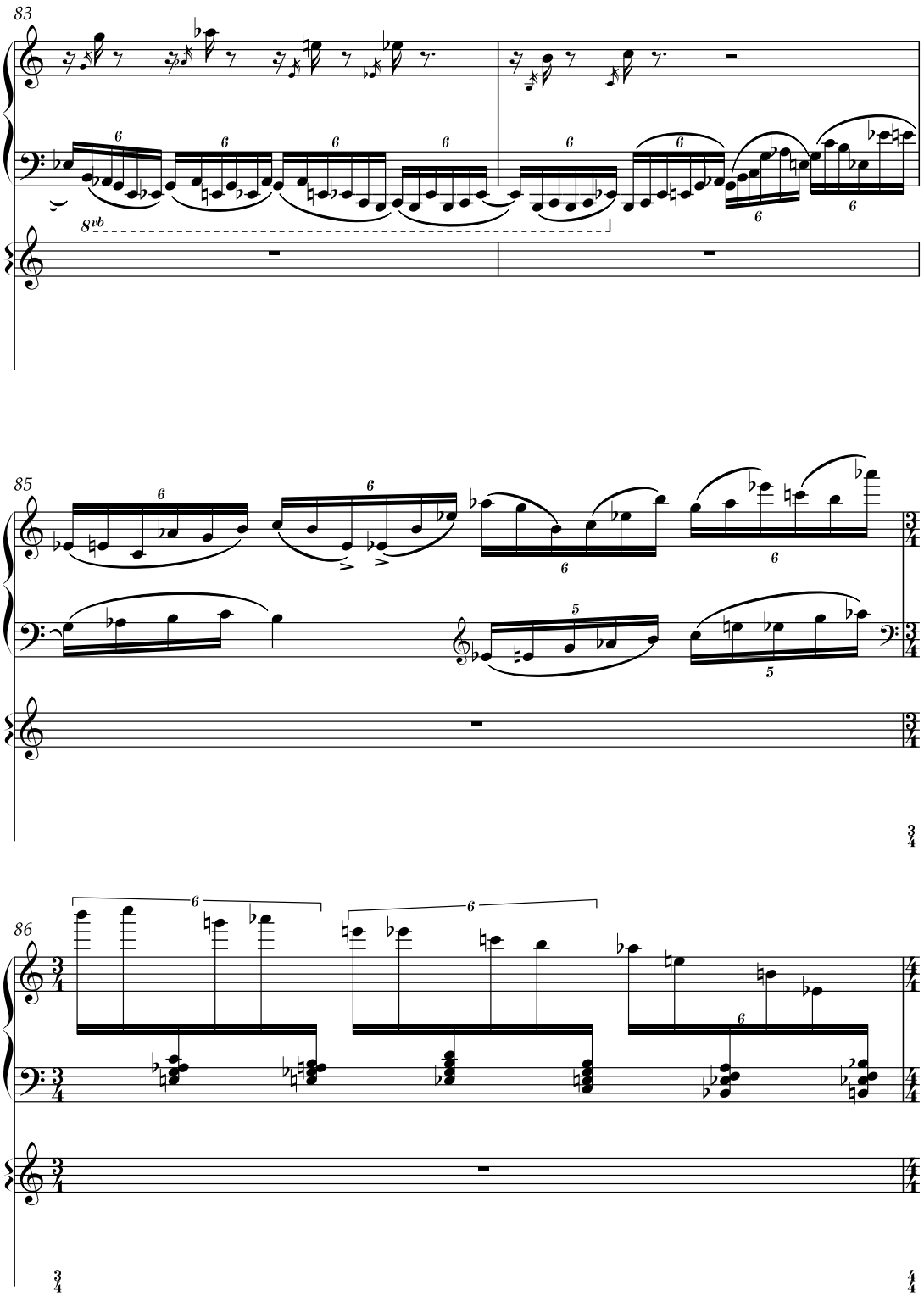

56
58
60
(8va)
(8va)
(8va)
Ped.
Ped.
Ped.
Ped.

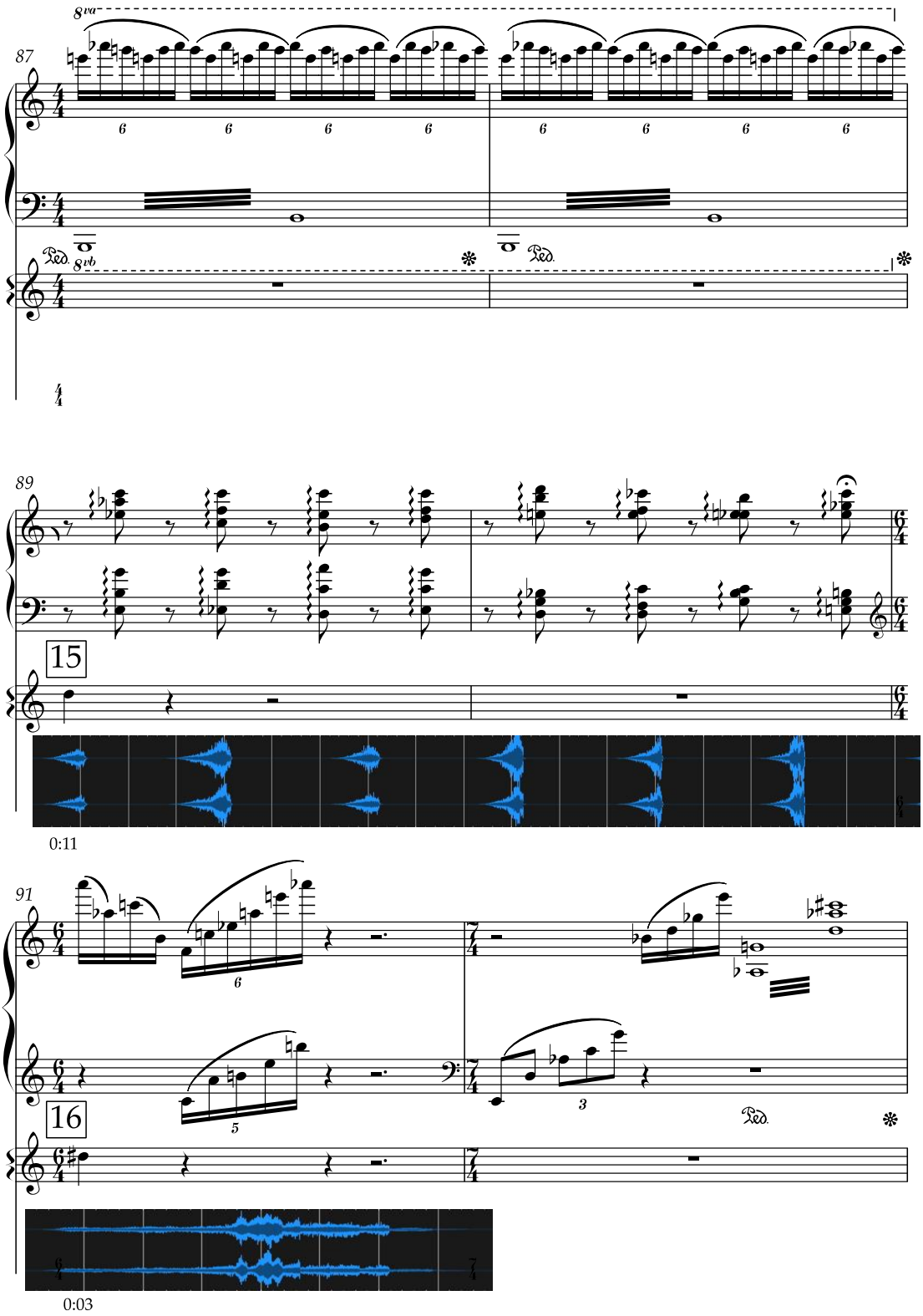

62
(8va)
(8va)
Ped.
64
Ped.
accel.
rit.
66
6
7
13
Ped.
0:55


♩ = 40-42
68
3
70
3
3
72
3
2/4


74
5
2/4
4/4
76
6
6
tr
pp
Ped.
78
14
8vb
0:06


80
8vb
81
f
82


83
8vb
85
86


87
8va
8vb
Ped.
89
15
0:11
91
16
0:03

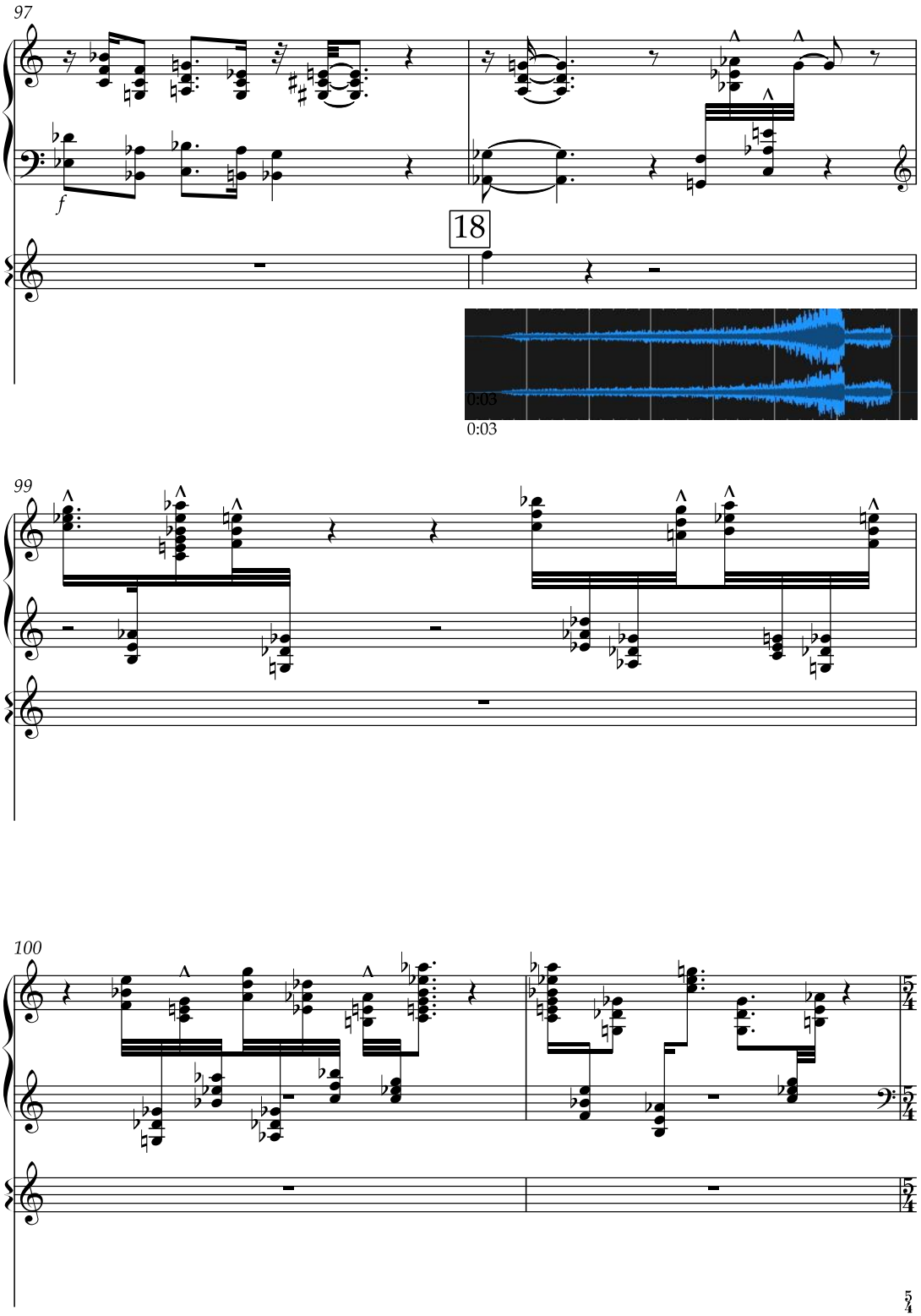
93

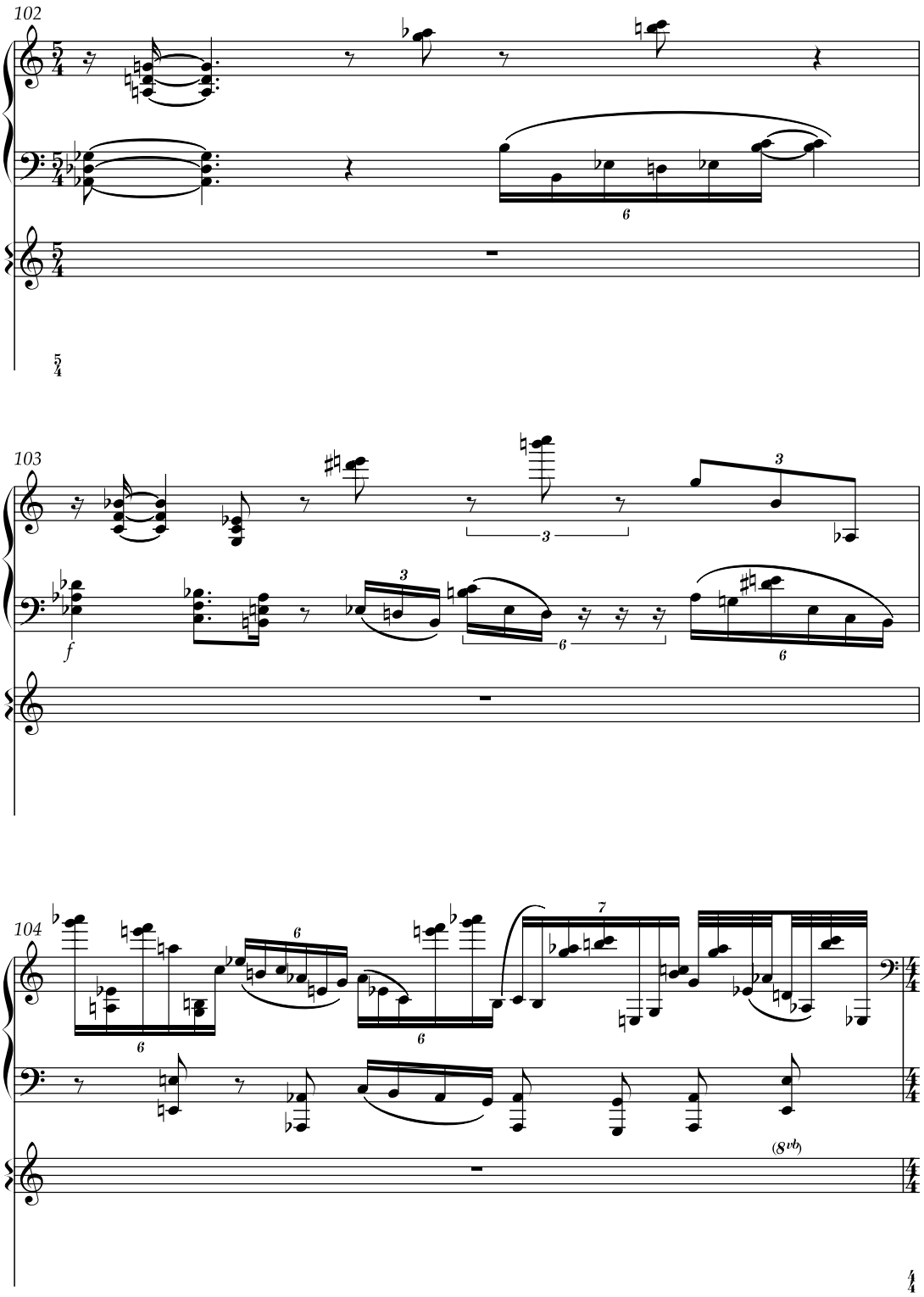
94

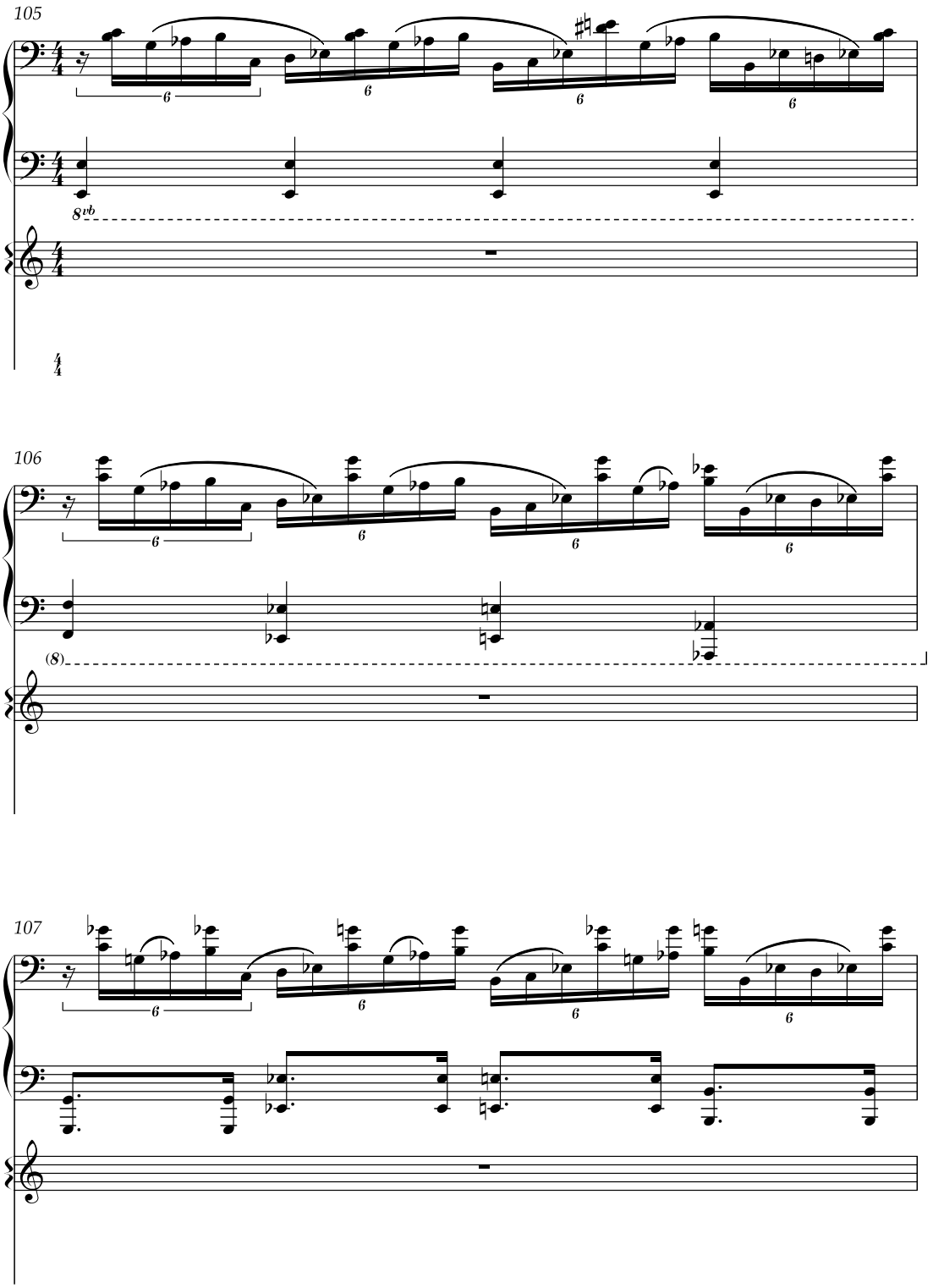
17

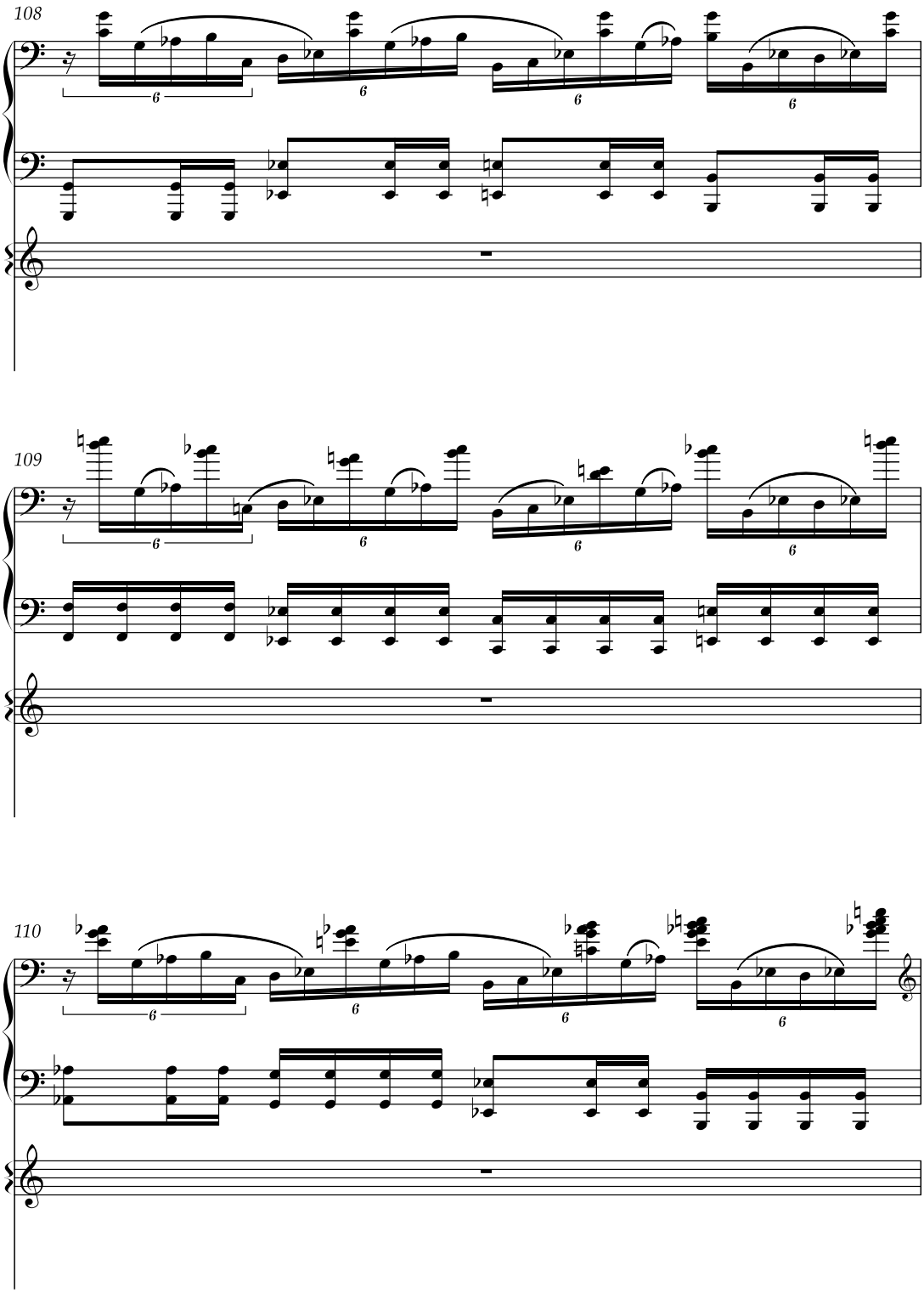
0:14

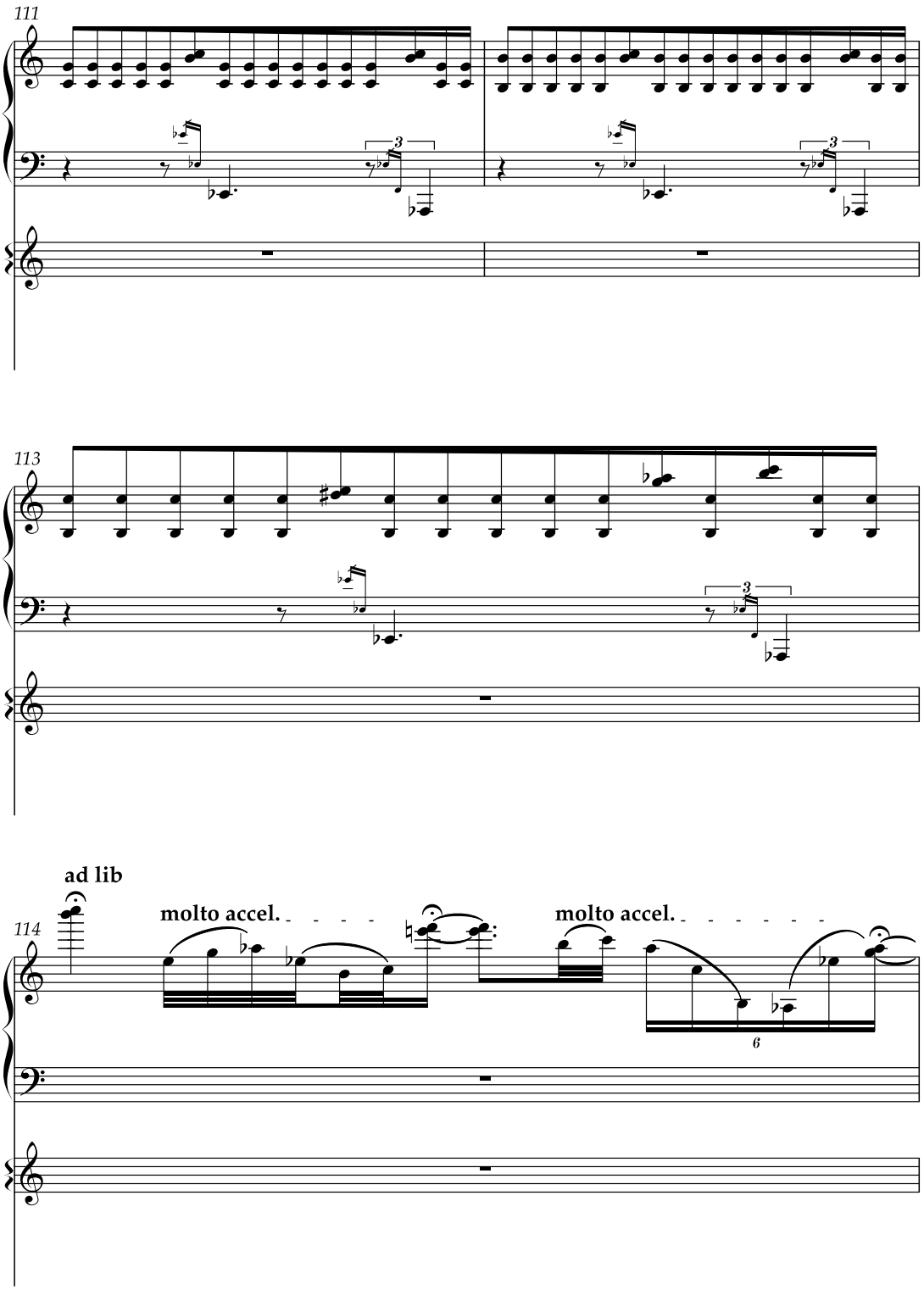
96

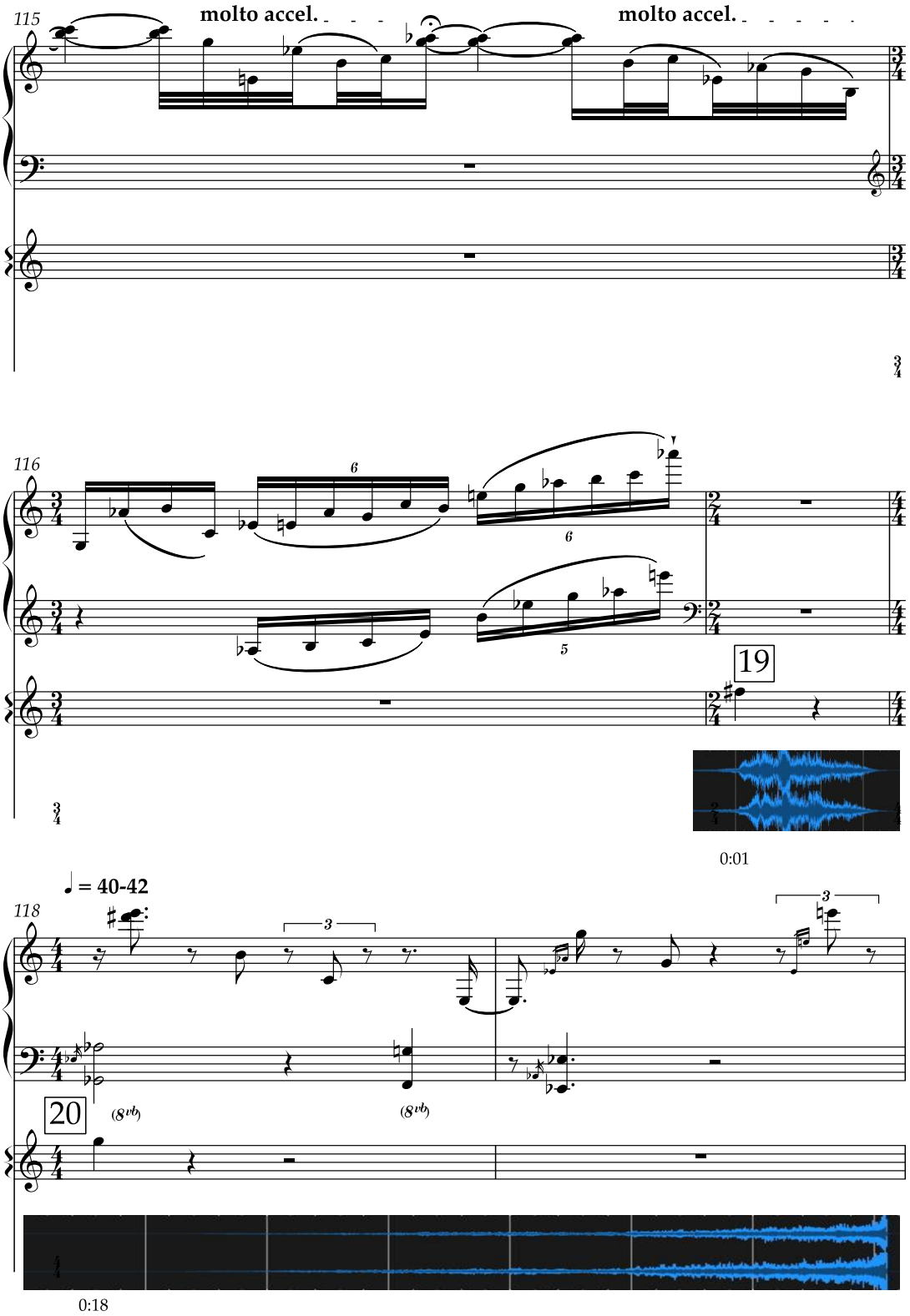

97
f
18
0:03
0:03
99
100
5/4
5/4

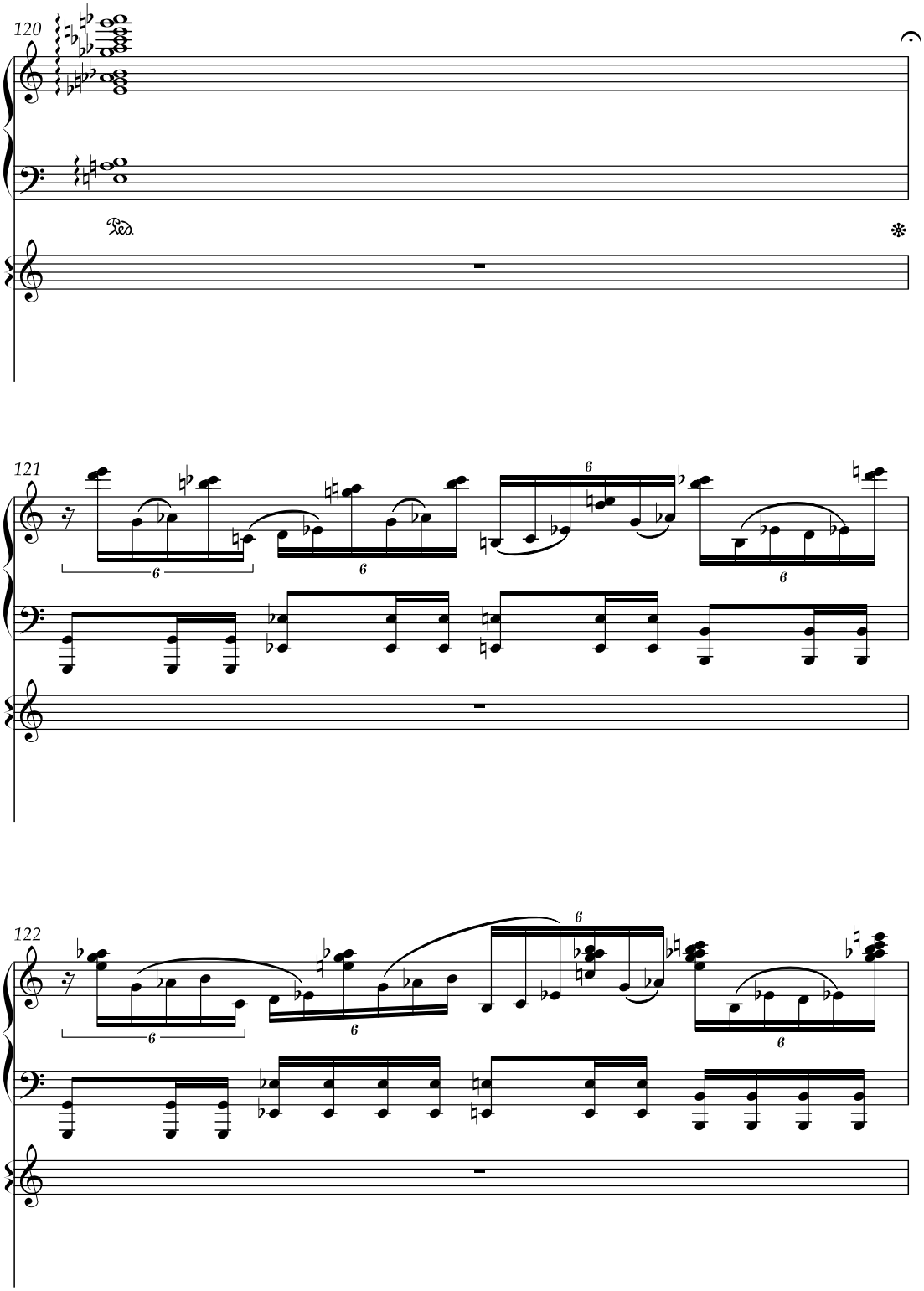

102
103
104
(8vb)

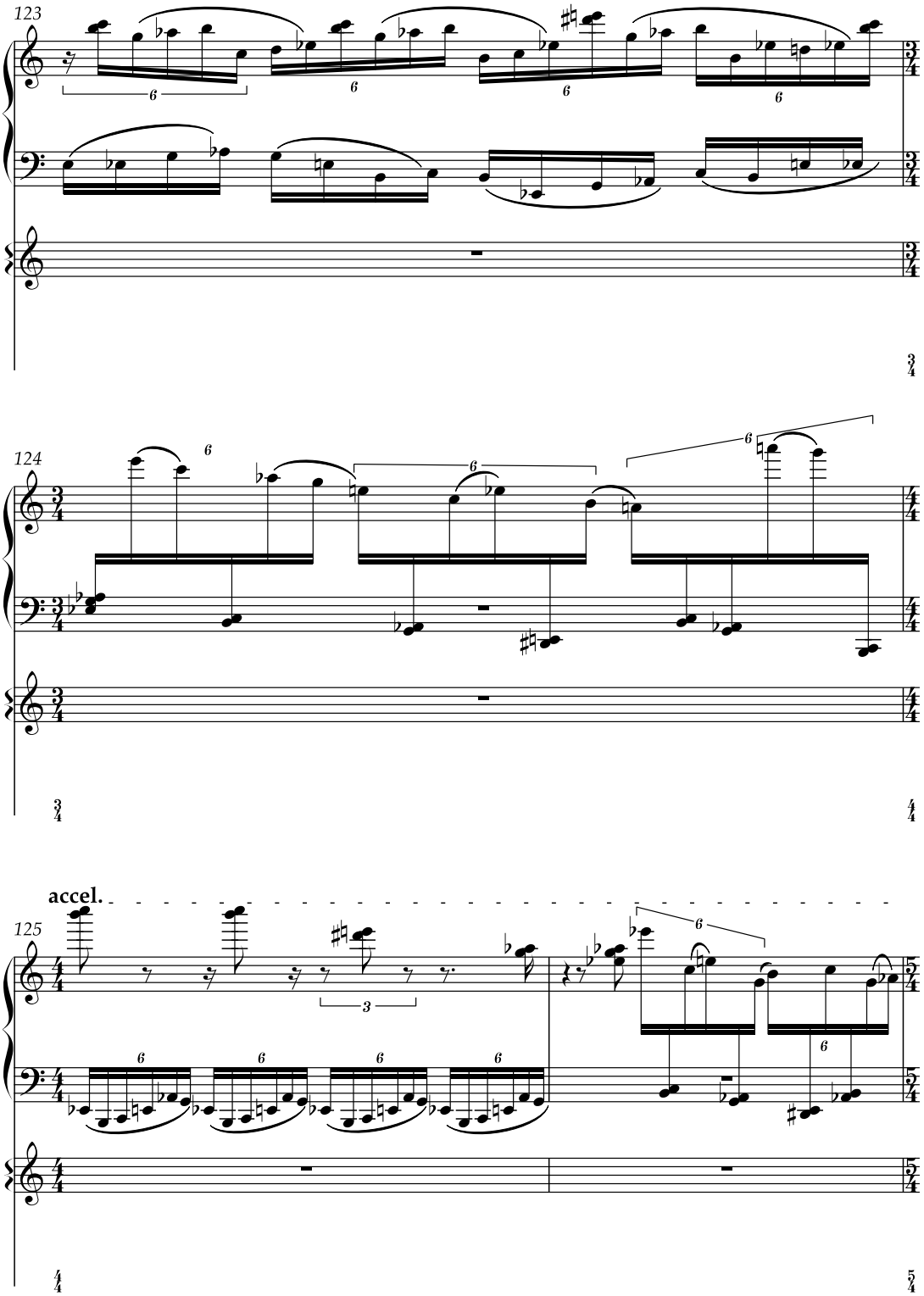

105
8vb
106
(8)
107

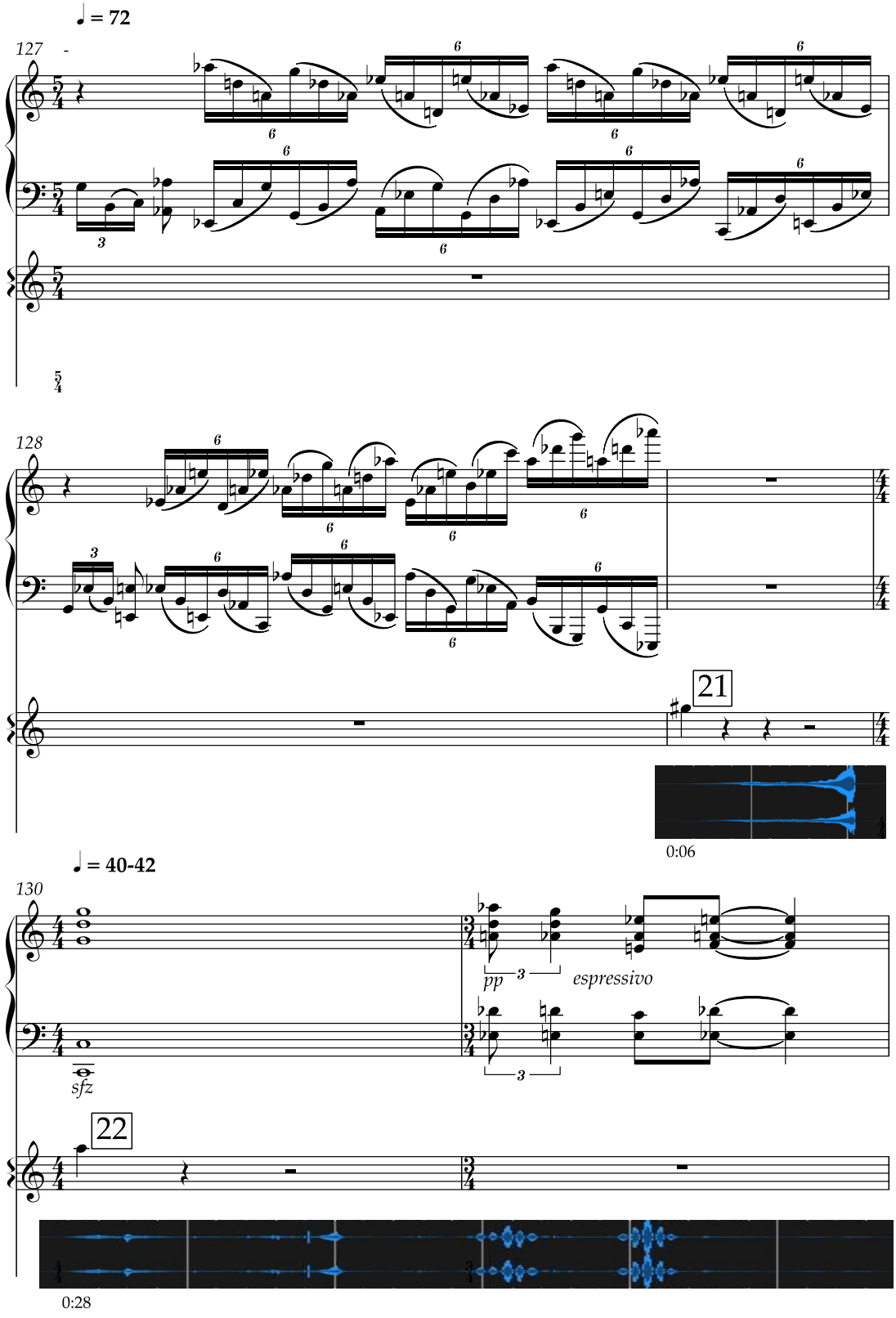

108
109
110

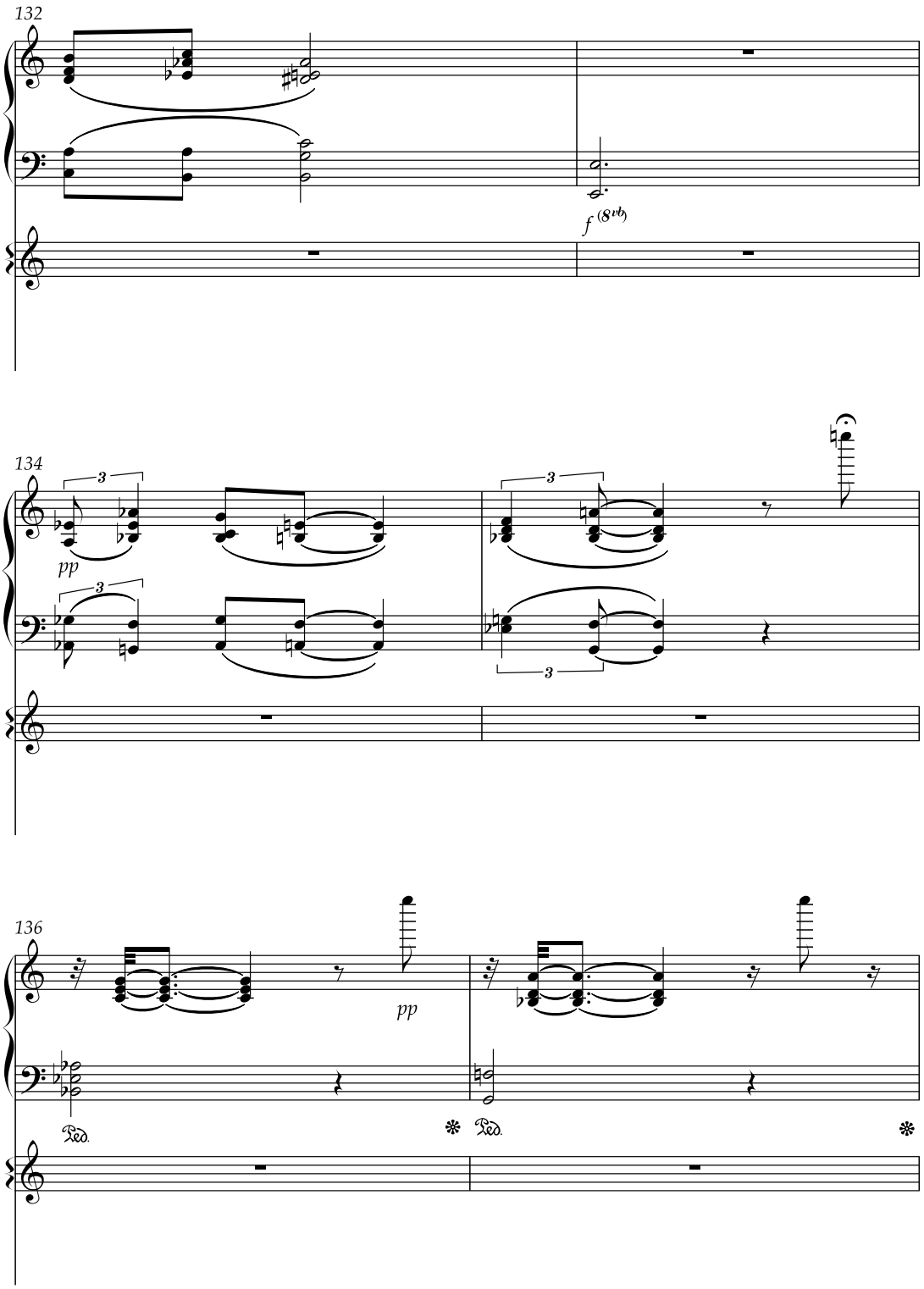

111
113
ad lib
114
molto accel.
molto accel.

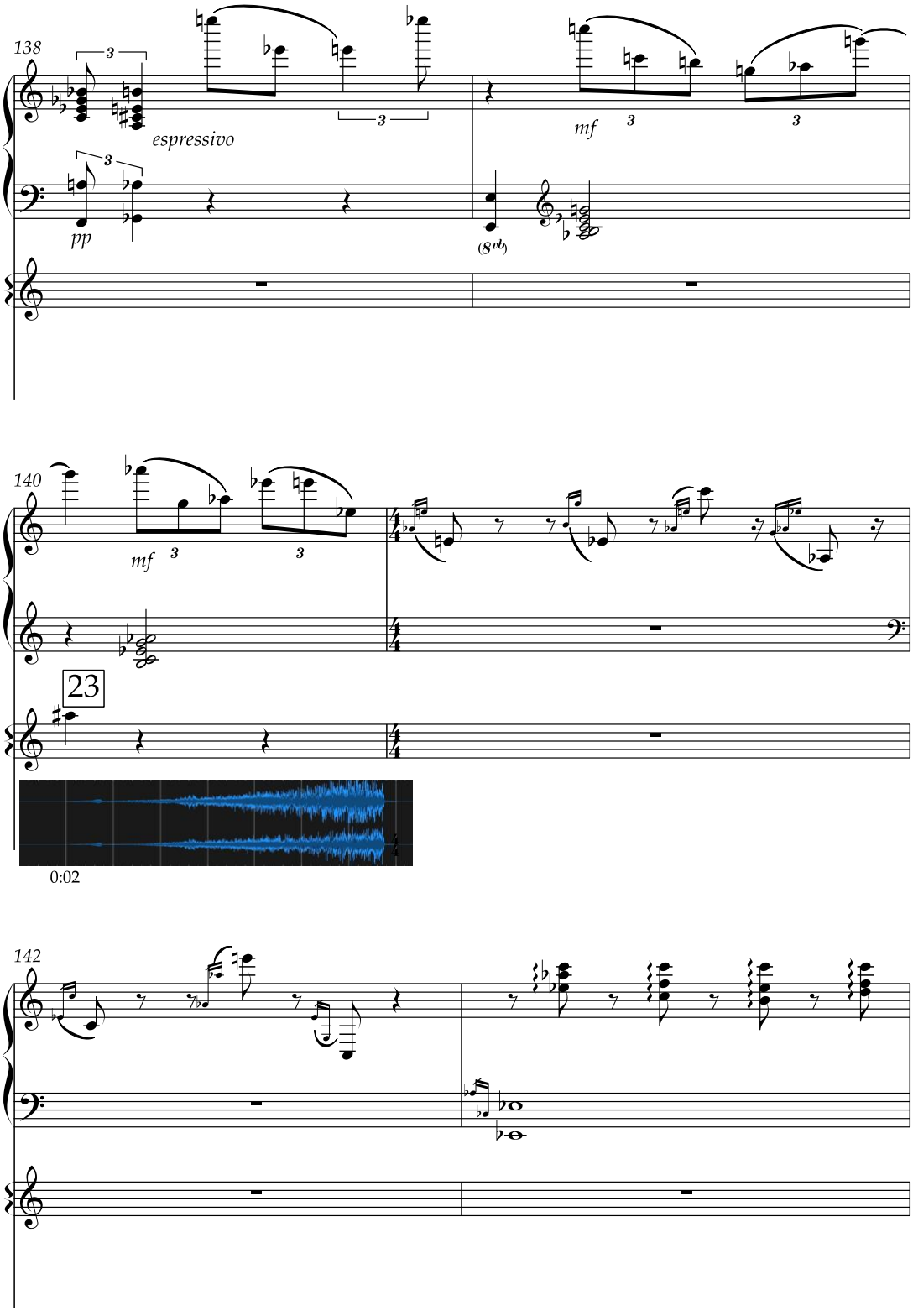

115
molto accel.
molto accel.
116
6
6
5
19
0:01
♩ = 40-42
118
3
3
20
(8vb)
(8vb)
0:18


120
Ped.
121
122


123
124
accel.
125


♩ = 72
127
128
21
0:06
♩ = 40-42
130
pp
espressivo
sfz
22
0:28

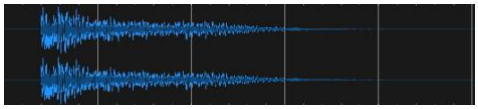

132
f (8vb)
134
3
pp
136
pp
Ped.
Ped.


138
espressivo
pp
mf
(8vb)
140
mf
23
0:02
142

144

24

Ped.



0:12

146

pp

Ped. (8vb)

3/4

148