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The Temple of Immensity: for Choir and Electronics

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THE TEMPLE OF IMMENSITY: FOR CHOIR AND ELECTRONICS

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HONORS PROJECT

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I. Introduction

Humans have great difficulty understanding large numbers; the physicist Albert Allen Bartlett once spoke of this difficulty: "The greatest shortcoming of the human race is our inability to understand the exponential function."[1] Terms such as "million," "billion," and "trillion" are seen regularly in news and other media, but many do not understand how truly different these values are. This phenomenon has been called exponential growth bias[2], and can also be seen in the field of astronomy. Extremely large values of sizes and distances are often encountered in the field, with a wide array of units employed to quantify these values. One of the guiding questions of the current project was how one can most wholly depict astronomical ideas and concepts with music. These concepts grew to include the sizes of stars and the distances between them and the Earth. The goal of this project evolved to be the musical depiction of celestial bodies through human voices and electronics, a depiction rooted in wonder, awe, and reverence.

II. Literature Review

With the decision to write this piece for choir and electronics on astronomical themes, I began searching for works that would serve as inspirations or guides for this project for one or more of the above categories. A wide collection of choral works served as inspirational foundations for *The Temple of Immensity*. Most prominently in these works is Dutch composer Joep Franssens' *Harmony of the Spheres*, written between 1994 and 2001. *Harmony of the*

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[1] "Professor Emeritus Al Bartlett - Physics at University of Colorado at Boulder." Articles on Exponential Growth, Peak Oil and Population Growth, Sustainability, Renewable Resources and the Environment. Accessed December 07, 2021. https://www.albartlett.org/.

[2] Robson, David. "Exponential Growth Bias: The Numerical Error behind Covid-19." BBC Future. August 12, 2020. Accessed December 07, 2021. https://www.bbc.com/future/article/20200812-exponential-growth-bias-the-numerical-error-behind-covid-19.

Spheres is a 65-minute work for double choir and string orchestra setting texts by 17th century Dutch philosopher Benedictus de Spinoza. In the first and final movements, Franssens divides the choir in half. He writes the same music for both halves, but one choir is a fraction of a beat behind, writing into the music a delay and reverberation reminiscent of cathedrals and other vast, echoing spaces. In each movement, Franssens takes listeners through a wide harmonic journey as well, taking the music through multiple keys.

Another choral work significant to this project's inspiration was the final movement of Kile Smith's concert-length work *The Arc in the Sky*, setting texts by Robert Lax. The final movement is titled "The Arc," the whole piece's namesake. Throughout this movement, Smith has the choir split into two groups and gives them a series of interlocking chords constantly varying in harmonies and voicings. Smith's incredible variety in regard to voicing is an aspect my project sought to replicate.

György Ligeti's *Lux Aeterna* is for 16-part choir, a formation *The Temple of Immensity* eventually took on (with the addition of electronics). There is a cultural aura of outer space portrayal with this piece, as it was used in Stanley Kubrick's film *2001: A Space Odyssey*. Beyond this aura, the tight harmonies and choral voicings of this piece, as well as its lack of discernible pulse, served as inspirations for this project's aspects of harmony and pulse.

Arguably the most famous crossing between celestial bodies and music, Gustav Holst's orchestral suite *The Planets* is a piece any composer writing about space must acknowledge. I have kept this piece close to me for years, as it was one of my largest entry points into classical music; its harmonies and musical sensibilities have informed my own in some ways. This piece also includes two female choirs in its final movement, "Neptune, The Mystic;" this choir is situated offstage during performance, so that to the audience the vocal sounds emanate from

beyond the orchestra. This idea of nonstandard choir positioning in the performance space partially informed this project's circular choir formation surrounding the audience.

Pauline Oliveros' *Sonic Meditations* were, in contrast with the Holst above, a more recent source of inspiration. The *Meditations* are text-based "scores" providing instructions for the "performance" of pieces in a group setting; these pieces are not intended to be performed in front of an audience as much as they are played by all participants in the group, for the group. The instruction-based style of the text, as well as its goals of heightened awareness and positive energy production, were influential in the composition of this project's original text.

Electronic inspirations for this project include Tangerine Dream's 1972 album *Zeit* (German: "Time") and Adam Stanović's electroacoustic work *Ten Billion* from 2018. Both of these works successfully depict vast, unfamiliar spaces through their choice of sounds and instruments.

The writings of Stephen Hawking and Carl Sagan were also influential in the conception and formulation of this project. Reading Hawking's *A Brief History of Time* in high school largely expanded my sense of cosmology. Sagan's humanist approach to studying outer space, such as that presented in *Cosmos*, greatly influenced my perspective on humanity's place in the universe.

III. Results

The Temple of Immensity is an original musical work for 16-part mixed choir and electronics based on astronomical themes; the work is twenty-eight minutes in duration. Original texts for the piece were written by the composer. The music focuses on depicting the stars closest to us in space, and conveys their primeval, colossal nature, as well as the vast distances between

them. These subjects are monumental, humbling, but ultimately terrifying for many people when ruminated upon. One of this work's intentions is to give the vastness of space a more approachable, almost tactile veneer for performers and listeners who might otherwise stray from these subjects for fear of space's emptiness. The piece argues that in space there is just as much to gravitate towards which is dynamic and in motion than there is which is bleak and static.

The choice to compose for choir is personally meaningful. One of the most rewarding aspects of singing in a choir is the notion that each performer contributes their own voice to something larger than themselves. In centering on these massive celestial spaces and objects, *The Temple of Immensity* encourages further introspection about humans being so small, yet actively contributing to the universe somehow. This introspection does not intend to encourage nihilistic spirals; members of choirs will vouch that they are groups which naturally give rise to positive emotions. A choir performing a work on these topics will imbue them with a bright outlook.

The electronics of this piece connect the work further to the practice of astronomy itself. Through centuries of technological advancements, we have incredible amounts of information on outer space, including astronomical data used to compose this piece. Using electronic sounds in this piece serves to expand the piece's sonic world beyond the traditional acoustic palette while simultaneously paying homage to the technology that has made it possible for us to observe outer space to great extents. *The Temple of Immensity*'s electronic sounds expand the choir's sonic palette and inspire ideas of massive objects and large spaces. Inspiration for these sounds were taken from experiments in data sonification, a process by which data of different forms of electronic vibrations are converted from data into soundwaves audible to human ears.

Instrumentation:

- 16-part mixed choir divided into four SATB vocal quartets
- Fixed media electronic part composed with Logic Pro and played in performance using Cycling 74's Max software

Technical requirements:

- Laptop running Cycling 74's Max software
- Audio interface
- Sound system consisting of at least two loudspeakers configured in a stereo array

IV. Methodology

1. Title

"The temple of immensity" is an archaic term that has been used infrequently across all literary periods. I discovered this phrase while exploring archaic words and forms online in January 2021; this discovery launched the conception of the resulting composition. One definition of the term reads as follows: "The universe as felt to be in every corner of it a temple consecrated to worship in with wonder and awe."[3] Another definition reads: "The universe or the complete overhead expanse of the heavens, especially as conceived as an object of religious reverence."[4] These definitions offer a sense of the state of mind this piece will give listeners and performers: wonder, awe, and reverence in relation to these giant, pre-ancient celestial objects seen in the night sky. The phrase's beauty lends it to be a wonderful entry-point for performers and listeners into the ideas this composition conveys, and the historically low

[3] Wood, Rev. James, ed. The Nuttall Encyclopedia. London: Frederick Warne and, 1920.
[4] "Temple of Immensity." Wiktionary. October 16, 2019. Accessed December 07, 2021. https://en.wiktionary.org/wiki/temple_of_immensity.

usage of the phrase ensures that its use as a composition title is unique in the field of contemporary music.

2. First Movement: the sky at night

The first movement of *The Temple of Immensity* is a prologue that serves as both an evocation of the emotions surrounding the work and a preparation for the second movement. The movement is approximately 2.5 minutes long and sets a self-composed original text:

> the sky at night –
> how much light, how many worlds,
> shine through the darkness?
> imagine flying from Earth into the plane of stars,
> flying to each drop of light –
> feel the awe as every drop
> expands to massive spans as you approach,
> and retracts to a twinkle as you depart –
> feel a kinship with the stars,
> with their profound light –
> feel the stardust in you
> glow
> with each passing star,
> and keep it with you through the darkness,
> until their radiance
> holds you again…

The entire movement utilizes Sprechgesang, a vocal technique between speech and song wherein the dramatic inflections of speech are incorporated into the technique of singing. The above text is set expressively and utilizes many different groupings of voices within the 16-part ensemble.

3. Second Movement: from earth into the plane of stars

a. Astronomical Data and Star Events

For the second movement of *The Temple of Immensity*, multiple types of astronomical data concerning the stars nearest to Earth were used to determine different musical elements. The

composer used two primary sources from which data was collected[5] [6]. My astronomy advisor Dr. Dale Smith assisted with the collection of data sources which were accurate and digestible to someone outside the professional field of astronomy. The following paragraphs will detail the relationships between astronomical data and musical elements in this piece. (See Appendix 2, Fig. 1 for a complete table of data compiled during this phase of composition.)

Of the two data sources used, one contained data up to fifteen light years away from Earth, and the other up to sixteen light years. A maximum distance of fifteen light years was determined for the composition and the compiled data. A central tenet to this work's conception was that the distance from Earth represented in the data and the music's temporal aspects would be equivalent to each other. In other words, there would be a direct correlation between a certain unit of spatial distance and a unit of musical time. The correlation for the piece was determined as follows: the fifteen light years of the piece were broken into hundredths of a light year, resulting in 1,500 hundredths of a light year. Each hundredth was correlated to one beat of the music. The tempo, the piece's direction for musical time, was assigned to 60 beats per minute, or one beat per second, meaning that one hundredth of a light year correlated to one second. 1,500 seconds equals a duration of twenty-five minutes, allowing the piece to evolve organically over time and inviting listeners and performers to fully immerse themselves in the piece's sounds, events, and abstract journey.

The primary form by which the choir contributes to the second movement is through "star events," musical events uniquely depicting each star within the aforementioned fifteen light year

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[5] Tate, Karl. "The Nearest Stars to Earth (Infographic)." Space.com. December 19, 2012. Accessed December 07, 2021. https://www.space.com/18964-the-nearest-stars-to-earth-infographic.html.
[6] Routley, Nick. "The 44 Closest Stars and How They Compare to Our Sun." Visual Capitalist. June 27, 2020. Accessed December 07, 2021. https://www.visualcapitalist.com/the-44-closest-stars-and-how-they-compare-to-our-sun/.

radius of the Earth. Each star event's temporal placement in the piece, duration, and dynamic level were assigned based on different data sets.

Data for each star's distance from Earth was approximated to two decimal places. Using the direct 1/100-light year-per-beat relationship, a manuscript prototype score was made with each page equaling twelve beats, or 0.12 light years. (See Appendix 2, Figs. 3-7 for examples from the prototype manuscript.) Preparing the manuscript with this predetermined duration allowed for star events and other notated elements to be written in the score as they were prepared throughout the compositional process. In a staff dedicated to such points, a mark was made at the point where a star's distance from Earth correlated with its relative spot in the score.

The duration of each star event was determined by its luminosity, or the amount of energy a star emits. Luminosity of a star is measured in terms of the Sun's luminosity; stars can be millions of times more or less luminous than the Sun. Within fifteen light years of Earth, stars range from 0.00004 to 25.4 times the Sun's luminosity (see Appendix 2, Fig. 1). Musically representing this accurately was beyond the boundaries of this project; the difference in duration between the most and least luminous stars would be too much for most of the smaller nearby stars to be musically perceived. A logarithmic scale was intuitively mapped following musical considerations, assigning star events a duration between four and 120 beats.

The musical dynamics (loudness or softness) of star events were determined by each star's radius, with larger stars assigned louder dynamics and smaller stars softer dynamics. As with the varying luminosities of stars, their radii spanned too wide a range for accurate musical representation, and so a logarithmic scale was again used to give each star a dynamic between fff (fortississimo, or loudest dynamic) and pp (pianissimo, or softest dynamic). This process was

also intuitive, going through trial and error to find a set of dynamics that musically imitated the logarithmic growth of star radii.

With temporal placing, durations, and dynamics set, the final necessary musical element was pitch. Harmonically, *The Temple of Immensity*'s star events follow a trajectory of chaos to order, or dissonance to consonance. For the first three star events, singers are provided a range of notes, from which they will select one, singing independently from the singers around them. The fourth star event introduces specifically notated pitches, with high harmonic ambiguity and no focus of key center. As the piece progresses, the tonality of D Major becomes an increasing focus, until the final nine star events, which use pitches solely from the key of D Major. The final star event of the piece is an extended D Major chord, finalizing the journey to order and ending the composition.

b. Aleatoric Events

Due to the results of the spatial distance-musical time correlation (see above), there are long stretches of the piece during which the choir does not sing. Out of movement two's twenty-five minute duration, the choir sings for 7.5 minutes and is silent for 17.5 minutes (see Appendix 2, Fig. 2). In the prototype manuscript, this resulted in large numbers of pages with no marks on them whatsoever. To mitigate this (and to avoid underuse of the choir), another layer of choral activity was added to the music. This secondary layer consists of select consonants that are sustained for five to ten seconds. These consonants are not precisely notated into the music as the choir's singing events are; rather, there is simply an indication as to when the events could sound, and it is up to the performers to listen carefully to all the sounds happening and contribute meaningfully. This chance-based musical technique is known as aleatoric music. The consonant-

based texture builds in density throughout the second movement, from single occurrences separated by long intervals to a dense, multi-voiced texture by the end. The consonants were separated into voiced and unvoiced categories which are used separately at different points of the movement: more unvoiced at the beginning and growing in usage of voiced as the movement continues. The available consonants are described in the International Phonetic Alphabet as fricative pulmonic consonants. (See Appendix 1, pgs. 2-3 for the complete design of aleatoric events.)

c. Notation

The score of *The Temple of Immensity* went through multiple revisions, taking considerations of legibility, understandability, and succinctness into account. For the first movement, the non-standard Sprechgesang technique had to be present in the notation throughout. Historically, Sprechgesang has been musically notated using X-shaped noteheads to contrast with the circular noteheads of standard vocal music; this notation was used for the first movement. (See Appendix 1, pgs. 4-12 to see this notation used in the final score.)

The second movement went through multiple phases of notation. The first score involved notating the star events and their midpoints. This score retained the large gaps of rest-filled pages seen in the original prototype manuscript. This was amended in the next version, which gathered groups of rests into single measures with a duration of the rest given above the music. The star events were then put into the context of a choral ensemble, and choir parts were substituted for "star event" staves in the score. The assignment of specific star events to the sixteen singers of the choir underwent many versions, searching for assignments utilizing all members of the choir as equally as possible, while also continually varying the singers being used from event to event.

Finally, pitches were added to the score, details of score layout and notation were finalized, and the movement was complete. *The Temple of Immensity* was notated using Avid Technology's software Sibelius.

4. Electronics

The Temple of Immensity's electronics are a constant element in the second movement, humming underneath the choir's star and aleatoric events. They were composed using Apple's Logic Pro X software, primarily using the software synthesizer Alchemy. Numerous layers comprise each composite sound, with each layer creating different textures. For instance, one provides primarily low, rumbling sounds; another provides mid-range wind-reminiscent sounds; and a third provides a variety of mid- to high-range textures. Each layer has multiple instruments that enter then fade one after the other using time scales unique to each layer. The result is a constantly morphing group of sounds, with never the exact same sounds happening twice. Another layer of sounds serves the purpose of doubling the choir and providing cueing pitches just before their entrances.

Once complete, all the synthesizer parts were exported out of Logic as one large sound file. Cycling 74's Max software was used to build a patch that will play the sound file when triggered, as well as provide a timer and cueing system for the conductor or other performer controlling the electronics.

V. Results and Conclusions

The Temple of Immensity strives to give listeners and performers the opportunity to pause and reflect on their place in the world and the stars. The music allows them to be at peace with

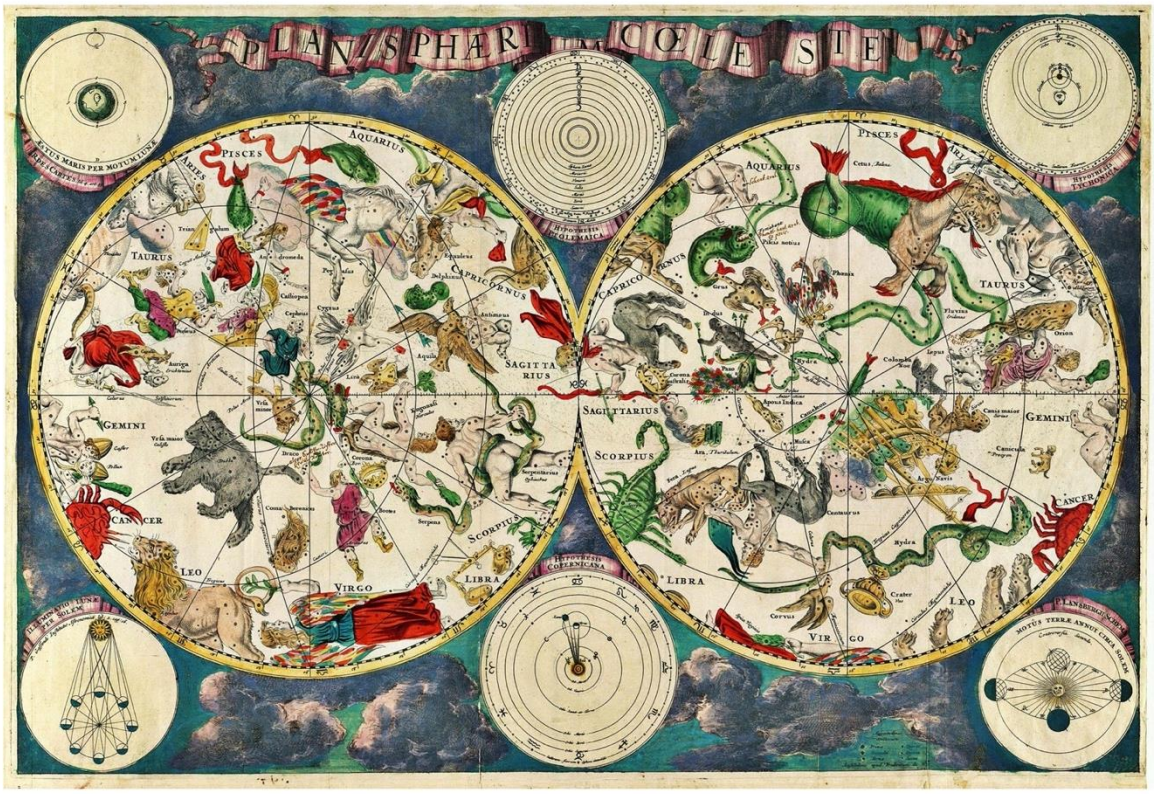
space's gigantic scope, and to feel wonder and joy at the daily opportunity to observe the incredible universe. This composition is the longest single piece I have written (my second longest single piece is half this length) and is my first compositional endeavor to include both the mediums of choir and electronics in one piece. I plan to have this piece performed on my senior composition recital, scheduled for February 26, 2022, with a gathered ensemble of 16 singers and a conductor performing the piece; this will be the largest ensemble I have ever gathered to perform a piece of mine.

The Temple of Immensity is a gateway into further compositions occupying a cross-disciplinary territory between the sciences and the arts. Astronomy is a highly inspiring subject; there are many other aspects of outer space that I plan to musically depict in future composition projects. Creating music inspired and influenced by astronomy brings the subject closer to performers and listeners, making the subject matter more approachable on its own terms. My colleague Eli Chambers, writing about the emergence of a particular strain of 20th century classical music focusing on the environment and ecology, notes that music makes such topics far more accessible to wider audiences than charts of data can. The same is true of astronomy and cosmology: although one can attempt imagining the astronomical sizes and distances written about in textbooks, it is ultimately an impossible task. Music has the capacity to take people soaring above the mundane and give them an experience outside their normal experience of time. I attempt doing so with this piece, creating a multidisciplinary project and a striking musical experience.

Appendix 1: Full Score

the temple of immensity

Steven Naylor



for 16-part mixed choir and electronics

duration: 28 mins.

2021

2

Performance Notes

Mvt. 1: the sky at night
This movement serves as the piece's prologue and consists entirely of Sprechgesang vocal technique. X-shaped noteheads indicate an approximate pitch the singer should vocalize on for that note. The movement's text serves as both an evocation of the emotions surrounding this work, and a preparation for the second movement.

the sky at night –
how much light, how many worlds,
shine through the darkness?
imagine flying from Earth into the plane of stars,
flying to each drop of light –
feel the awe as every drop
expands to massive spans as you approach,
and retracts to a twinkle as you depart –
feel a kinship with the stars,
with their profound light –
feel the stardust in you
glow
with each passing star,
and keep it with you through the darkness,
until their radiance
holds you again…

Mvt. 2: from earth into the plane of stars
In this movement the choir contributes in two ways: star events and aleatoric events.

Star Events
For each star event, a group of singers in the ensemble are grouped together to sonically represent approaching and leaving a star. Each event involves a crescendo from pppp (practically niente) to a peak dynamic, and back to pppp. Each event also involves singing on modulating vowels, moving from closed vowels (such as u) in the quieter dynamics to open vowels (such as a and ɑ) in the louder dynamics. For the first few star events, singers choose their own pitches from a given range. Listen around the ensemble and contribute a pitch you do not hear being sung.

Aleatoric Events
As the piece progresses, there gradually accumulates a layer of sustained consonants, primarily improvised by the choir in aleatoric fashion. Below is a list of guidelines for the aleatory. Each "aleatoric event" is about 5-10 seconds in duration.

Aleatoric Event Design
- Designate individual choir members to give unvoiced, static events at 1:40, 2:30, 3:15, 3:55, 4:30, 5:00, 5:25, 5:45, 6:03, 6:19, 6:33, and 6:45. Avoid two adjacent singers performing two adjacent events.
- At Rehearsal B, the events are free to the whole choir.
  - One event every 10-15 seconds. Only static, unvoiced sounds.
- At Rehearsal C:
  - One event every 5-10 seconds. Slight overlap between some events. Mostly static, some modulating sounds; all unvoiced.
- At m. 56 (1 before Rehearsal F):
  - More consistent overlap between events. Half static, half modulating sounds. Gradually introduce voiced sounds, based on pitches of D Major scale.
- At Rehearsal K:
  - Constant, multilayered texture. Mostly modulating sounds. Increasingly more voiced sounds, as D Major is reached.

"Static" refers to remaining constant in sound or pitch.
"Modulating" refers to changing in sound or pitch.

Sounds available for choir to choose from:
Fricative pulmonic consonants (visit https://www.ipachart.com to hear examples)

Unvoiced	Voiced	
ɸ	β	bilabial
f	v	labiodental
θ	ð	dental
s	z	alveolar
ʃ	ʒ	post alveolar
ʂ	ʐ	retro flex
ç	ʝ	palatal
x	ɣ	velar
χ	ʁ	uvular
ħ	ʕ	pharyngeal
h	ɦ	glottal

Technical requirements

- Computer/Laptop running Cycling 74's Max software
- Audio interface
- Sound system consisting of at least two loudspeakers configured in a stereo array

Program Notes

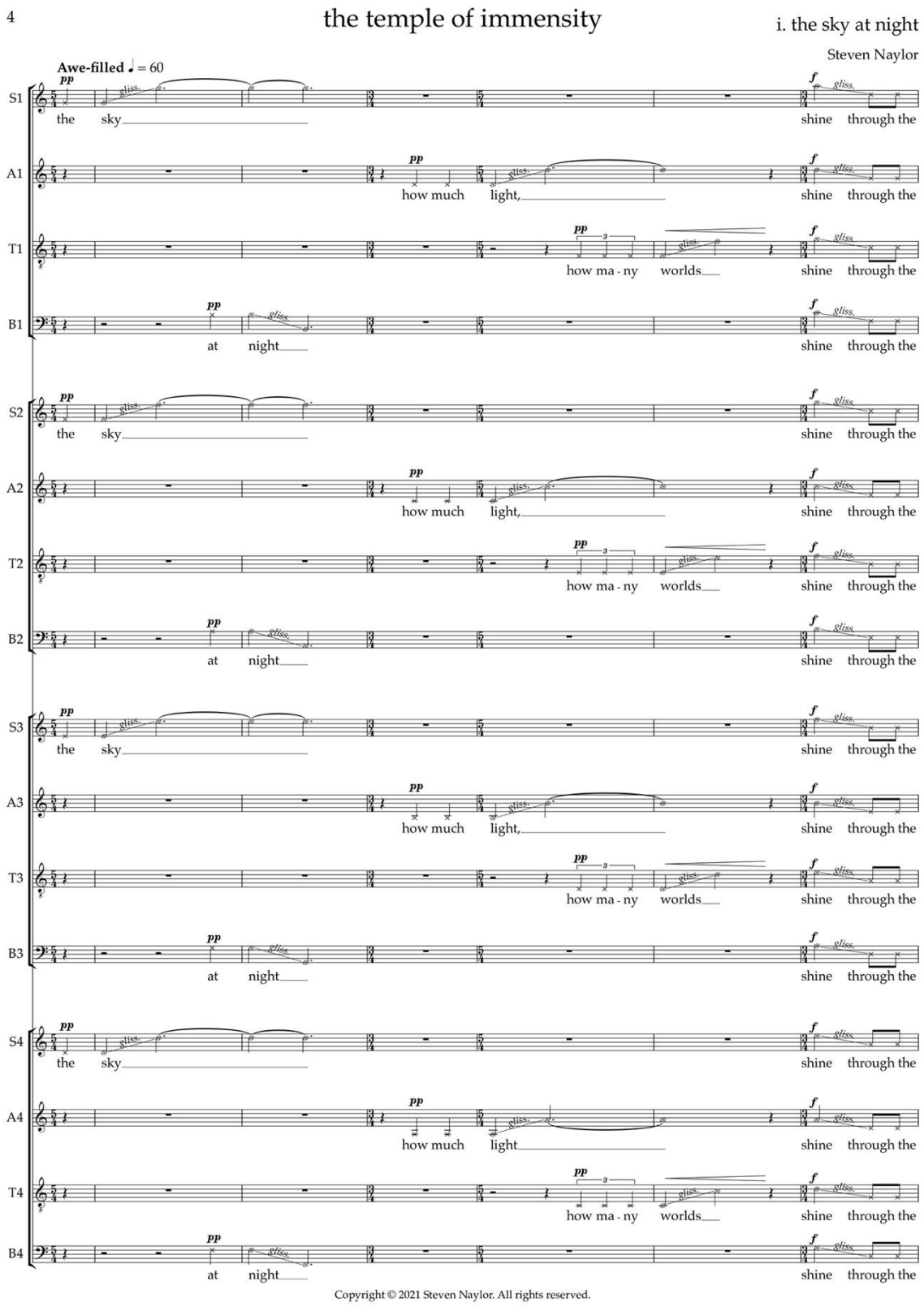
"The temple of immensity" is an archaic term; one definition reads: "the universe or the complete overhead expanse of the heavens, especially as conceived as an object of religious reverence" (Wiktionary). Another definition reads: "The universe as felt to be in every corner of it a temple consecrated to worship in with wonder and awe" (The Nuttall Encyclopedia, 1907). This piece is ultimately about looking at all the universe with wonder, awe, and reverence.

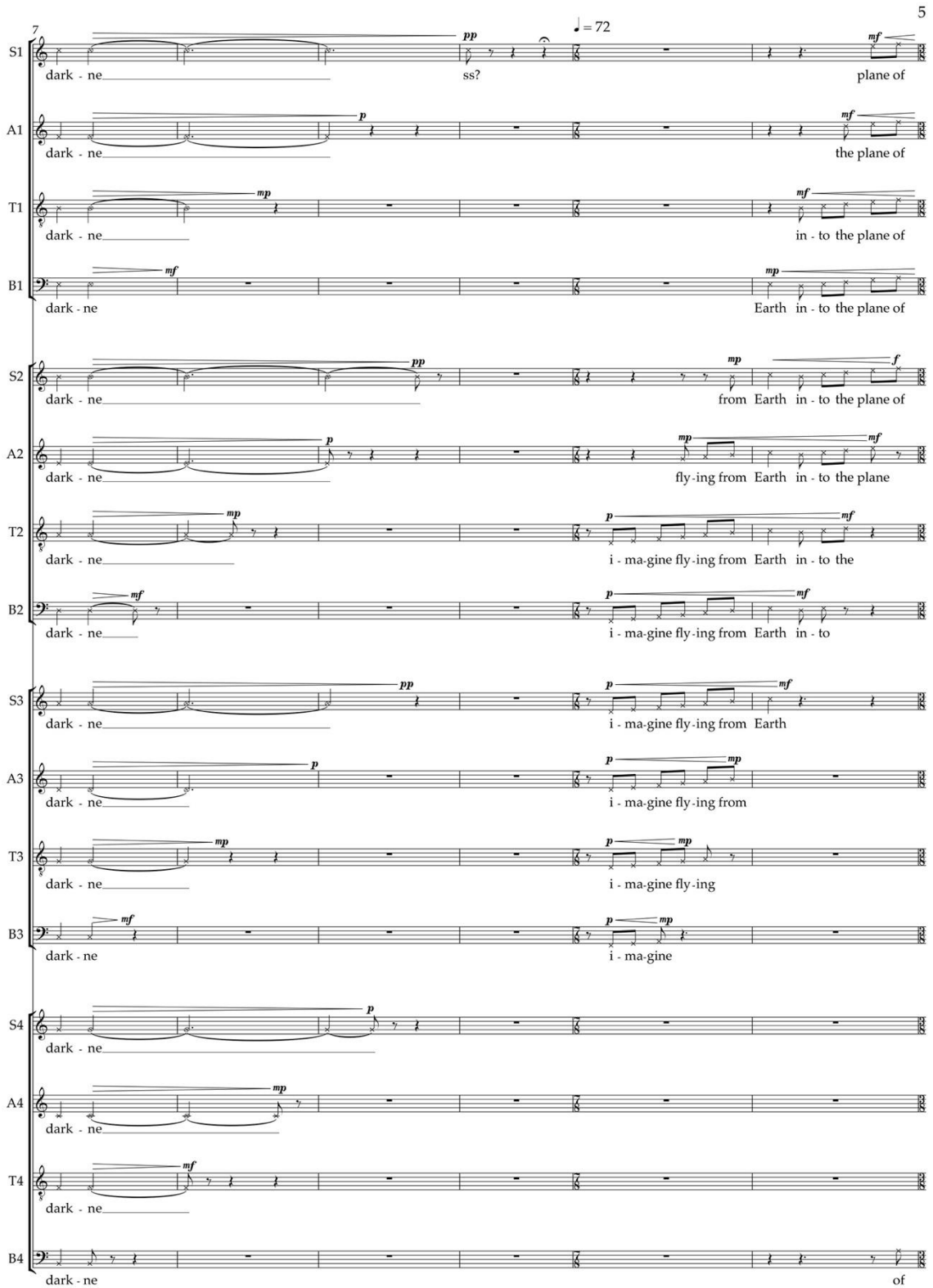
This piece is for 16-voice mixed choir and electronics. I think of the piece as quasi-antiphonal; in performance, the choir should ideally encircle the audience. The electronic sounds were composed in Logic Pro X, which are triggered in performance using a patch built in Cycling 74's Max software.

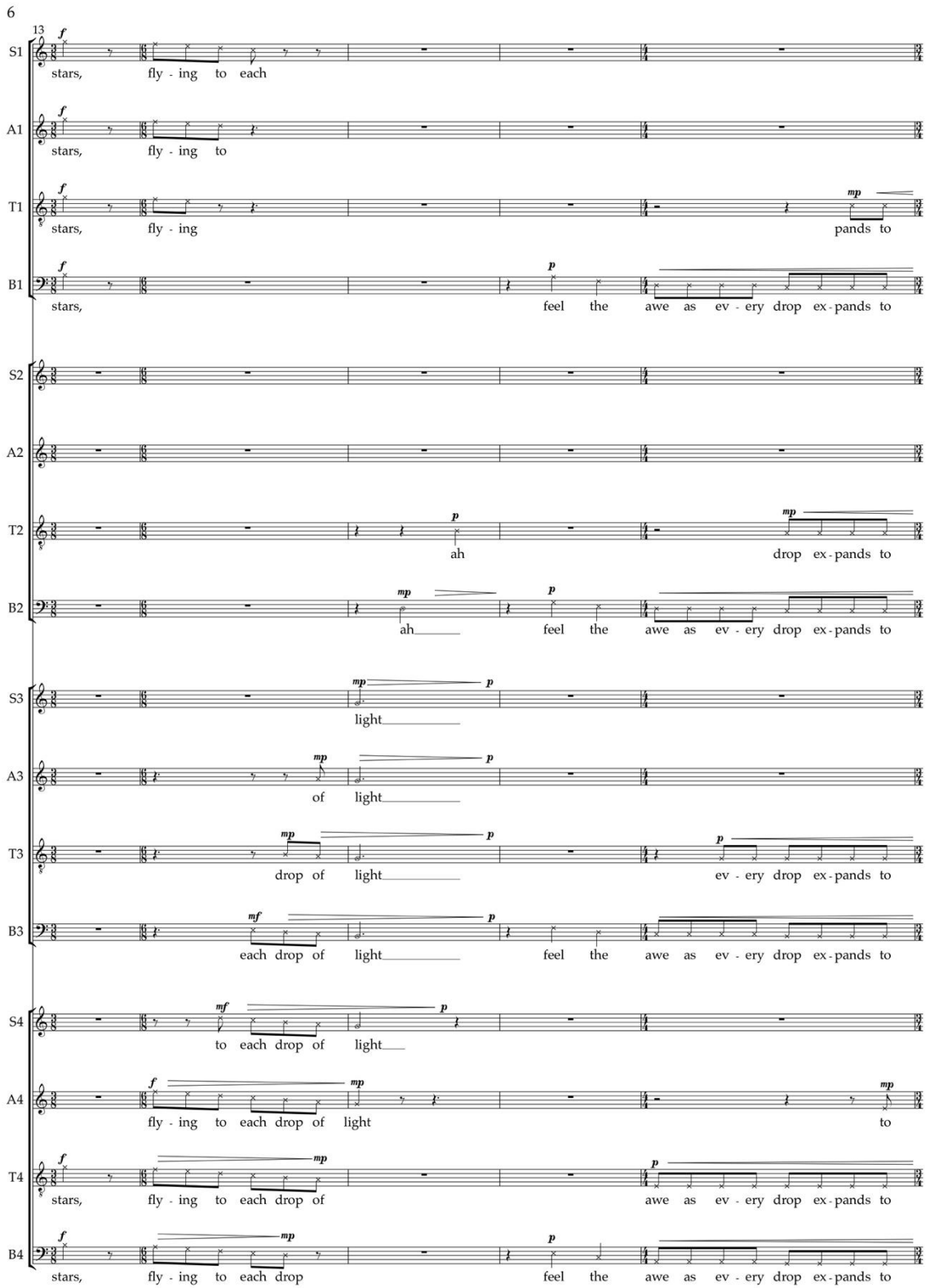
The piece is in two movements: a prologue, and a long movement in which I have used astronomical data to determine many musical attributes; in a sense, I have set astronomical data to music. The very start of this second movement correlates with the starting position of Earth. Then we conceptually travel outwards from Earth into outer space at a constant speed. For every star observed in space, there is a corresponding musical event in the piece, placed in a specific temporal spot. Other data types determine musical factors as well: data of each star's distance from Earth correlates to the peak of each "star event" in the piece. Data of each star's radius correlates with the dynamic peak of each star event. Data of each star's luminosity correlates with each star event's duration.

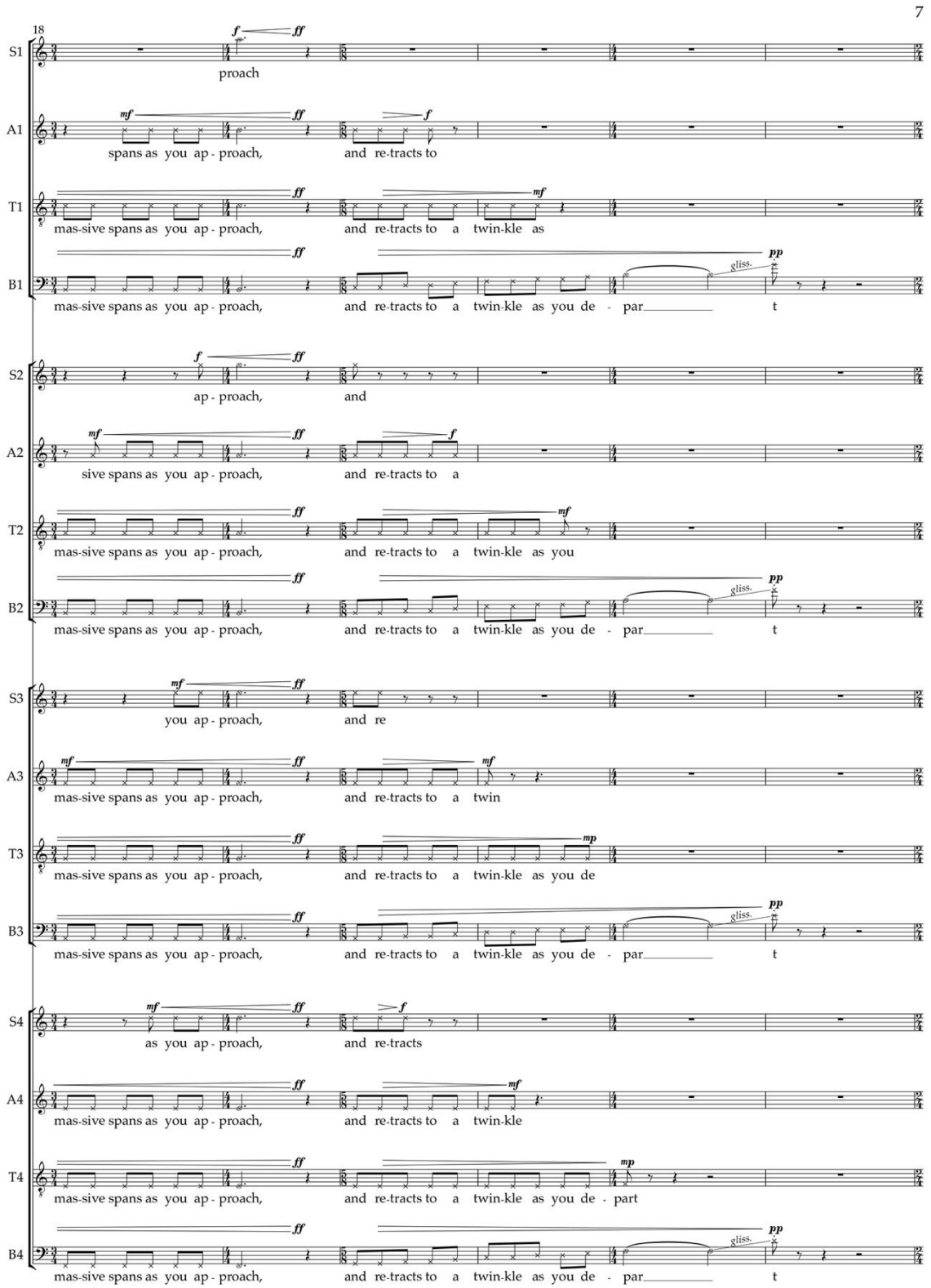
It is my hope that the scientific underpinning of these musical decisions helps the audience to see our small part of the universe in a different light. There are 50 stars represented in this piece. Astronomers estimate there are about 100 billion stars in the Milky Way Galaxy, and recent estimations say there are two trillion galaxies in the observable universe. I've barely scratched the surface of what a musical depiction of our Universe might look like, but I hope to continue working with similar musical experiments in my work.

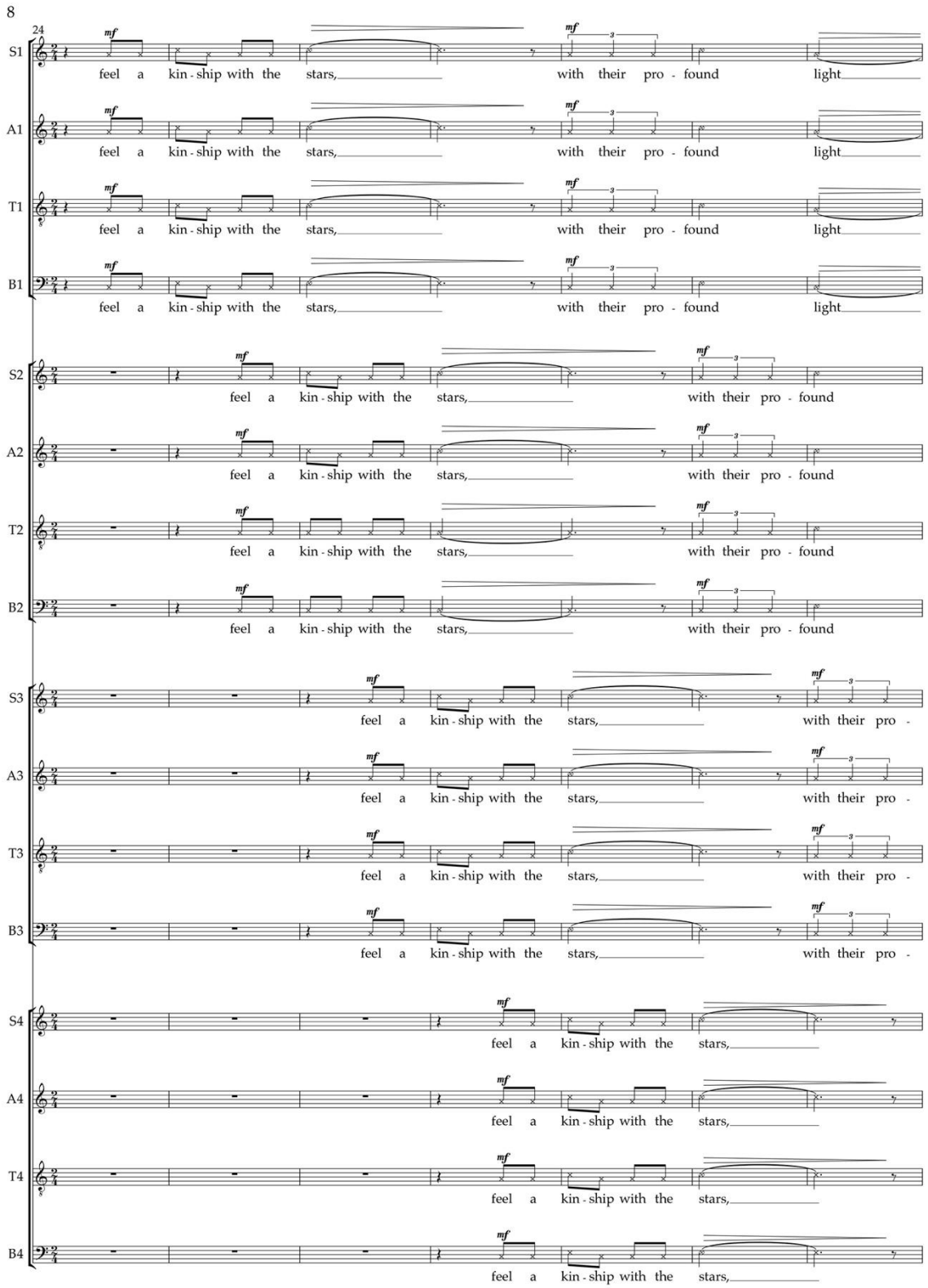
Title image: a celestial map made in 1670 by Dutch cartographer Frederik de Wit.

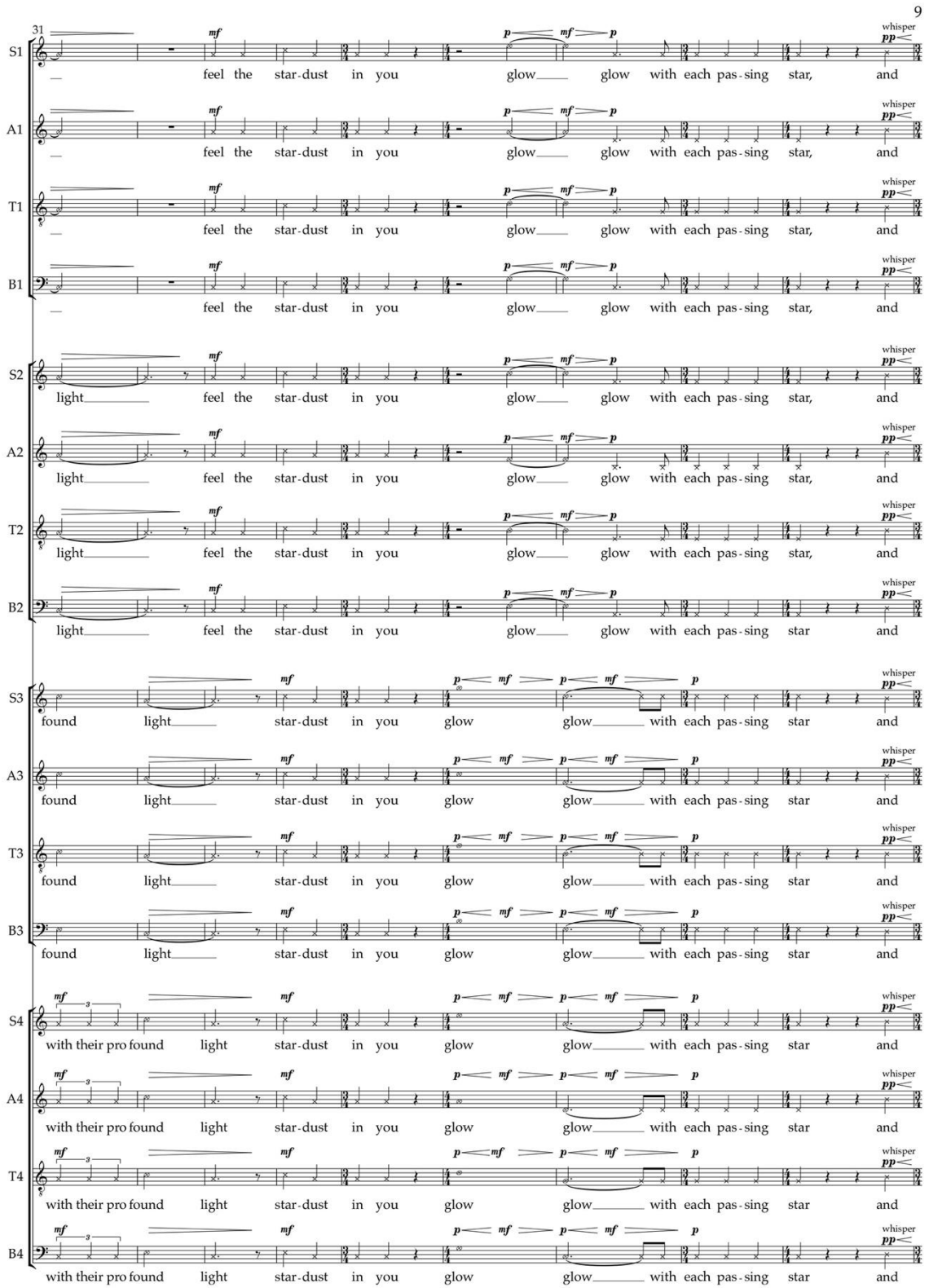


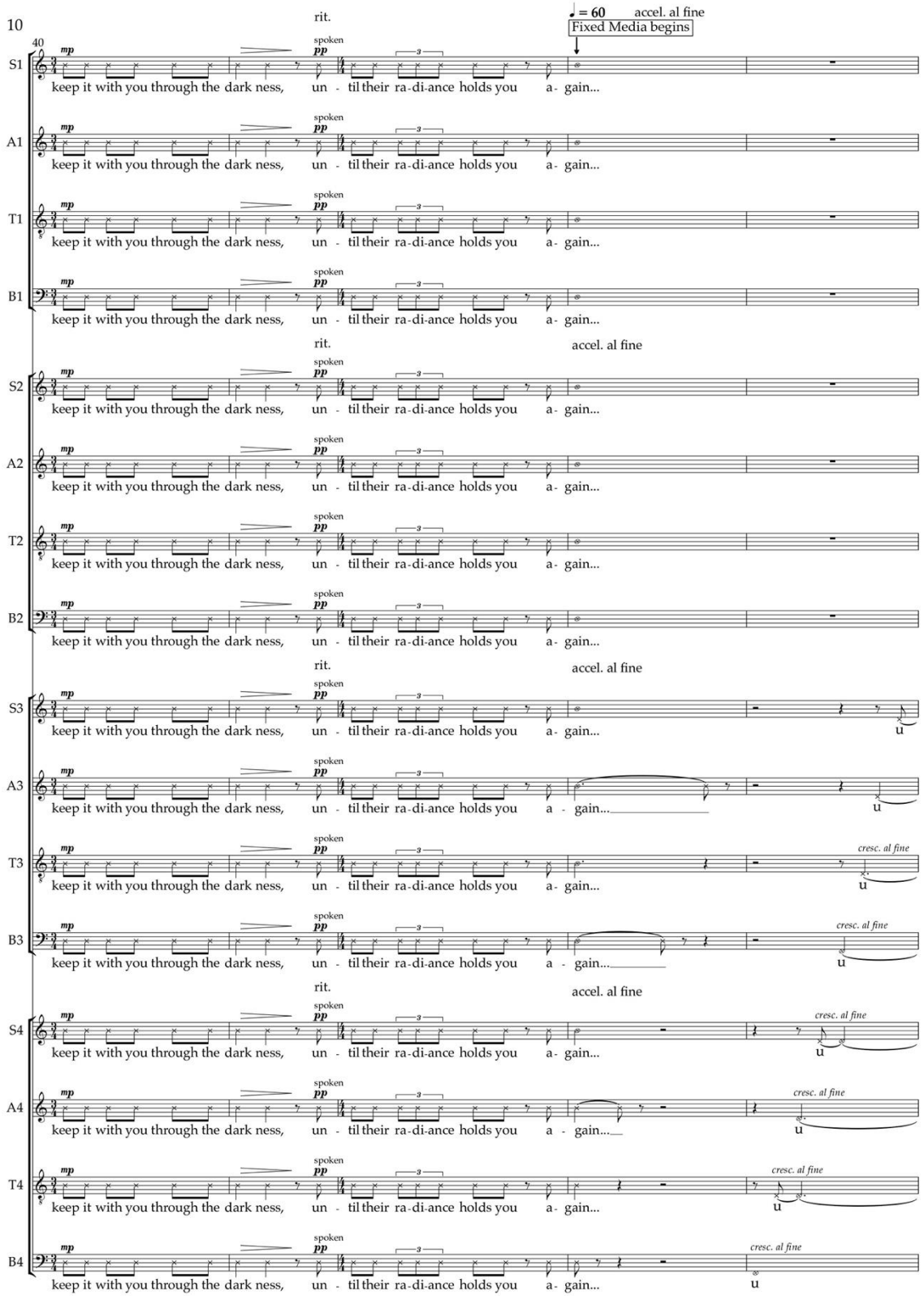

5
7
♩ = 72
S1
dark - ne
ss?
plane of
A1
dark - ne
the plane of
T1
dark - ne
in - to the plane of
B1
dark - ne
Earth in - to the plane of
S2
dark - ne
from Earth in - to the plane of
A2
dark - ne
fly - ing from Earth in - to the plane
T2
dark - ne
i - ma - gine fly - ing from Earth in - to the
B2
dark - ne
i - ma - gine fly - ing from Earth in - to
S3
dark - ne
i - ma - gine fly - ing from Earth
A3
dark - ne
i - ma - gine fly - ing from
T3
dark - ne
i - ma - gine fly - ing
B3
dark - ne
i - ma - gine
S4
dark - ne
A4
dark - ne
T4
dark - ne
B4
dark - ne
of

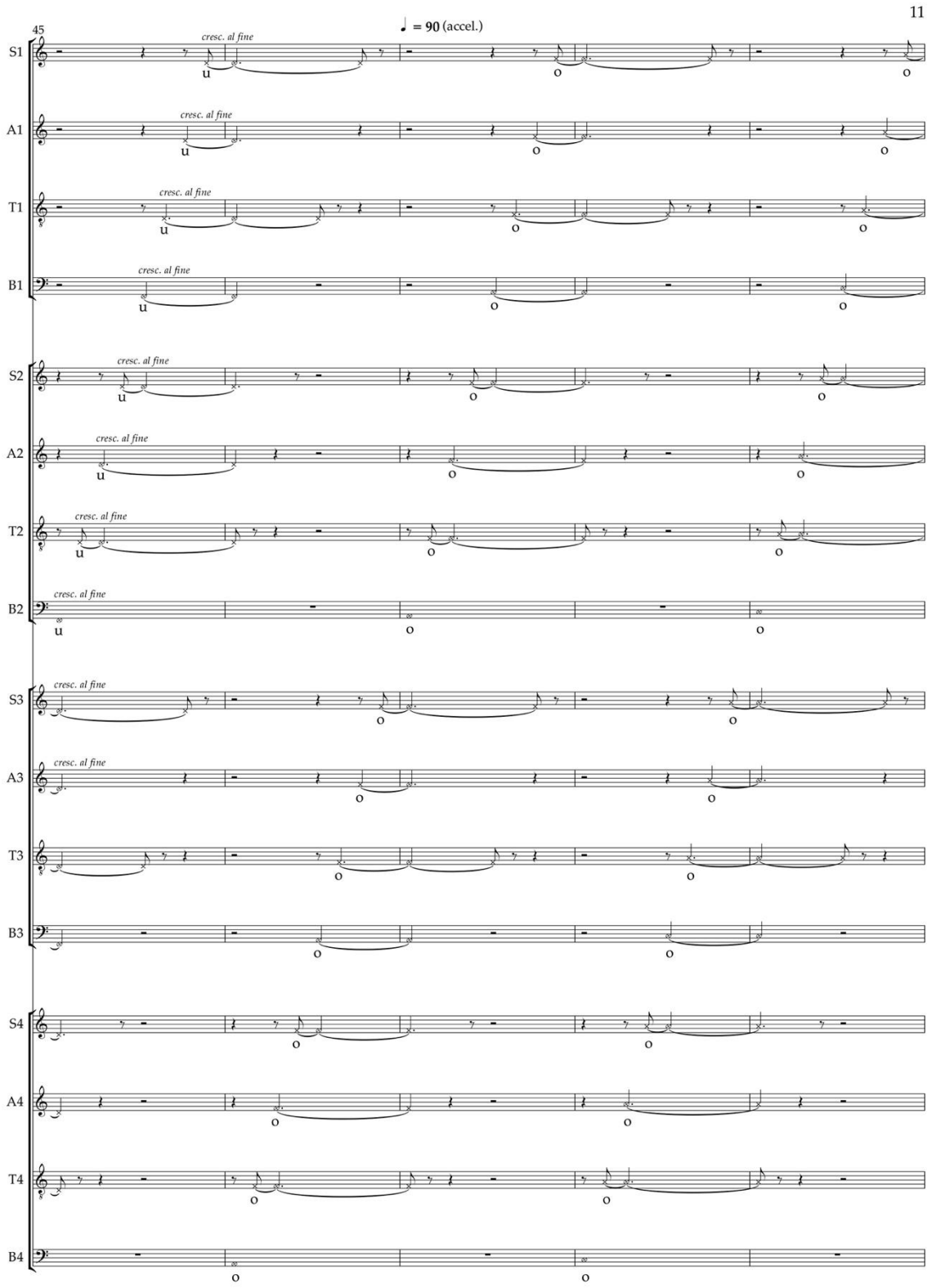

6
13
S1
stars, fly - ing to each
A1
stars, fly - ing to
T1
stars, fly - ing pands to
B1
stars, feel the awe as ev - ery drop ex - pands to
S2
A2
T2
ah drop ex - pands to
B2
ah feel the awe as ev - ery drop ex - pands to
S3
light
A3
of light
T3
drop of light ev - ery drop ex - pands to
B3
each drop of light feel the awe as ev - ery drop ex - pands to
S4
to each drop of light
A4
fly - ing to each drop of light to
T4
stars, fly - ing to each drop of awe as ev - ery drop ex - pands to
B4
stars, fly - ing to each drop feel the awe as ev - ery drop ex - pands to

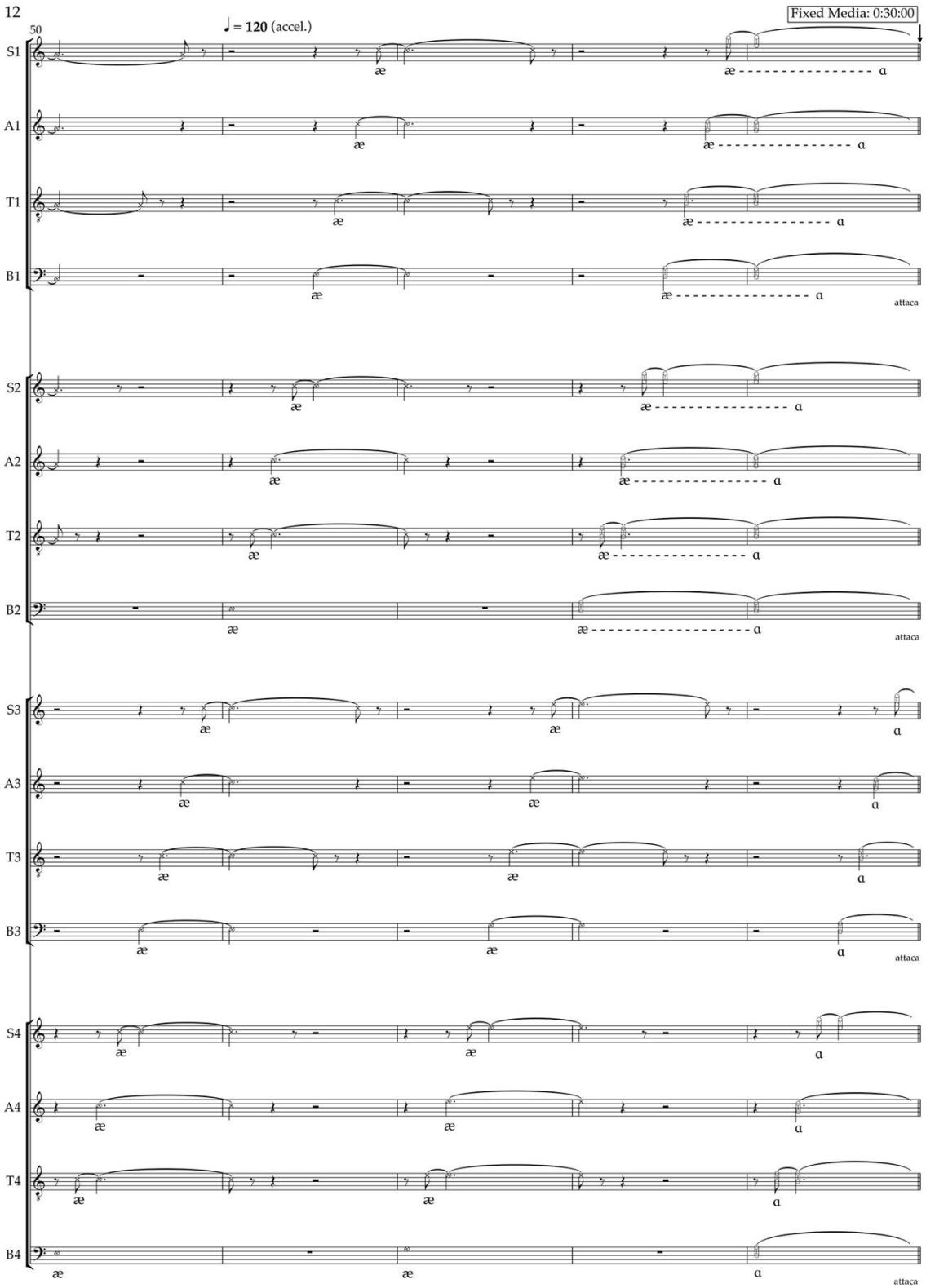

7
18
S1
proach
A1
spans as you ap - proach, and re-tracts to
T1
mas-sive spans as you ap - proach, and re-tracts to a twin-kle as
B1
mas-sive spans as you ap - proach, and re-tracts to a twin-kle as you de - par t
S2
ap - proach, and
A2
sive spans as you ap - proach, and re-tracts to a
T2
mas-sive spans as you ap - proach, and re-tracts to a twin-kle as you
B2
mas-sive spans as you ap - proach, and re-tracts to a twin-kle as you de - par t
S3
you ap - proach, and re
A3
mas-sive spans as you ap - proach, and re-tracts to a twin
T3
mas-sive spans as you ap - proach, and re-tracts to a twin-kle as you de
B3
mas-sive spans as you ap - proach, and re-tracts to a twin-kle as you de - par t
S4
as you ap - proach, and re-tracts
A4
mas-sive spans as you ap - proach, and re-tracts to a twin-kle
T4
mas-sive spans as you ap - proach, and re-tracts to a twin-kle as you de - part
B4
mas-sive spans as you ap - proach, and re-tracts to a twin-kle as you de - par t
gliss.

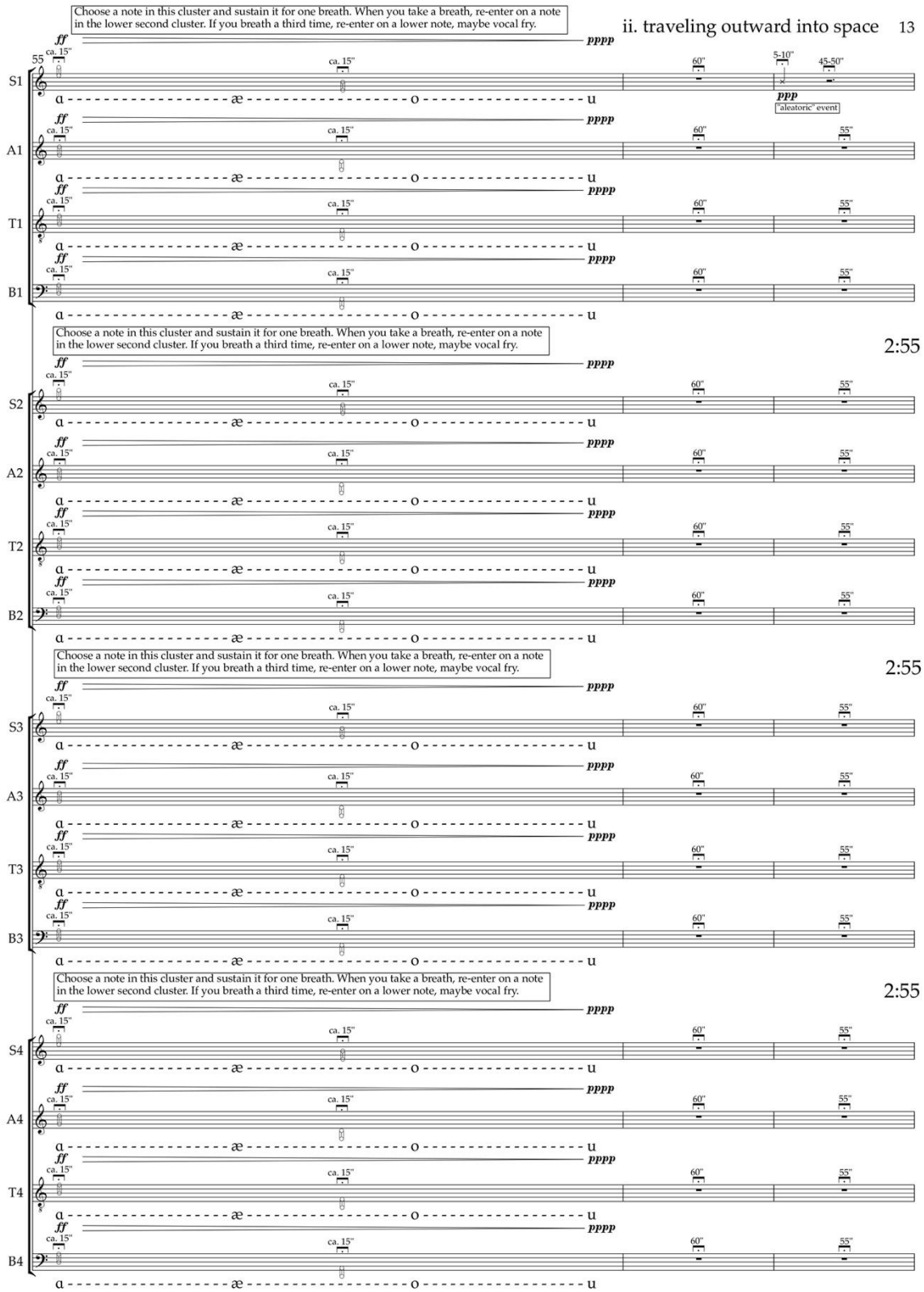

8
24
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
mf
feel a kin - ship with the stars,
with their pro - found light
with their pro -

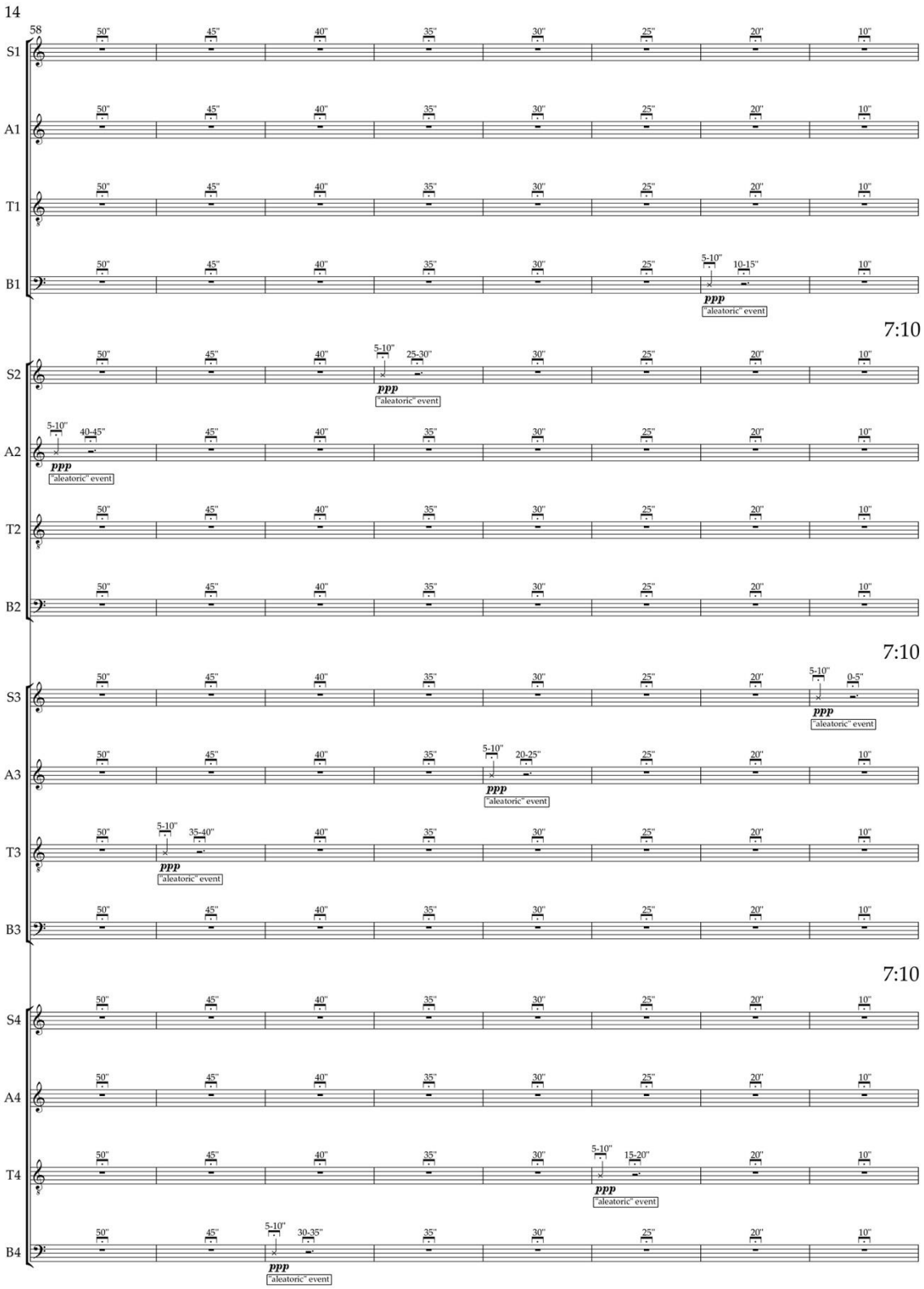

9
31
S1
feel the star-dust in you glow glow with each pas-sing star, and
A1
feel the star-dust in you glow glow with each pas-sing star, and
T1
feel the star-dust in you glow glow with each pas-sing star, and
B1
feel the star-dust in you glow glow with each pas-sing star, and
S2
light feel the star-dust in you glow glow with each pas-sing star, and
A2
light feel the star-dust in you glow glow with each pas-sing star, and
T2
light feel the star-dust in you glow glow with each pas-sing star, and
B2
light feel the star-dust in you glow glow with each pas-sing star and
S3
found light star-dust in you glow glow with each pas-sing star and
A3
found light star-dust in you glow glow with each pas-sing star and
T3
found light star-dust in you glow glow with each pas-sing star and
B3
found light star-dust in you glow glow with each pas-sing star and
S4
with their pro found light star-dust in you glow glow with each pas-sing star and
A4
with their pro found light star-dust in you glow glow with each pas-sing star and
T4
with their pro found light star-dust in you glow glow with each pas-sing star and
B4
with their pro found light star-dust in you glow glow with each pas-sing star and

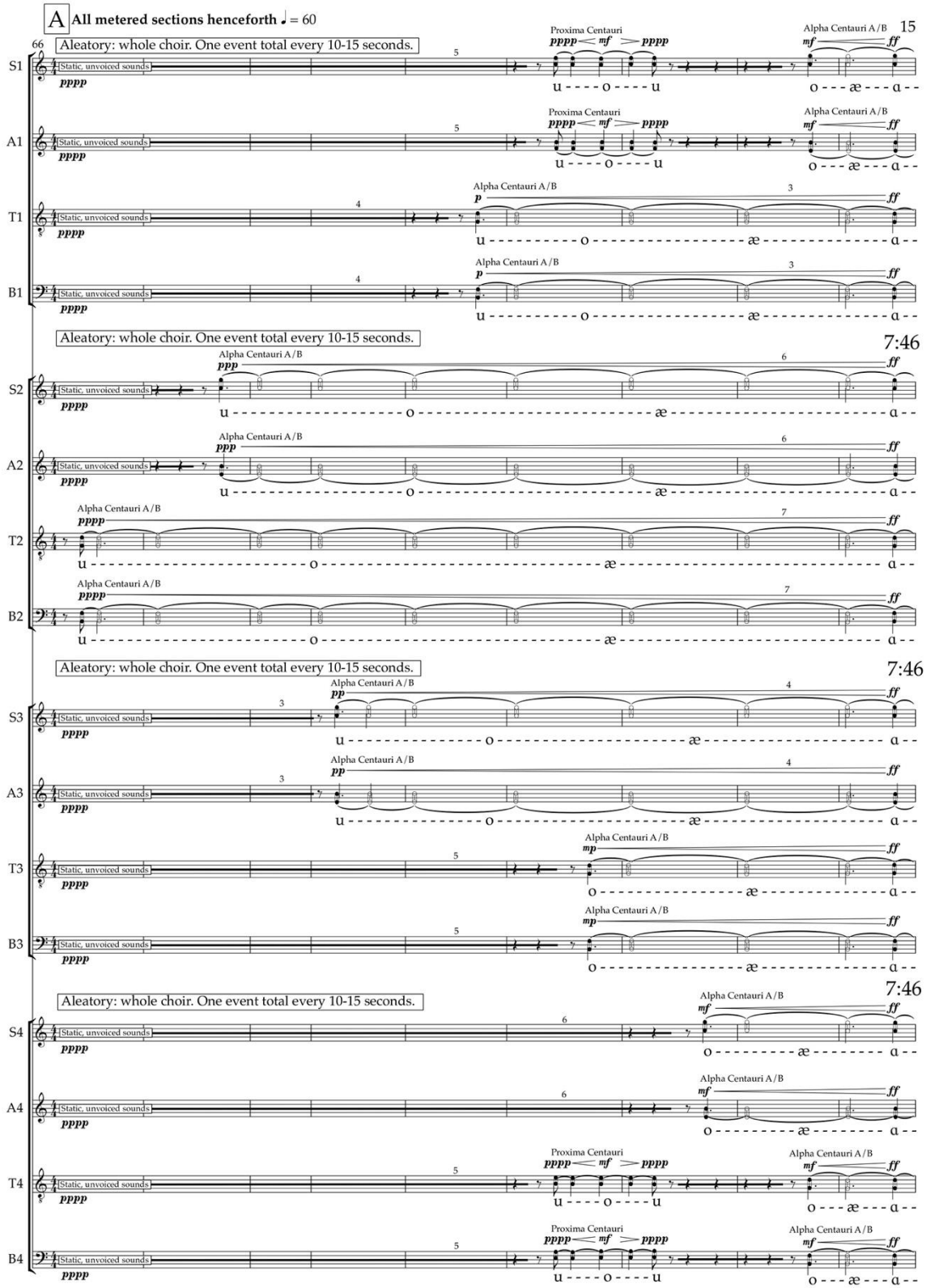

10
40
rit.
♩ = 60 accel. al fine
Fixed Media begins
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
mp
spoken
pp
keep it with you through the dark ness, un - til their ra-di-ance holds you a- gain...
a - gain...
cresc. al fine
u

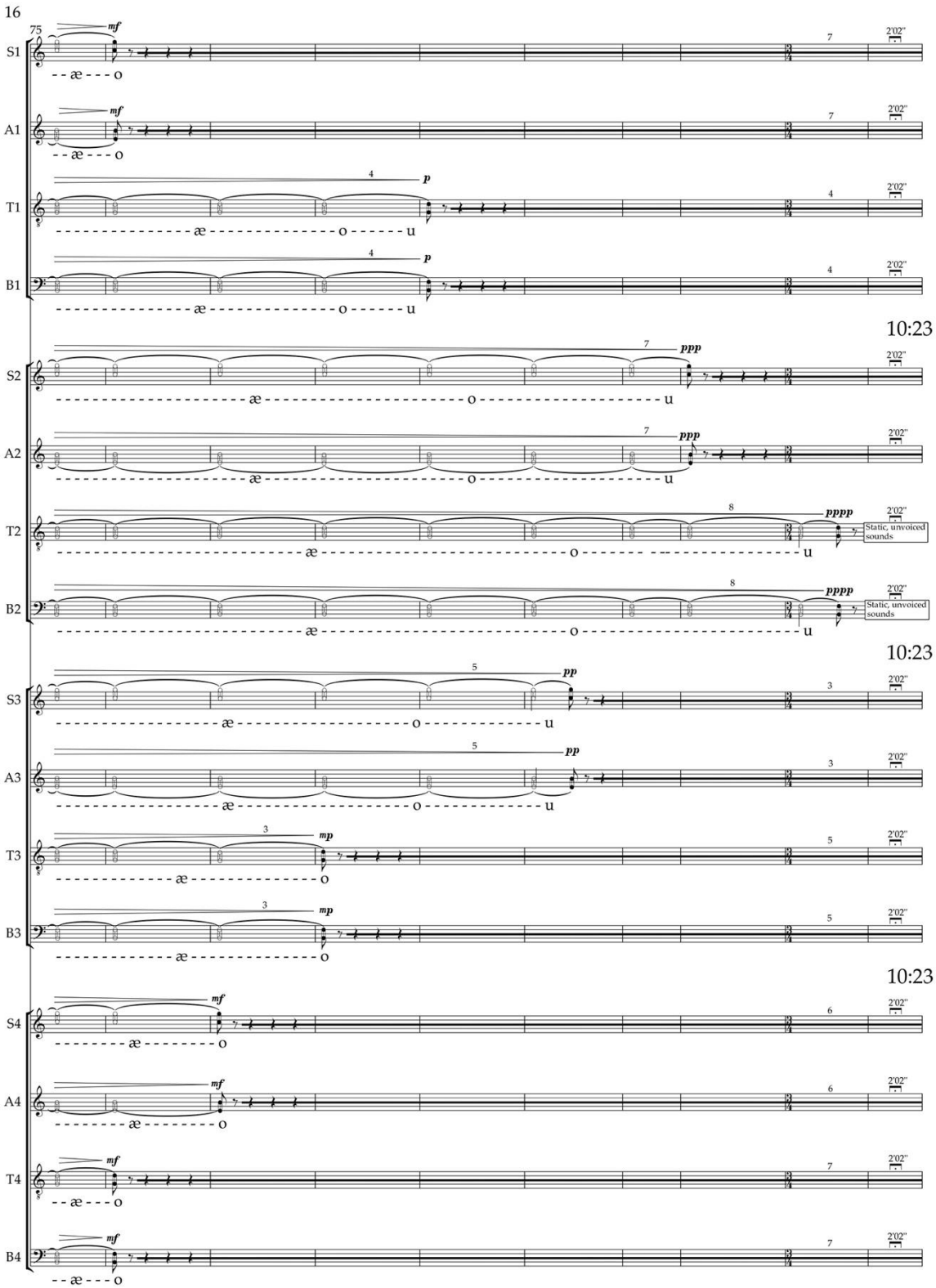

11
45
♩ = 90 (accel.)
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
cresc. al fine
u
o

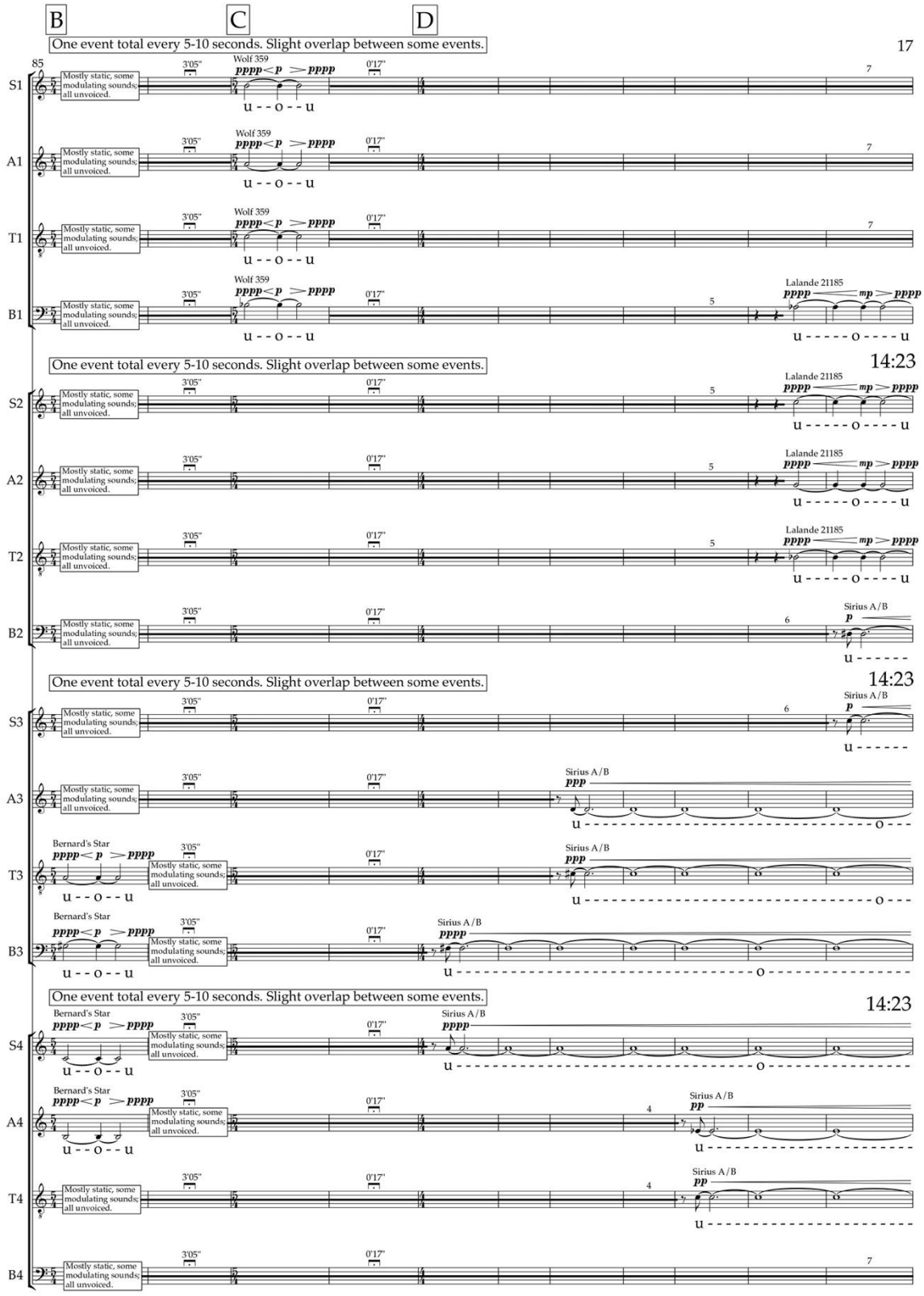

12
50
♩ = 120 (accel.)
Fixed Media: 0:30:00
S1
A1
T1
B1
attaca
S2
A2
T2
B2
attaca
S3
A3
T3
B3
attaca
S4
A4
T4
B4
attaca
æ
ɑ

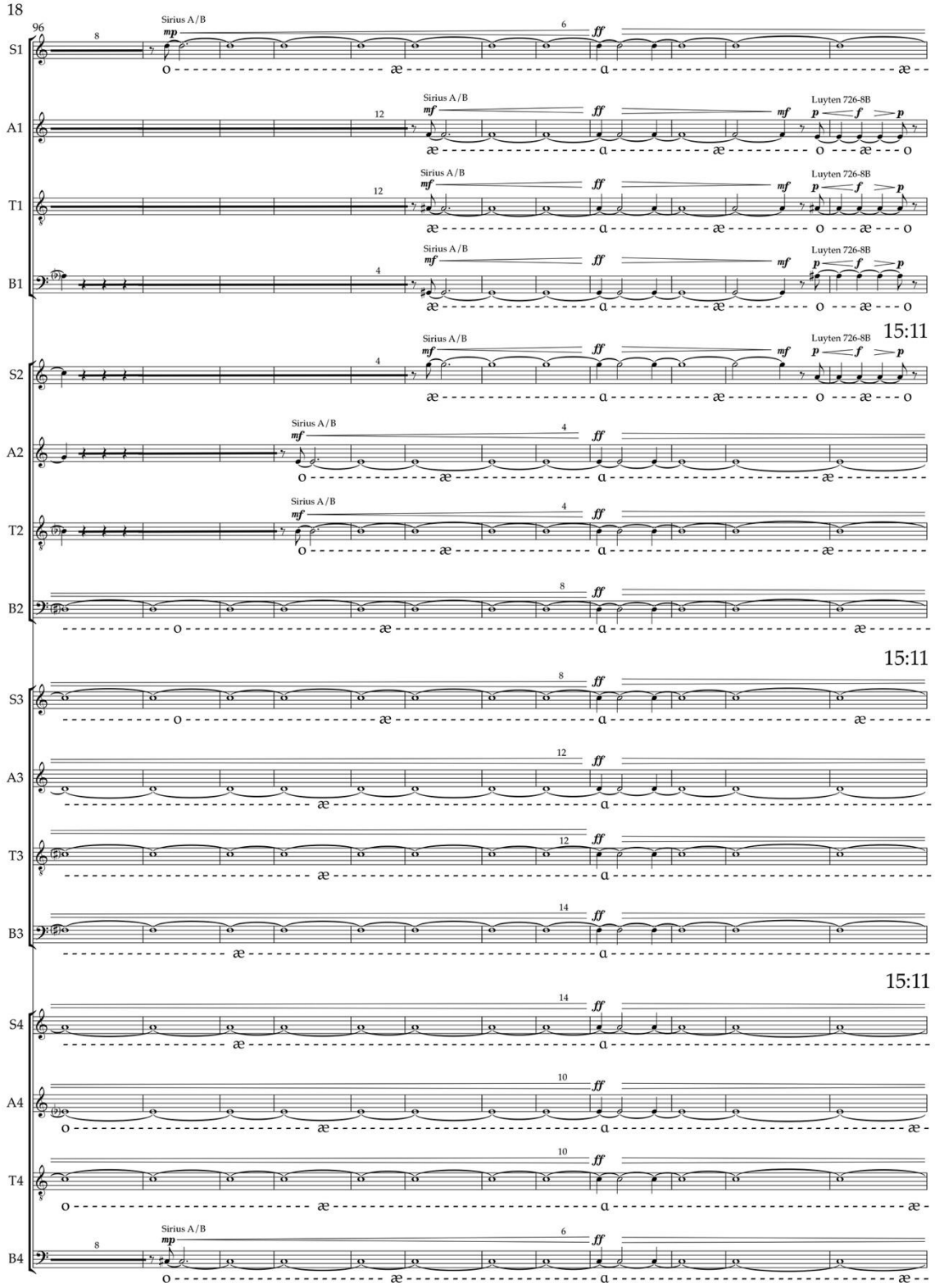

Choose a note in this cluster and sustain it for one breath. When you take a breath, re-enter on a note in the lower second cluster. If you breath a third time, re-enter on a lower note, maybe vocal fry.
ii. traveling outward into space
13
55
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
ff
pppp
ca. 15"
60"
55"
45-50"
5-10"
ppp
"aleatoric" event
a æ o u
2:55

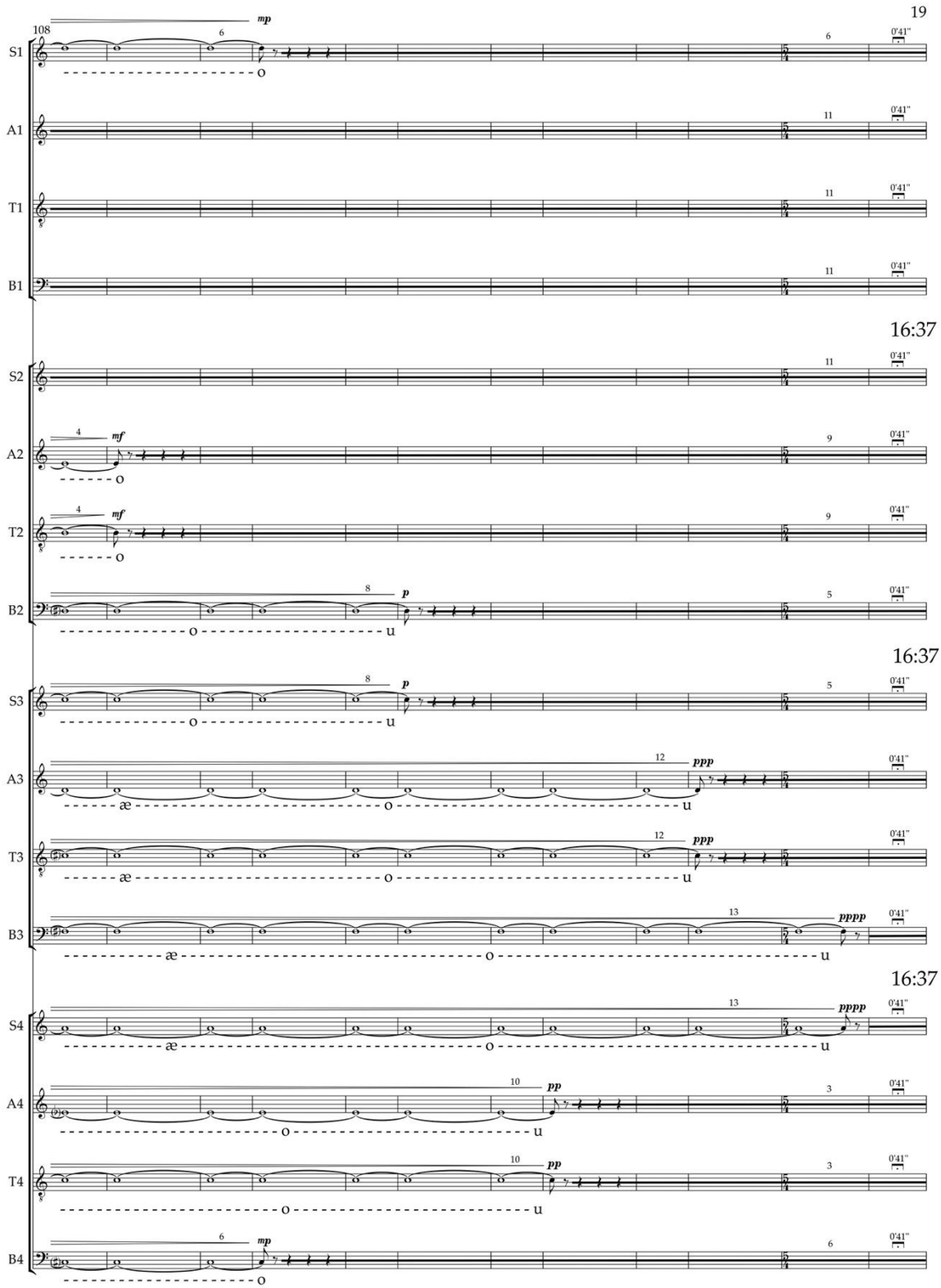

14
58
S1
A1
T1
B1
7:10
S2
A2
T2
B2
7:10
S3
A3
T3
B3
7:10
S4
A4
T4
B4
50"
45"
40"
35"
30"
25"
20"
10"
5-10"
10-15"
25-30"
40-45"
0-5"
20-25"
35-40"
15-20"
30-35"
ppp
"aleatoric" event

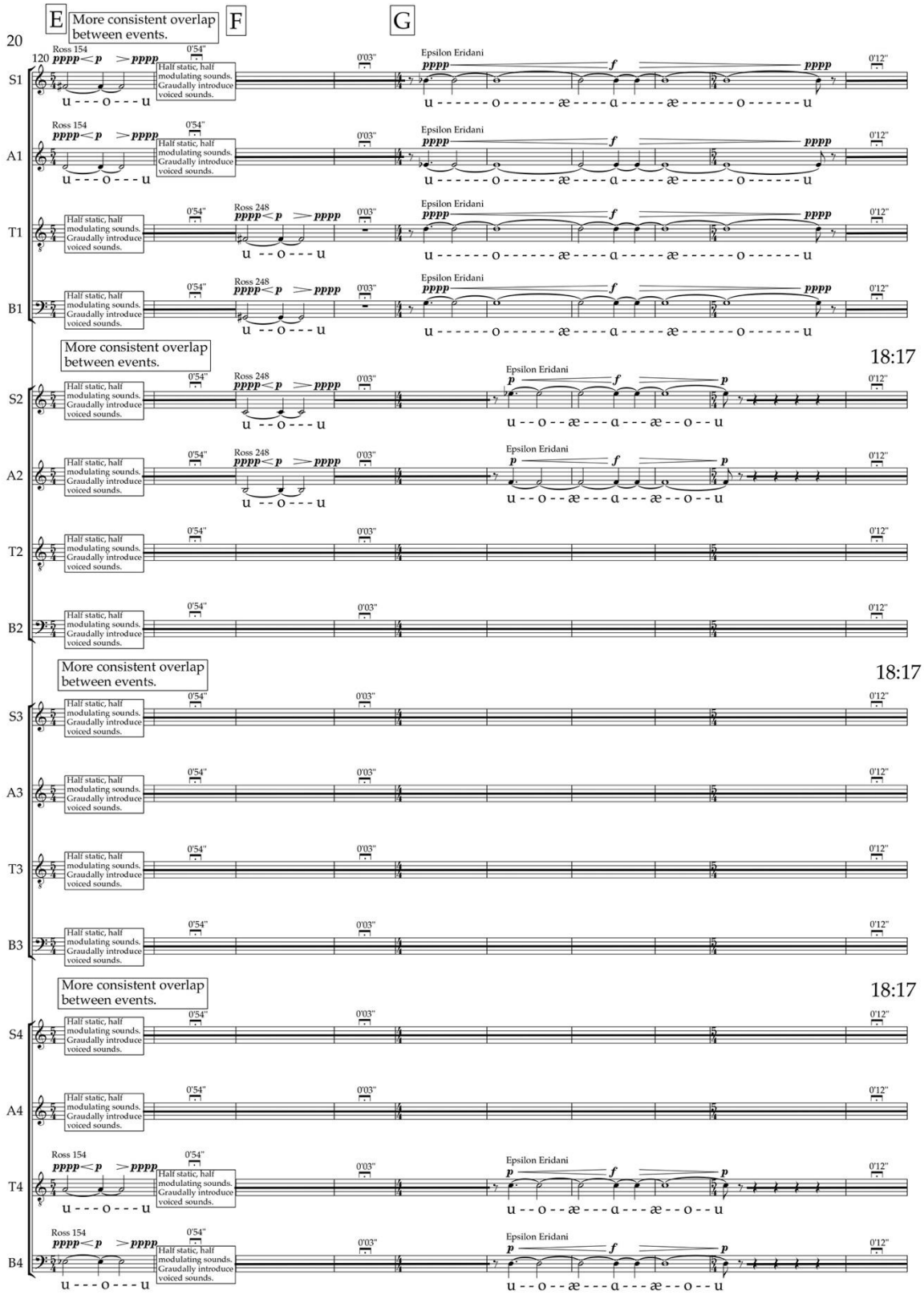

A All metered sections henceforth ♩ = 60
66
15
Aleatory: whole choir. One event total every 10-15 seconds.
Proxima Centauri
Alpha Centauri A/B
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
Static, unvoiced sounds
7:46

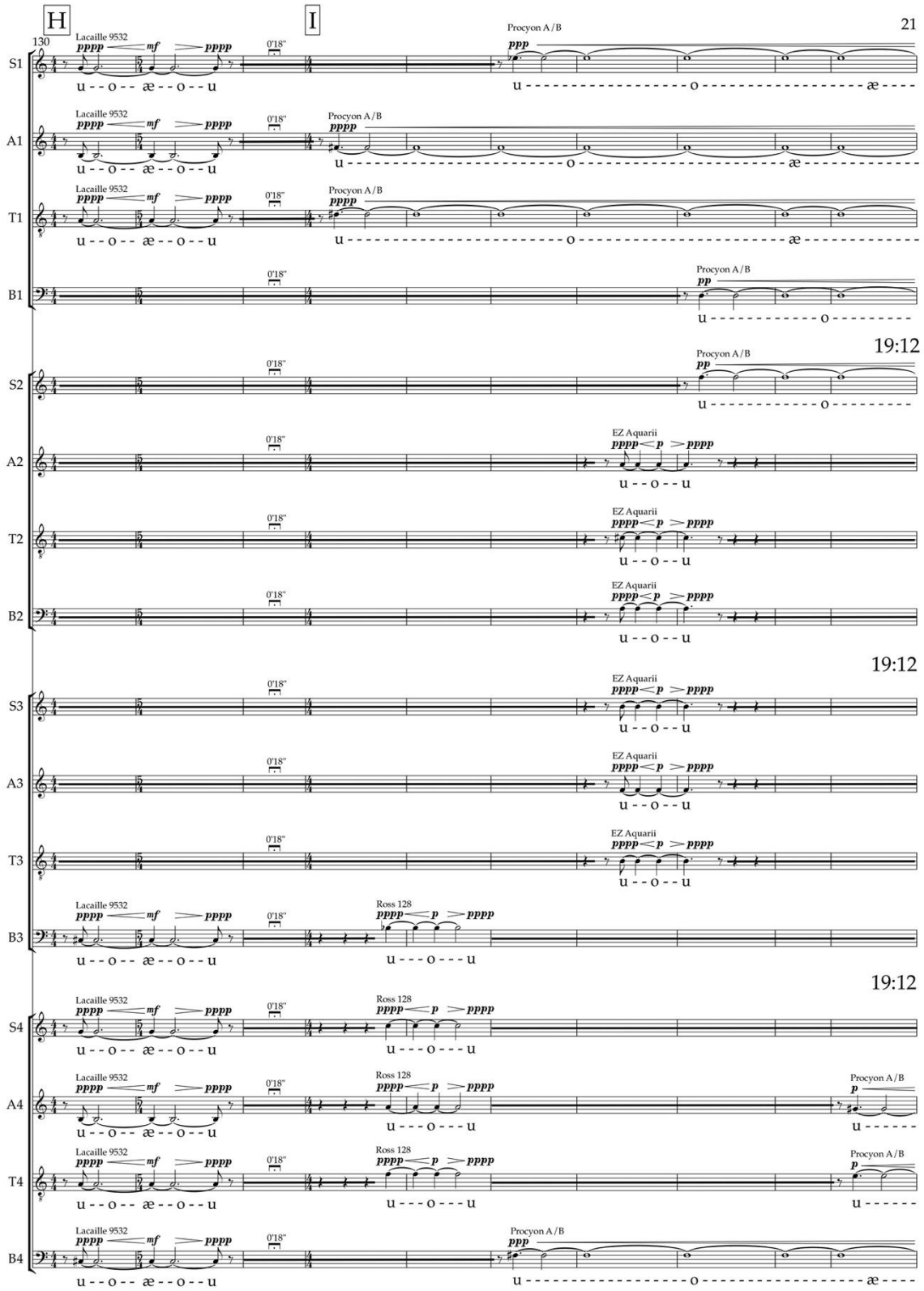

16
75
S1
A1
T1
B1
10:23
S2
A2
T2
B2
10:23
S3
A3
T3
B3
10:23
S4
A4
T4
B4
mf
p
ppp
pppp
pp
mp
æ
o
u
2'02"
Static, unvoiced sounds

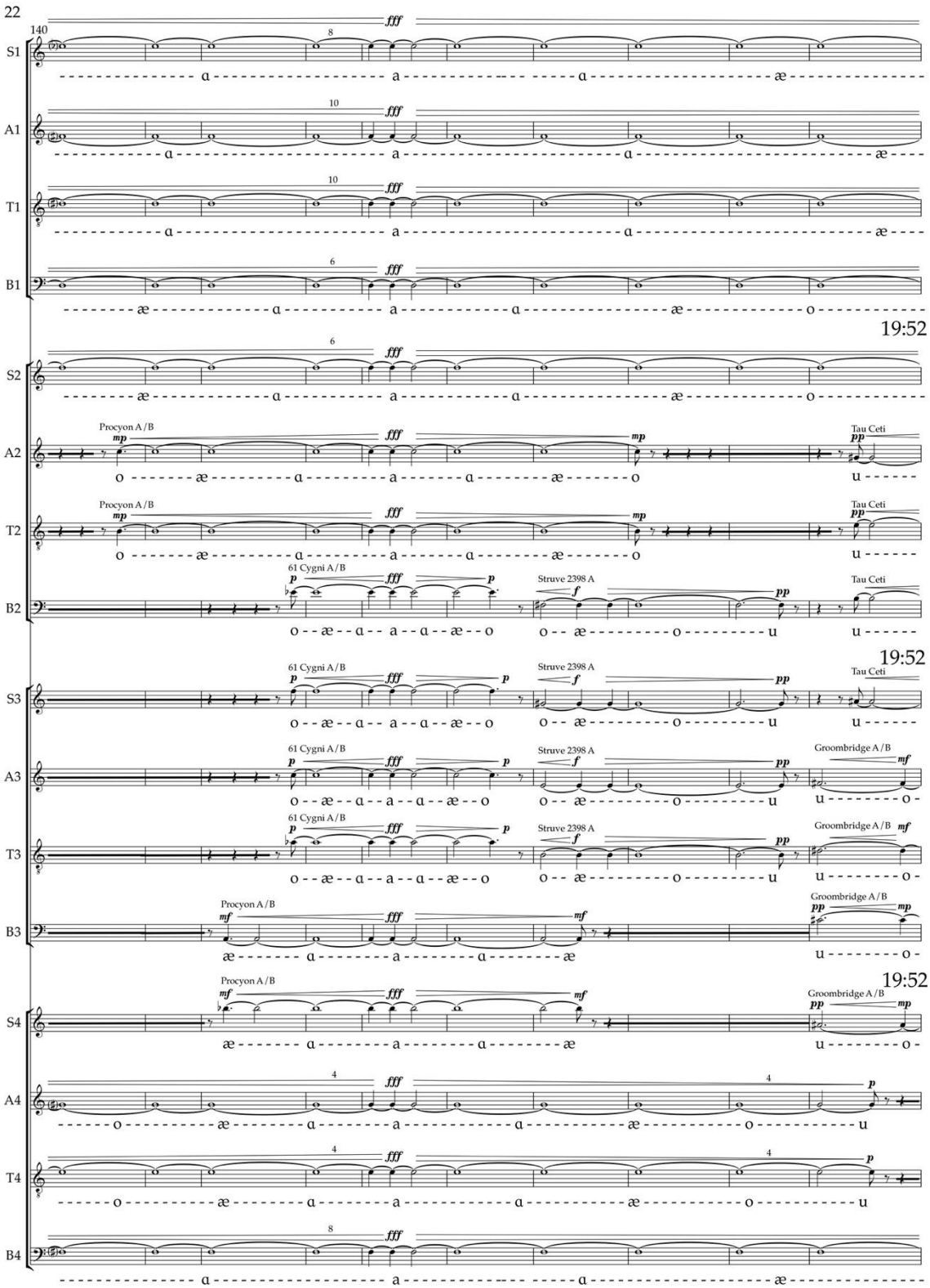

B
C
D
One event total every 5-10 seconds. Slight overlap between some events.
17
85
14:23
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
Mostly static, some modulating sounds; all unvoiced.
3'05"
0'17"
Wolf 359
Lalande 21185
Sirius A/B
Bernard's Star
u - - o - - u
u - - - - - o - - - - u

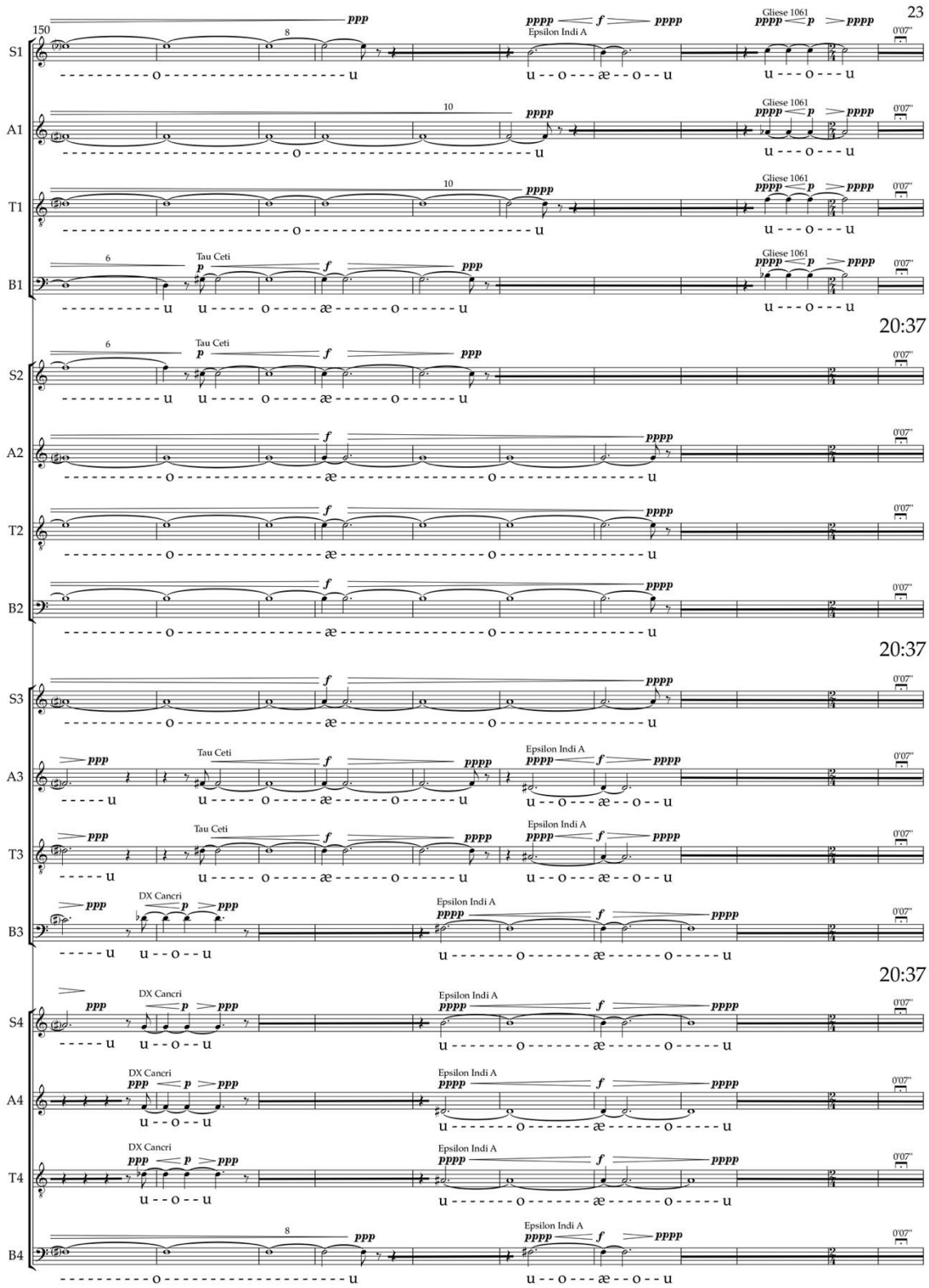

18
96
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
Sirius A/B
Luyten 726-8B
15:11
15:11
15:11

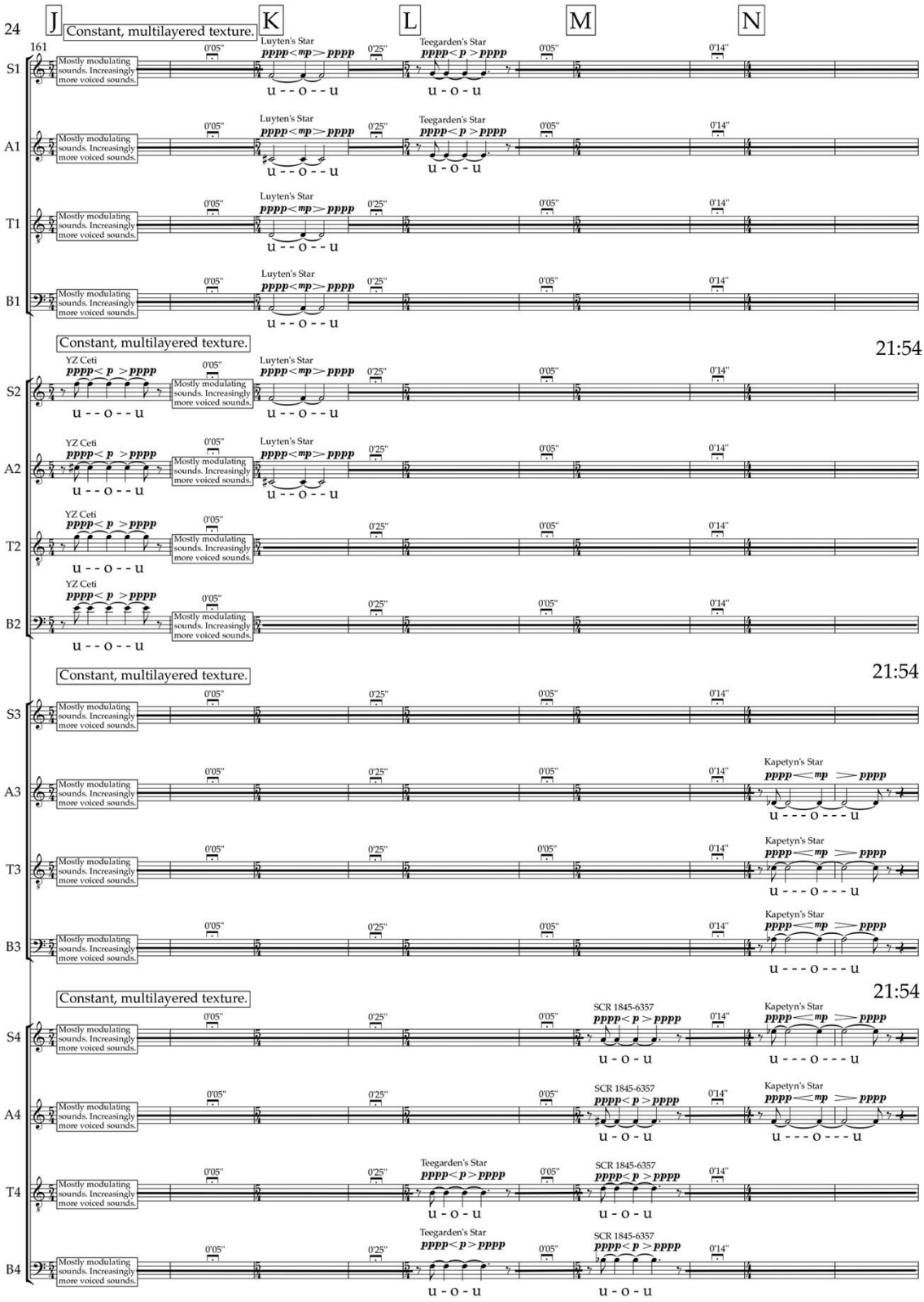

19
108
S1
A1
T1
B1
16:37
S2
A2
T2
B2
16:37
S3
A3
T3
B3
16:37
S4
A4
T4
B4
mp
mf
p
ppp
pppp
pp
o
u
æ
0'41"

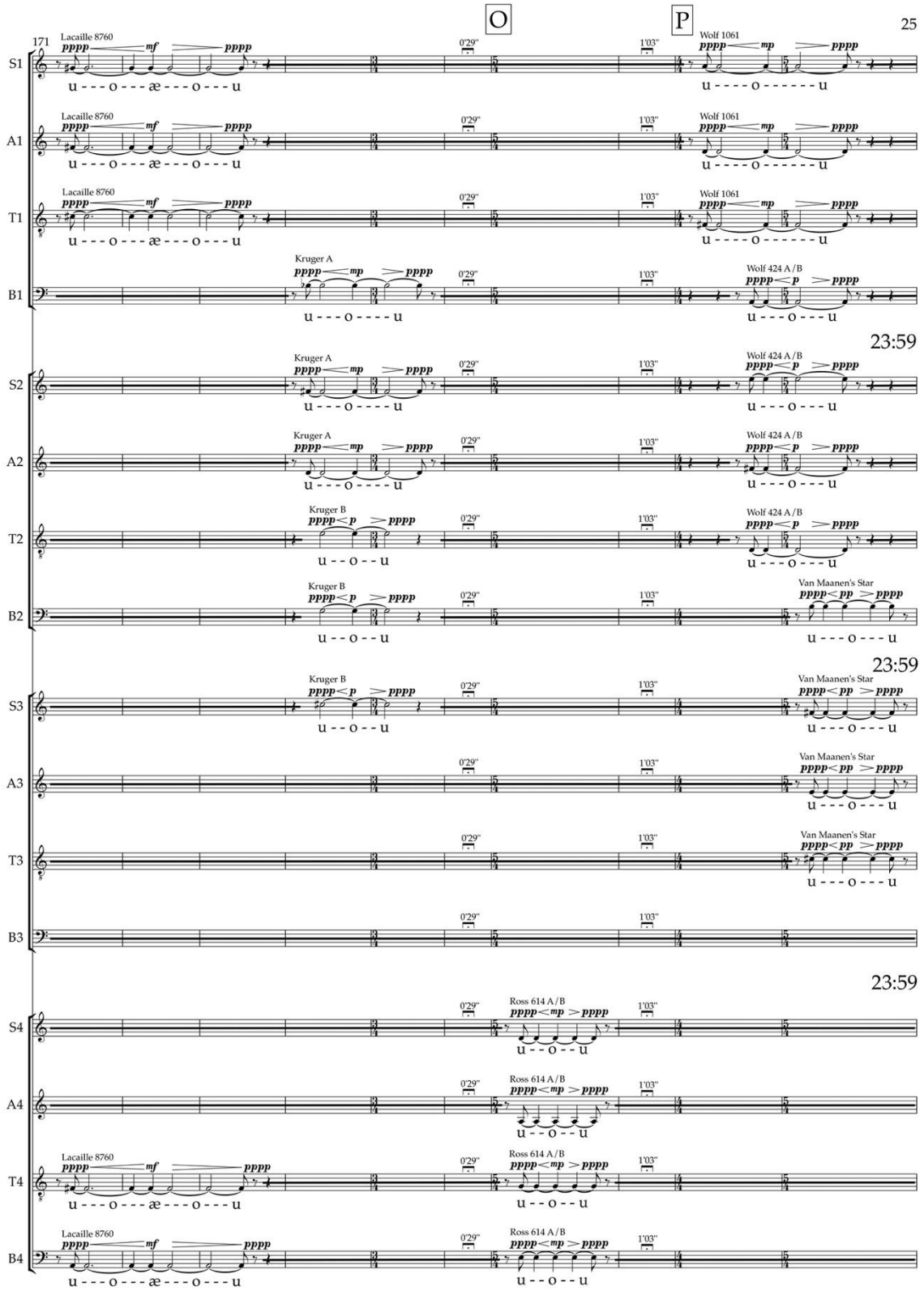

E
More consistent overlap between events.
F
G
20
120
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
18:17
Ross 154
Ross 248
Epsilon Eridani
Half static, half modulating sounds. Graudally introduce voiced sounds.
u - - - o - - - u
u - - - - - - o - - - - - - æ - - - - ɑ - - - - - æ - - - - - - o - - - - - - u

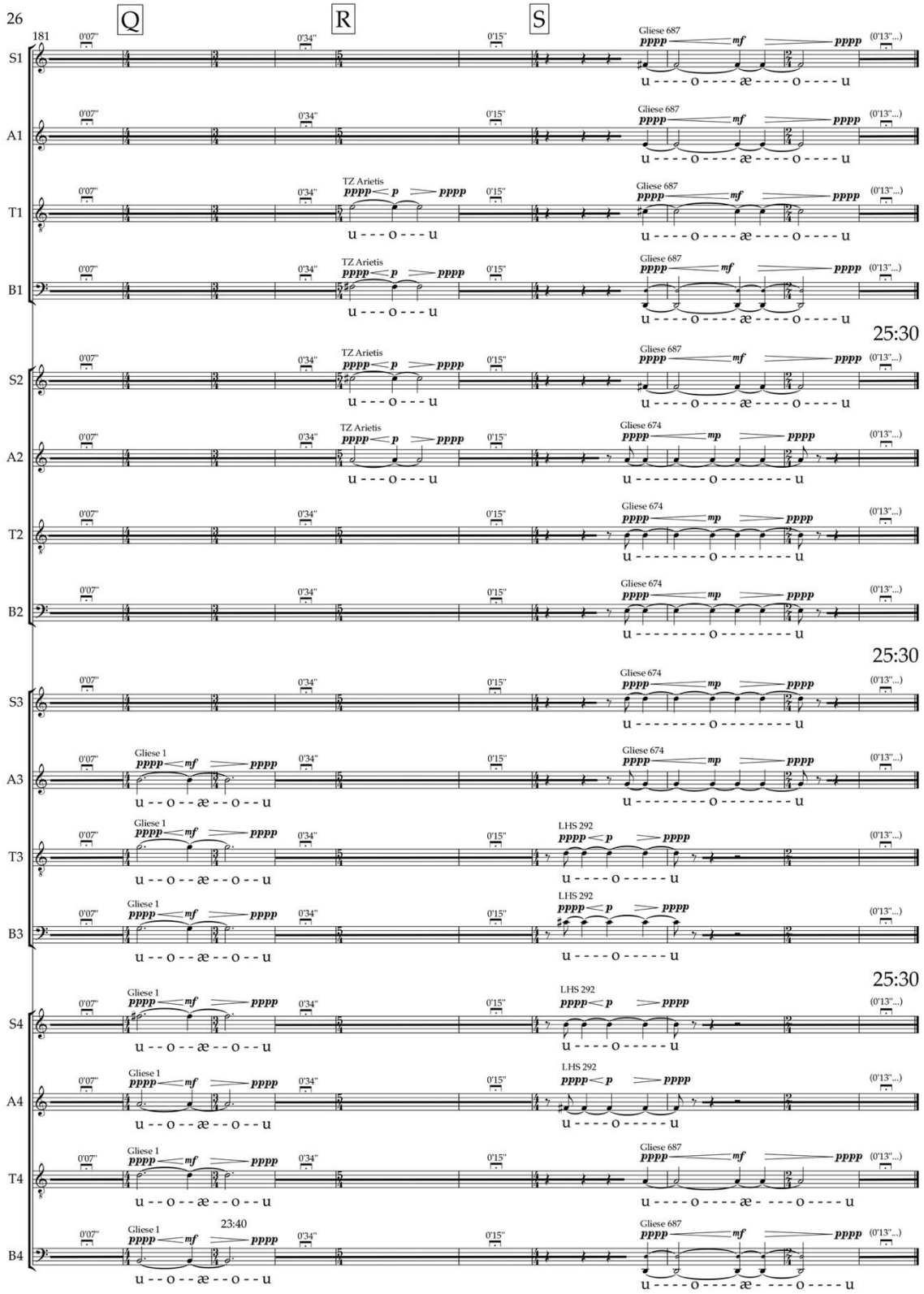

H
I
130
21
19:12
19:12
19:12
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
Lacaille 9532
Procyon A/B
EZ Aquarii
Ross 128
0'18"
u - - o - - æ - - o - - u


22
140
S1
A1
T1
B1
19:52
S2
A2
T2
B2
19:52
S3
A3
T3
B3
19:52
S4
A4
T4
B4
fff
mp
mf
p
pp
Procyon A / B
61 Cygni A / B
Struve 2398 A
Tau Ceti
Groombridge A / B


23
150
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
20:37
20:37
20:37
Tau Ceti
Epsilon Indi A
Gliese 1061
DX Cancri


24
J
Constant, multilayered texture.
K
L
M
N
161
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
Mostly modulating sounds. Increasingly more voiced sounds.
Luyten's Star
Teegarden's Star
YZ Ceti
Kapetyn's Star
SCR 1845-6357
0'05"
0'25"
0'14"
21:54


O
P
25
171
S1
A1
T1
B1
S2
A2
T2
B2
S3
A3
T3
B3
S4
A4
T4
B4
Lacaille 8760
Kruger A
Kruger B
Wolf 1061
Wolf 424 A / B
Van Maanen's Star
Ross 614 A / B
0'29"
1'03"
23:59
u - - - o - - - æ - - - o - - - u
u - - - o - - - u
u - - o - - u
u - - - o - - - - - - u
u - - - o - - - - - u


26
181
Q
R
S
S1
A1
T1
B1
25:30
S2
A2
T2
B2
25:30
S3
A3
T3
B3
25:30
S4
A4
T4
B4
23:40
0'07"
0'34"
0'15"
(0'13"...)
Gliese 687
TZ Arietis
Gliese 674
Gliese 1
LHS 292
pppp
mf
p
mp
u - - - o - - - æ - - - o - - - u

Appendix 2: Samples of compositional materials

	A	B	C	D	E	F	G	H	I	J	K	L
1	Star	Star System	Distance (LY)	Radius (solar radii)	Dynamics (log)	Luminosity	Event Lengths (log)	Stellar type	Temperature (k)	Star type	Color	Planets
2	Sun	Solar System	0	1	ff	1	60	G	5200 - 6000	Main sequence	Yellow white	8
3	Proxima Centauri	Alpha Centauri	4.244	0.1542	p	0.00005	4	M	2400 - 3700	Red dwarf	Orange red	1
4	Alpha Centauri A	Alpha Centauri	4.365	1.223	ff	1.519	70	G	5200 - 6000	Main sequence	Yellow white	
5	Alpha Centauri B	Alpha Centauri	4.37	0.863	f	0.5002	30	K	3700 - 5200	Main sequence	Light orange	
6	Bernard's Star	Ophiuchus	5.957	0.196	p	0.0035	5	M	2400 - 3700	Red dwarf	Orange red	1
7	Wolf 359 (CN Leonis)	Leo	7.856	0.16	p	0.0014	5	M	2400 - 3700	Red dwarf	Orange red	2
8	Lalande 21185	Ursa Major	8.307	0.393	mp	0.026	7	M	2400 - 3700	Red dwarf	Orange red	1
9	Sirius B	Canis Major	8.659	0.0084	pp	0.056	9	D	12000 - 100,000	White dwarf	White	
10	Sirius A	Canis Major	8.659	1.711	ff	25.4	120	A	7400 - 10,000	Main sequence	Blue white	
11	Luyten 726-8A	Cetus	8.791	0.14	p	0.00004	4	M	2400 - 3700	Red dwarf	Orange red	
12	Luyten 726-8B	Cetus	8.791	0.14	p	0.00004	4	M	2400 - 3700	Red dwarf	Orange red	
13	Ross 154	Sagittarius	9.7035	0.24	p	0.0038	5	M	2400 - 3700	Red dwarf	Orange red	
14	Ross 248	Andromeda	10.2903	0.16	p	0.0018	5	M	2400 - 3700	Red dwarf	Orange red	
15	Epsilon Eridani	Eridanus	10.446	0.735	f	0.34	20	K	3700 - 5200	Main sequence	Light orange	2
16	Lacaille 9352	Piscis Austrinus	10.7211	0.47	mf	0.0367	8	M	2400 - 3700	Red dwarf	Orange red	3
17	Ross 128	Virgo	11	0.1967	p	0.00362	5	M	2400 - 3700	Red dwarf	Orange red	1
18	EZ Aquarii A	Aquarius	11.1	0.175	p	0.000087	4	M	2400 - 3700	Red dwarf	Orange red	
19	Procyon B	Canis Minor	11.4	0.012	pp	0.00049	4	D	12000 - 100,000	White dwarf	White	
20	61 Cygni B	Cygnus	11.4	0.595	mf	0.085	11	M	2400 - 3700	Red dwarf	Orange red	
21	61 Cygni A	Cygnus	11.4	0.665	mf	0.153	12	M	2400 - 3700	Red dwarf	Orange red	3
22	Procyon A	Canis Minor	11.4	2.048	fff	6.93	90	F	6000 - 7500	Main sequence	Off-white	
23	Struve 2398 B	Draco	11.49	0.248	p	0.021	7	M	2400 - 3700	Red dwarf	Orange red	2
24	Struve 2398 A	Draco	11.49	0.35	mp	0.35	20	M	2400 - 3700	Red dwarf	Orange red	
25	Groombridge 34 B	Andromeda	11.62	0.18	p	0.00085	4	M	2400 - 3700	Red dwarf	Orange red	
26	Groombridge 34 A	Andromeda	11.62	0.38	mp	0.022	7	M	2400 - 3700	Red dwarf	Orange red	2
27	DX Cancri	Cancer	11.68	0.11	p	0.00065	4	M	2400 - 3700	Red dwarf	Orange red	
28	Tau Ceti	Cetus	11.75	0.793	f	0.52	30	G	5200 - 6000	Main sequence	Yellow white	5
29	Epsilon Indi	Indus	11.87	0.73	f	0.22	15	K, T, T	3700 - 5200	Main sequence	Light orange	1
30	Gliese 1061	Horologium	11.98	0.156	p	0.001	5	M	2400 - 3700	Red dwarf	Orange red	3
31	YZ Ceti	Cetus	12.1	0.168	p	0.000183	4	M	2400 - 3700	Red dwarf	Orange red	4
32	Luyten's Star	Canis Minor	12.2	0.35	mp	0.0088	5	M	2400 - 3700	Red dwarf	Orange red	4
33	Teegarden's Star	Aries	12.5	0.127	p	0.0007	4	M	2400 - 3700	Red dwarf	Orange red	2
34	SCR 1845-6357	Pavo	12.6	0.096	p	0.0004	4	M, T	2400 - 3700	Red dwarf	Orange red	
35	Kapteyn's Star	Pictor	12.8	0.291	mp	0.01	6	M	2400 - 3700	Red dwarf	Orange red	2
36	Lacaille 8760	Microscopium	12.9	0.51	mf	0.072	10	M	2400 - 3700	Red dwarf	Orange red	
37	Kruger 60 B	Cepheus (border)	13	0.24	p	0.0034	5	M	2400 - 3700	Red dwarf	Orange red	
38	Kruger 60 A	Cepheus (border)	13	0.35	mp	0.01	6	M	2400 - 3700	Red dwarf	Orange red	
39	Wolf 1061	Ophiuchus	14.04	0.307	mp	0.0102	6	M	2400 - 3700	Red dwarf	Orange red	3
40	Wolf 424 A	Virgo	14.05	0.17	p	0.00014	4	M	2400 - 3700	Red dwarf	Orange red	
41	Wolf 424 B	Virgo	14.05	0.14	p	0.0008	4	M	2400 - 3700	Red dwarf	Orange red	
42	Van Maanen's Star	Pisces	14.07	0.011	pp	0.00017	4	D	12000 - 100,000	White dwarf	White	
43	Gliese 1	Sculptor	14.2	0.46	mf	0.02	7	M	2400 - 3700	Red dwarf	Orange red	
44	TZ Arietis	Aries	14.6	0.161	p	0.00135	5	M	2400 - 3700	Red dwarf	Orange red	
45	Gliese 674	Ara	14.83	0.41	mp	0.016	6	M	2400 - 3700	Red dwarf	Orange red	1
46	Gliese 687	Draco	14.84	0.492	mf	0.0213	7	M	2400 - 3700	Red dwarf	Orange red	1

Figure 1: Compiled list of astronomical data used in *The Temple of Immensity*.

Reh.	Choir	Noise	Duration	#Stars	Dynamics	Silence	Duration		Fourths		Thirds		Fifths	
	All	0:00-0:30	0:30	1	ff									
						0:30-6:40	6:10						1/5 point	1 star in 1/5
A	2&3	6:40-7:51	1:11	3	p, ff, f				1/4 point	1 star in 1/4				1 noise event
						7:51-9:53	2:02			1 noise event	1/3 point	4 star in 1/3		
B		9:53-9:58	0:05	1	p							2 noise events		
						9:58-13:03	3:05						2/5 point	4 star in 2/5
C		13:03-13:08	0:05	1	p				Midpoint	4 star in 2/4				2 noise events
						13:08-13:25	0:17			2 noise events				
D	3, 1	13:25-15:26	2:01	5	mp, ff/pp, p/p									
						15:26-16:07	0:41						3/5 point	6 star in 3/5
E	1&2	16:07-16:12	0:05	1	p									2 noise events
						16:12-17:06	0:54				2/3 point	8 star in 2/3		
F		17:06-17:11	0:05	1	p							4 noise events		
						17:11-17:14	0:03							
G		17:14-17:35	0:21	1	f									
						17:35-17:47	0:12							
H	1&2	17:47-17:56	0:09	1	mf									
						17:56-18:14	0:18							
I	All	18:14-19:54	1:40	13	p, p, fff/mf/mf/pp, p/mp, mp/p, p, f, f				3/4 point	10 star in 3/4				
						19:54-19:55	0:01	(written as quarter rest)		7 noise events				
	1&4	19:55-20:00	0:05	1	p									
						20:00-20:07	0:07						4/5 point	18 star in 4/5
J		20:07-20:12	0:05	1	p									6 noise events
						20:12-20:17	0:05							
K	3&4	20:17-20:22	0:05	1	mp									
						20:22-20:47	0:25							
L	1&4	20:47-20:52	0:05	1	p									
						20:52-20:57	0:05							
M		20:57-21:02	0:05	1	p									
						21:02-21:16	0:14							
N		21:16-21:23	0:07	1	mp									
						21:23-21:24	0:01	(written as quarter rest)						
		21:24-21:35	0:11	1	mf									
						21:35-21:36	0:01	(written as quarter rest)						
		21:36-21:43	0:07	2	mp/p									
						21:43-23:20	1:37							
O		23:20-23:29	0:09	4	mp, p/p, pp									
						23:29-23:36	0:07							
P		23:36-23:43	0:07	1	mf									
						23:43-24:17	0:34							
Q		24:17-24:22	0:05	1	p									
						24:22-24:39	0:17							
R		24:39-24:47	0:08	2	mp, mf									
						24:47-25:00	0:13		Endpoint	30 star in 4/4		33 star in 3/3		16 star in 5/5
										12 noise events		16 noise events		11 noise events
			Total: 7:31				Total: 17:29							
			22 sound events											

Figure 2: Comparison of choral activity ("noise") and inactivity ("silence"), with divisions of piece into various fractions to study density of choral activity over time.

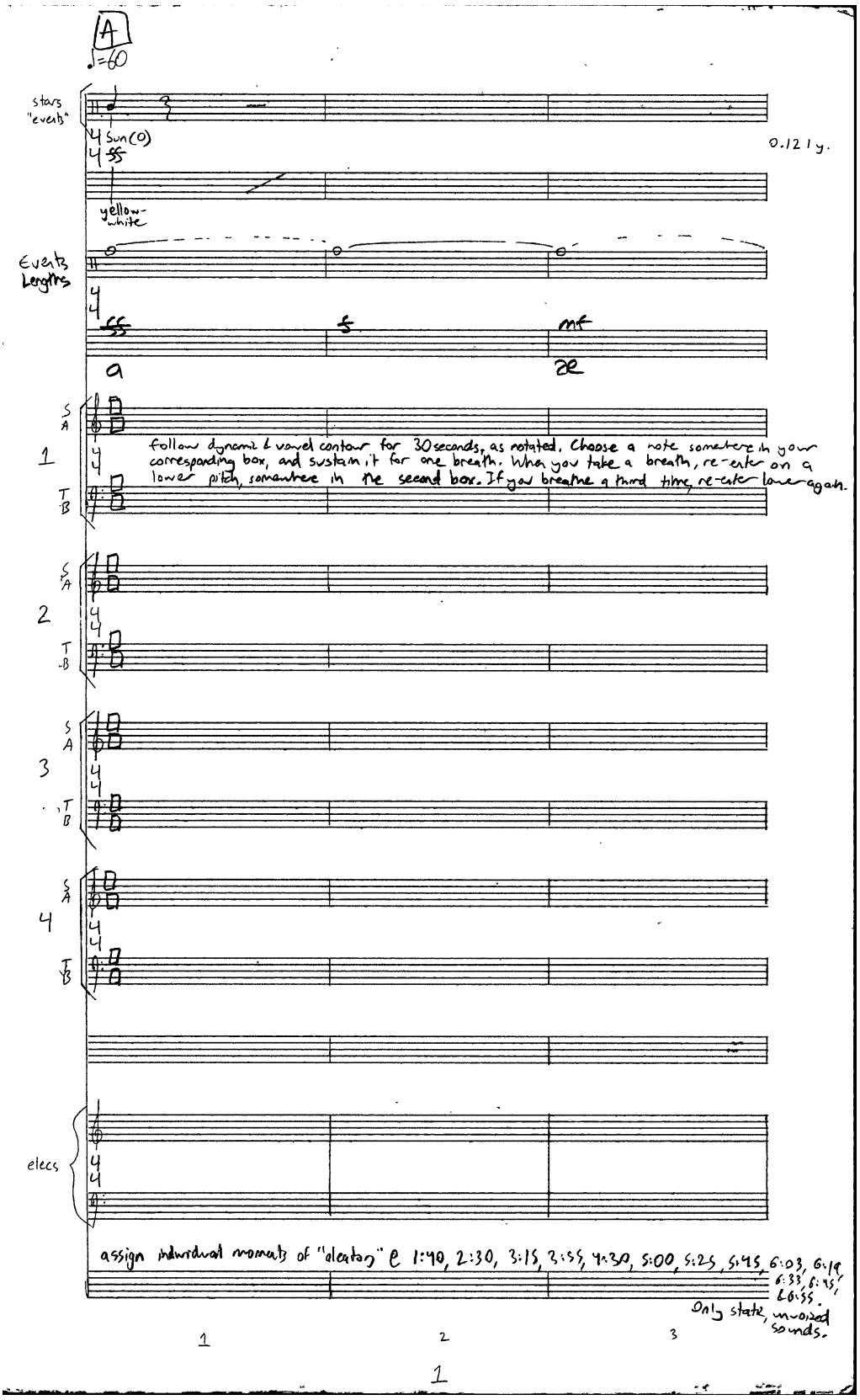


Figure 3: First page of prototype manuscript of *The Temple of Immensity*.

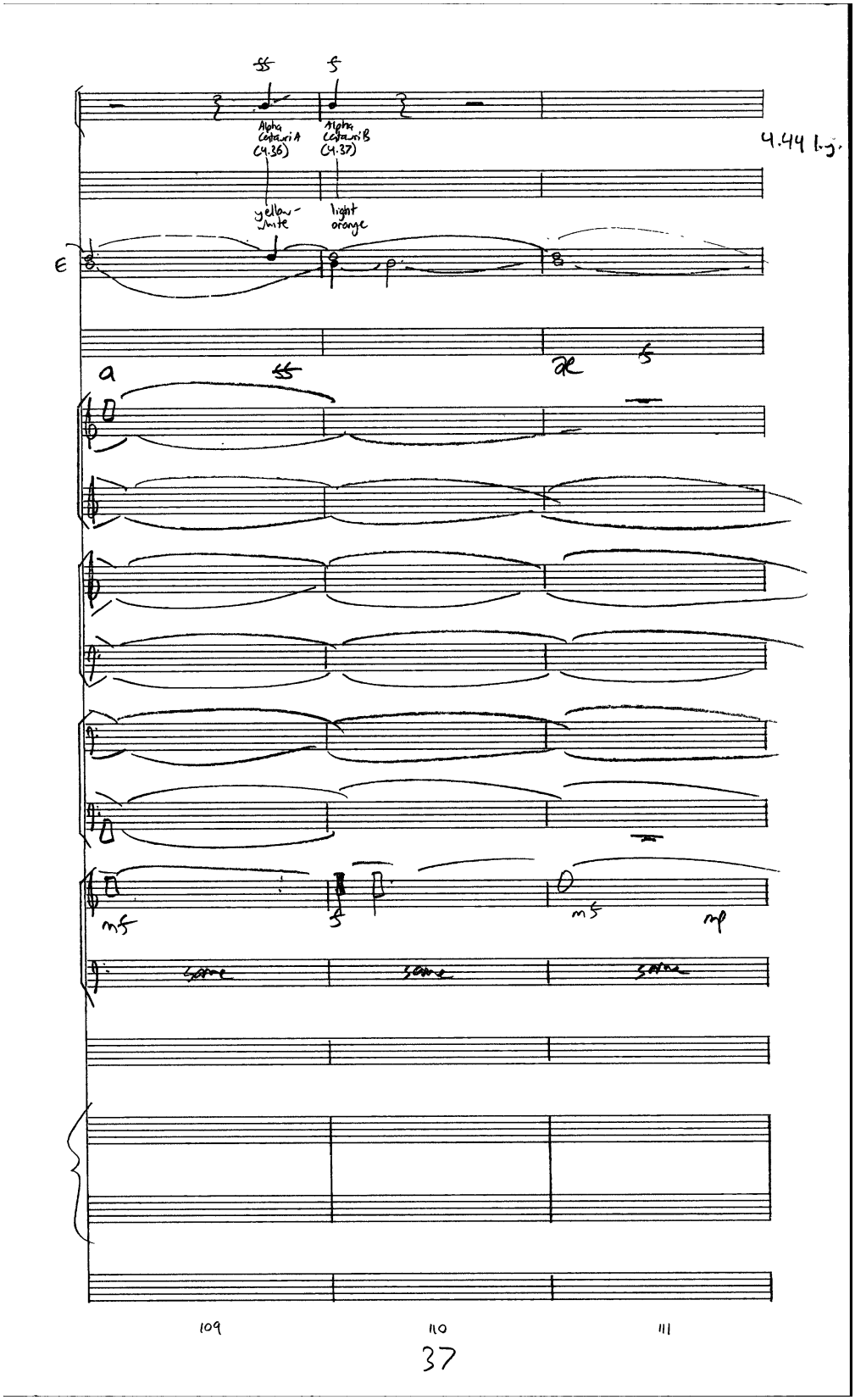


Figure 4: page 37 of the prototype manuscript.

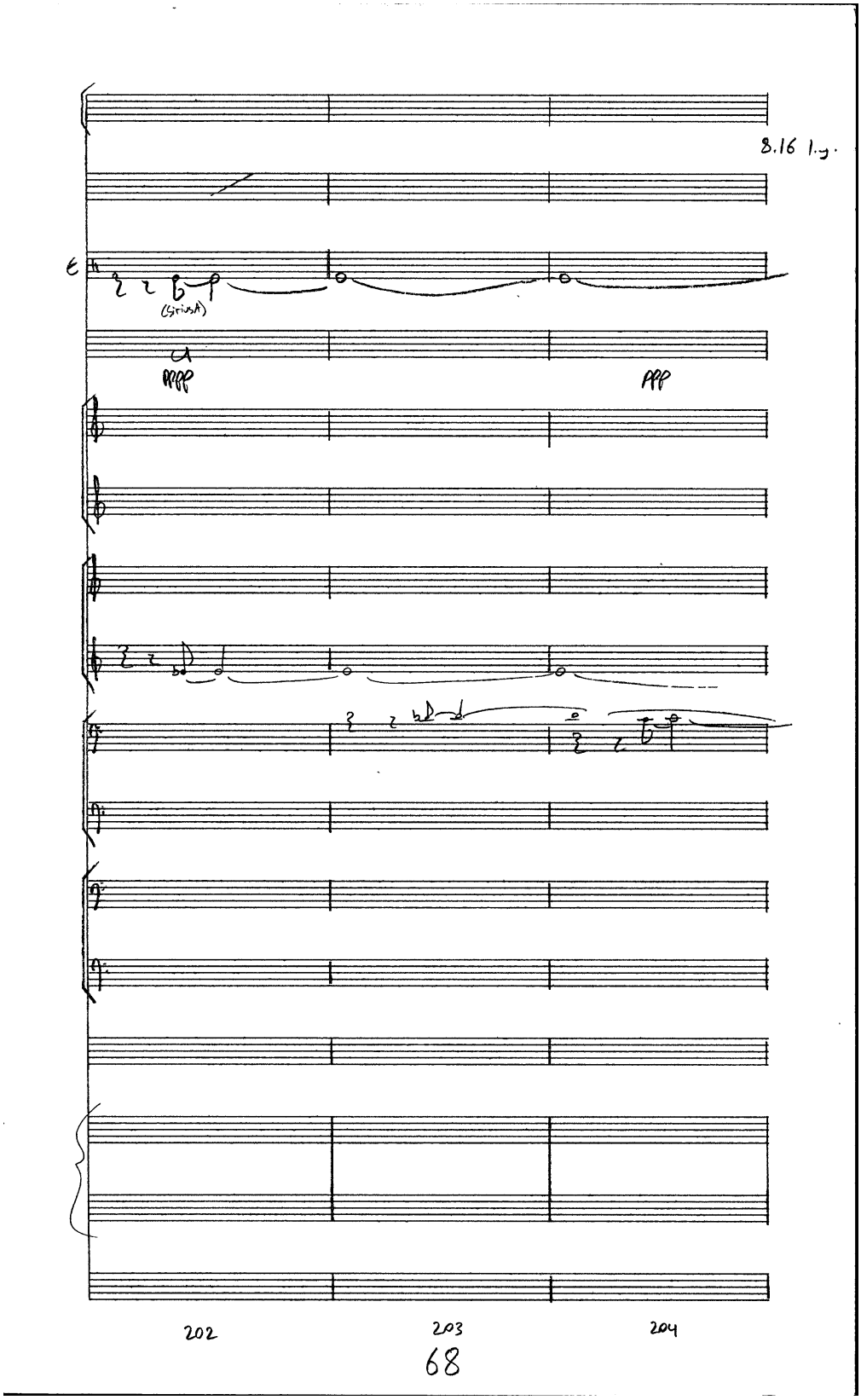


Figure 5: page 68 of the prototype manuscript; the beginning of a star event.

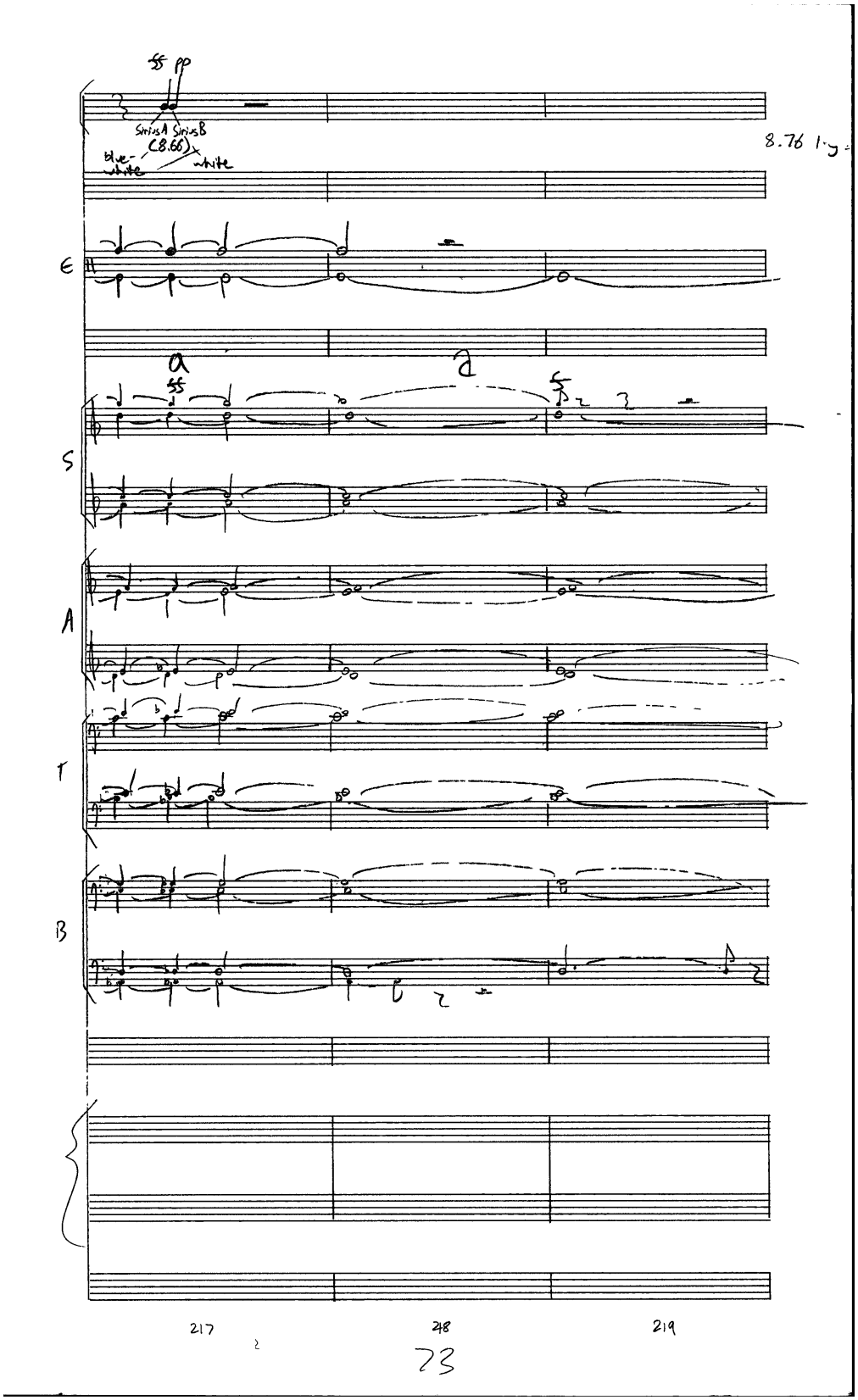


Figure 6: page 73 of the prototype manuscript; the apex of a star event.

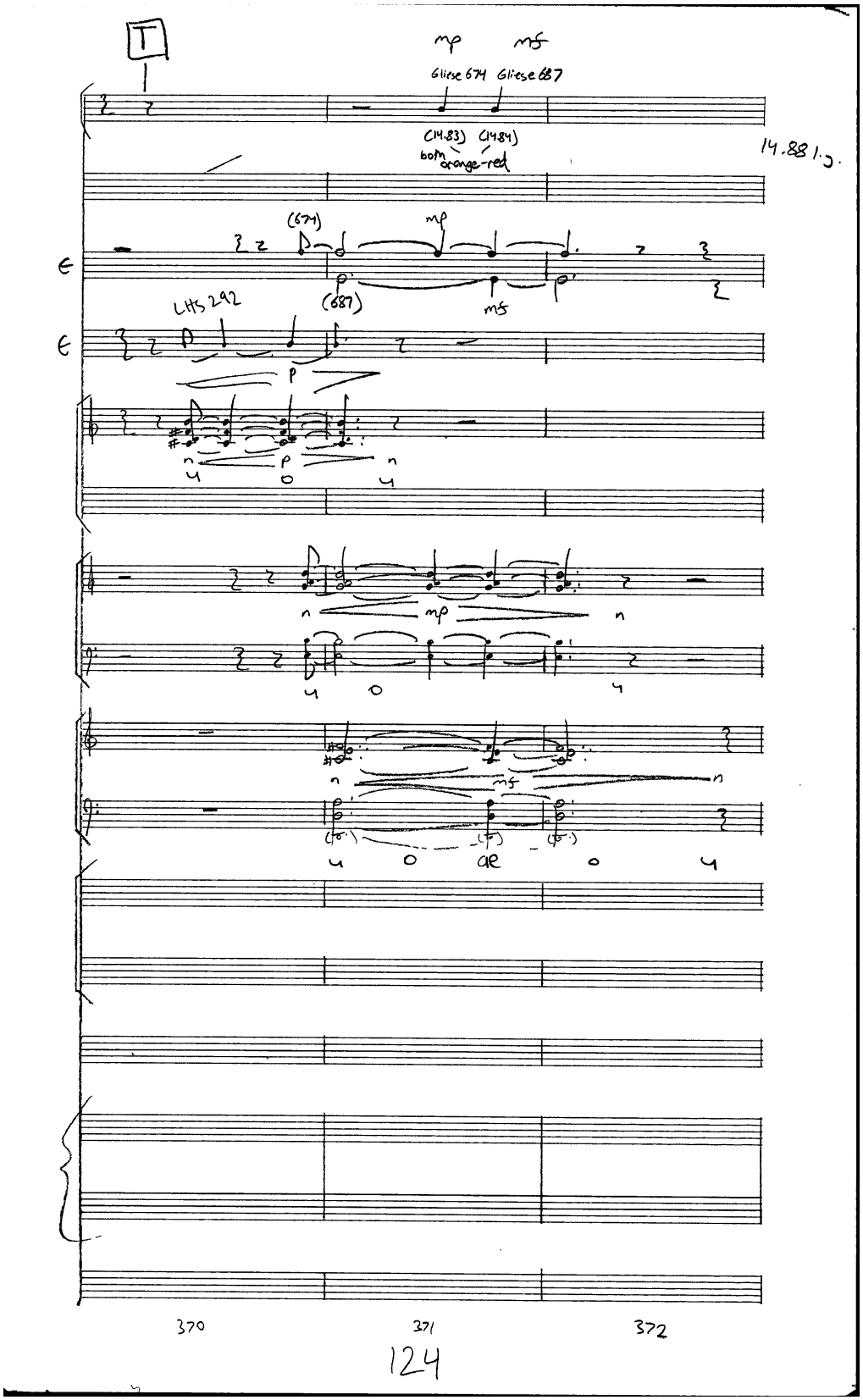


Figure 7: page 124 of the prototype manuscript; last page with musical notation.

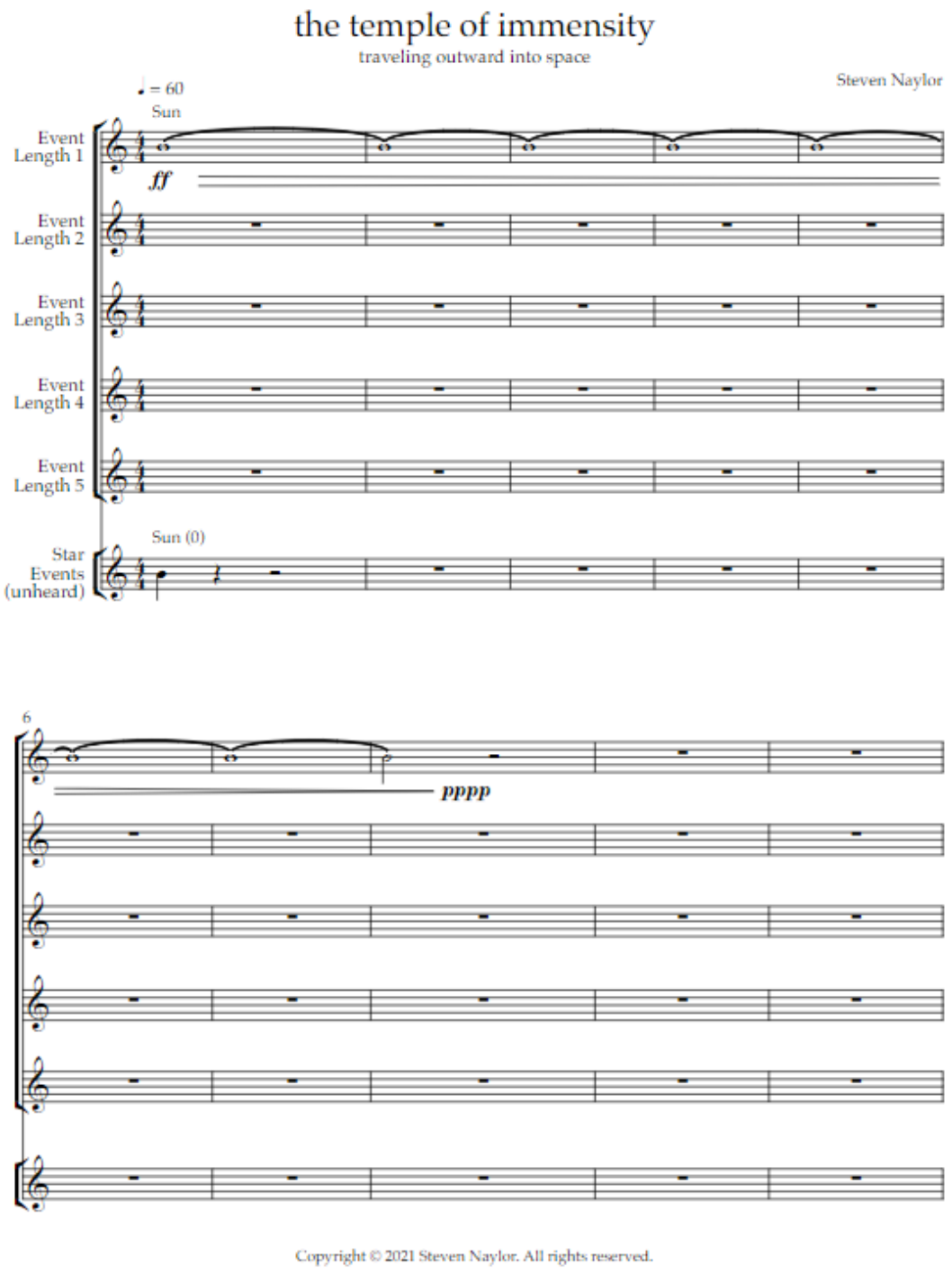


Figure 8: First page of the prototype computer notated score of *The Temple of Immensity*.

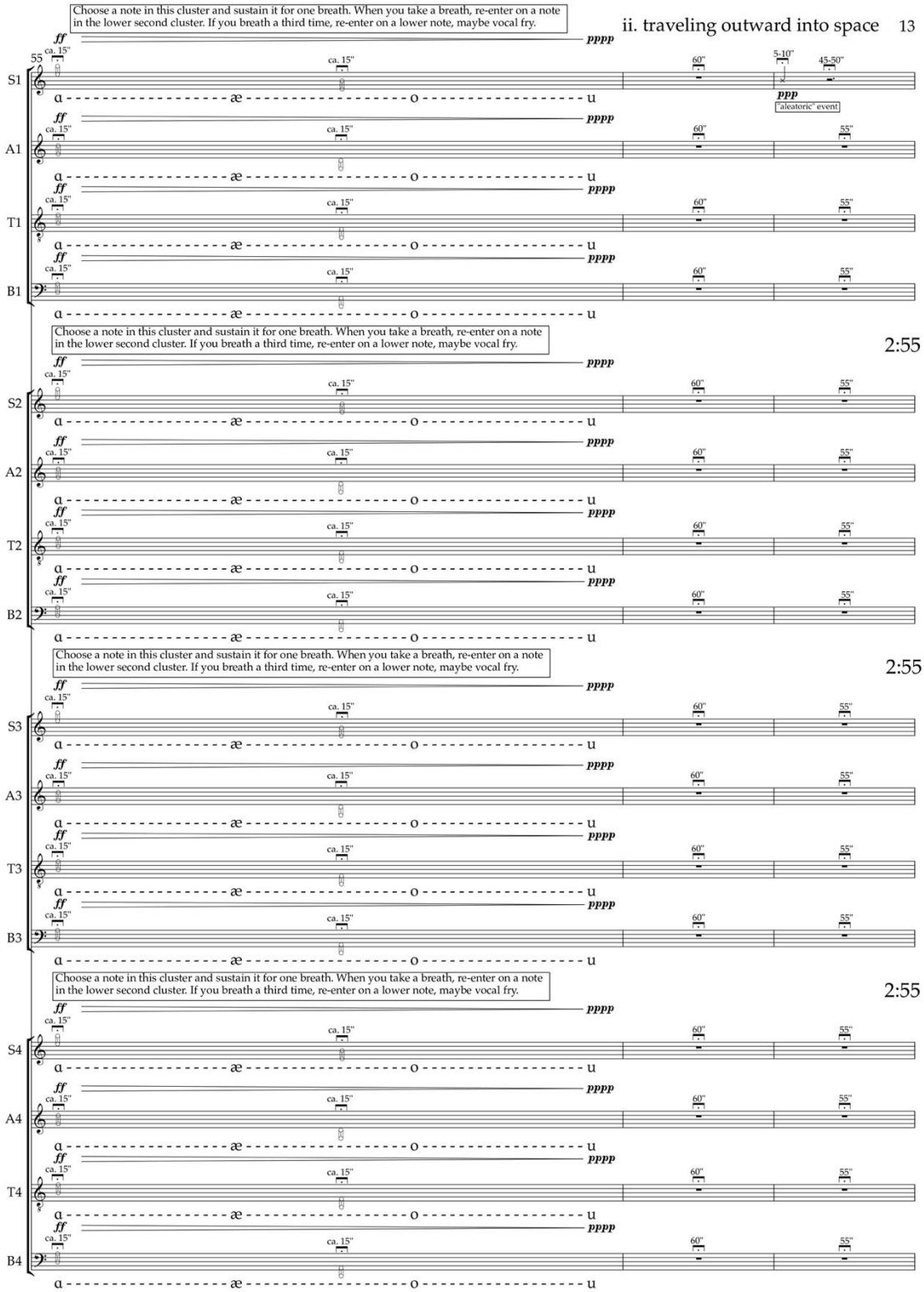


Figure 9: First page of the finalized second movement of *The Temple of Immensity*.