Towards more objective translations for a non-synesthesiac: Light to sound

Sean Kiley

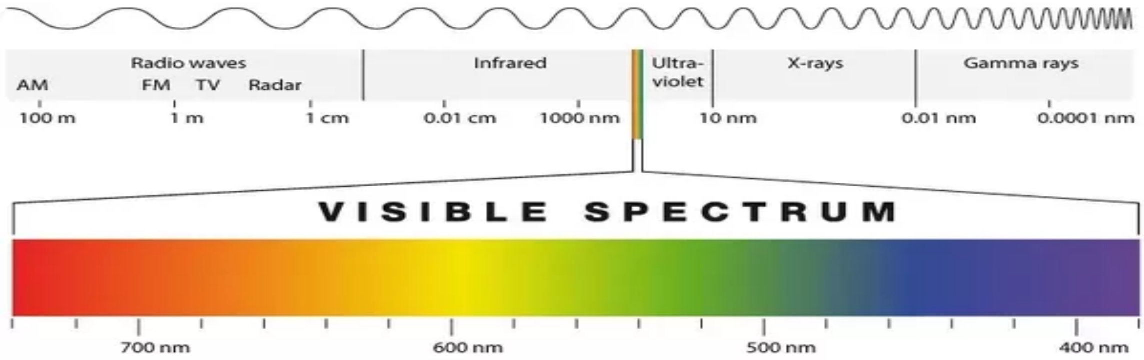
Directed Study

University of Victoria

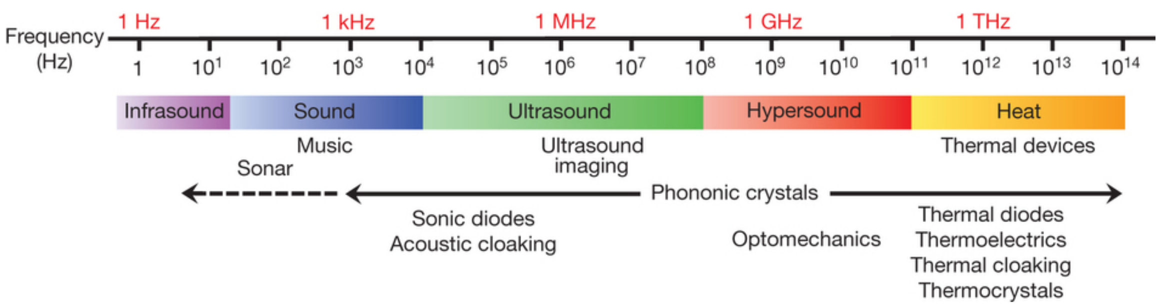
Professor Andrew Schloss

2018

Table of Contents



electromagnetic spectrum



sonic spectrum

The goal of this experiment is to create a basis and model for a scientific translation from light to sound, which is as objective as possible. To clarify, while the concept of synesthesia is an inspiration for the project it is essentially of no consequence due to the experiment's focus on measurements of the physical world and universal function of organs i.e. eyes and ears. Synesthesia, on the other hand, has been classified as a phenomenon, which occurs as a result of the brain's construction, most likely stemming from the formation of neural pathways of perception at a young age. Synesthesia is unique to the individual, so that a common input may result in many different outputs amongst a group of synesthesiacs. Additionally, there is sufficient evidence that synesthesia colors do not interact with an individuals' determination of color appearance (Robertson, Sagiv).

While many conversions of light to sound exist, these versions contain a considerable amount of arbitrary decisions in the process of translation. These can range from the spectrum of color being graphed onto a curve where sound is triggered based on a colors' assigned location within a graph, to mapping frequencies of colors onto the 12 note equal temperament system. The reason these conversions can be said to be arbitrary is due to the presence of personal preference interjected by the creator, e.g. utilizing only 12 notes, or choosing the spectra of a sound to represent a color through synesthesia or another non-universal method. In this project, light's physical properties are measured as objectively as possible in relation to the way in which these properties are perceived by the human eye. Then, using only available scientific understanding of the physics and phenomena of waves, light (or color) is translated and reproduced as the closest replication in audible sound. Through understanding the differences and similarities of the physical nature of light and sound as well as the perception of these stimuli it is possible to make a more accurate translation of the information. As in any translation however, not all information is preserved or properly represented, but that which is, attempts to be free of all subjective interference. A translation as such, then allows the possibility of being built upon using the emerging scientific data to create a more accurate version.

However, there is one fundamental assumption necessary to serve as the basis of the translation. This is the rule of octaves in sound, wherein a frequency exactly twice the amount of another frequency is perceived as the same, only registrally displaced. By calculating the frequency of a light wave and transposing it into the audible spectrum, the result is theoretically the same, only registrally displaced. This theory however, is impossible to prove fully due to the fact that human perception of light does not extend to an octave. Therefore, the only evident assumption is that if we could see an octave of light, we would perceive the frequency presented as twice itself as the same, but in a different ocular register.

The first crucial step in translation is reconciling the fundamental physical difference between light and sound. Sound propagates as a mechanical wave in a longitudinal form and requires a medium to exist, whereas light propagates as an electromagnetic wave moving transversely, and does not require a medium to travel. However, when travelling through solids sound can propagate in a transverse manner, so wave propagation can exist cross-modally. Although light can exist in a vacuum, it is still affected by the atmosphere in which we perceive it normally, similar to sound waves. Therefore, the one major difference of a light and a sound wave is that of mechanical versus electromagnetic, both of which, follow the wave equation and exhibit identifiable wave behaviors. In terms of wavelength, sound exists in approximately the same section of the electromagnetic spectrum as do radio waves: 20,000Hz = 0.0172 m and 20Hz = 17.2m. The wavelength of light is then radically less than that of sound. To determine an equivalent frequency in the audible range using $f\lambda=v$, we take the speed of light in air, 299,792,458 m/s and divide it by one of the wavelengths present in light (ca. 380 nm through 720 nm). The resulting frequencies derived can be anywhere from 400 to 800 trillion Hz. To transpose the frequencies into the audible range, this frequency is halved or transposed down 36 times.

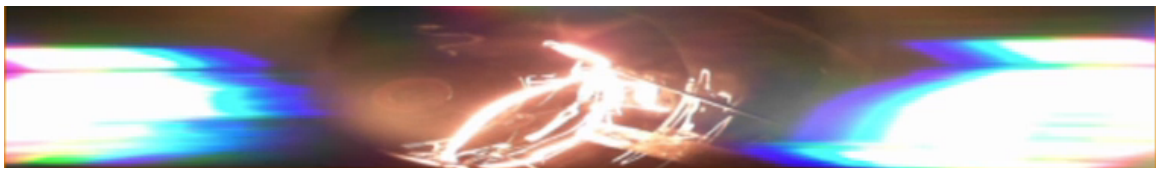
Determining the wavelengths present in a light source and/or reflective objects can be done in two ways. The first makes use of the digital or LCD representation of a light source and/or reflective object. Here the image can be processed and broken into color proportions. This tool designed by L. Jégou exports the palette of colors present in the makeup of an image. Thereafter, each individual color is processed by an 'image color summarizer', designed by Martin Krzywinski. The program outputs the colors HSV (Hue, Saturation, Value) values. From the 'Hue' value the wavelength can be determined by the formula:

Hue = (650 - wavelength)*240/(650-475)

(Dukes).

"Visible light is about 400 to 700 nm, with 650 nm being the frequency of red. 475 is blue. Both indigo and violet fall below this limit, but the CIE model that defines the theoretical map of wavelength to hue has to treat colors in that range separately, and it could be that 475 nm is the effective limit for standard Hue calculation, perhaps requiring negative Hue."(Roberson, Dukes)

In the example utilized for this project, analyzing a close-up image of an incandescent bulb, 58 different Hue values are present. While the Saturation (S) and Value (V) are equally as important to the make-up of the LCD represented color, it is difficult to translate these values as a function of sound without making arbitrary decisions e.g. saturation or richness represented as timbre. Thus, the result is uniform amplitude and timbral frequencies.



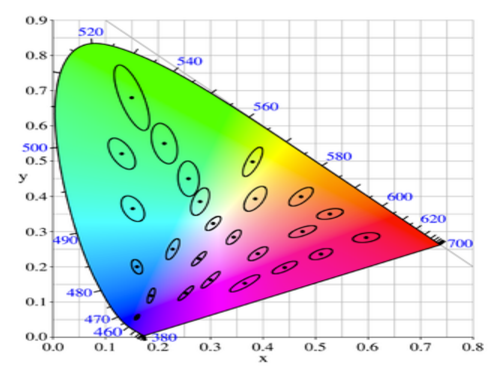
Incandescent bulb close-up photo taken from the program 'Theremino' with a light-grating camera

To represent these frequencies aurally, using sine waves is the most reasonably objective method at this point in the research. In graphing electromagnetic waves, each frequency consists of an electric field oscillating at a right angle to a complimentary magnetic field. Thereby, a Fourier transform of these fields will generate sinusoidal functions. However, true sinusoids are actually only present in perfect monochromatic plane waves e.g. a laser. Since, this project lacks the tools to analyze the true shape of the variation in electric and magnetic fields across space, graphical descriptions of these changing field vectors yield the closest to objective and most non-arbitrary representation of how light wave exist in air.

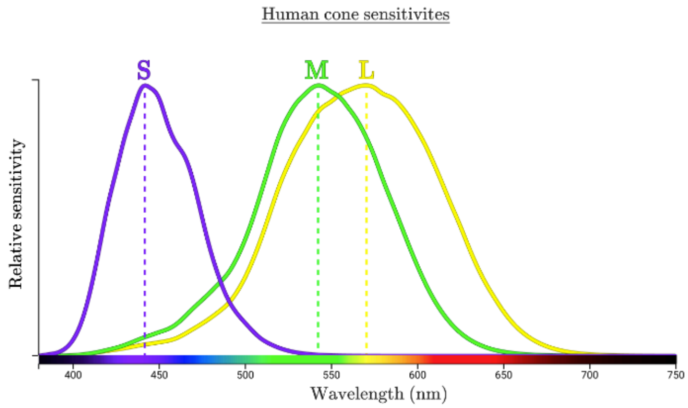
The second method of translation makes use of the program 'Theremino Spectrometer' and a light-grating camera from Microsoft. The 'Theremino Spectrometer' analyzes the image from the light-grating camera and outputs a graph with wavelength on the x-axis and intensity on the y-axis. The translation process can be implemented for every whole numbered wavelength in the visible spectrum, approximately 380 nm to 720 nm, which yields 340 different frequencies. Due to the fact that amplitude can be more objectively translated and applied through this process, it yields a more accurate translation then that of the first method. However, this translation assumes a whole-numbered bias i.e. using only the data gathered from only whole numbered wavelengths as opposed to any waves present in between; there is still a deal of research necessary to determine how to appropriately deal with this bias. A quantum understanding of the function of light as both a particle and wave including the role of photons in perception will have to be thoroughly explored to come to a more suitable conclusion. Studying 'Planck time', of which the reciprocal is 'Planck frequency' offers some insight into the smallest intervals of photons present in a light source, but has yet to be understood enough to yield application.

Theremino Spectrometer graph of an incandescent light bulb

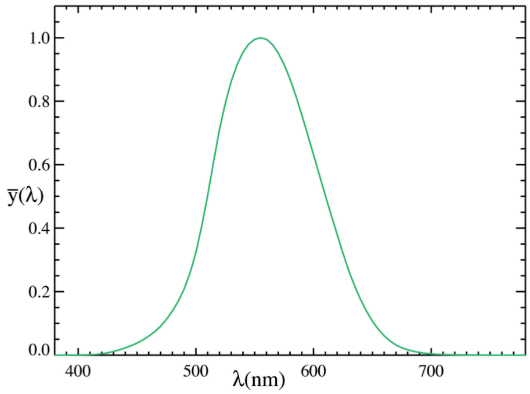
However, our eyes are not in fact able to process such discrete wavelength information. Evidently, the smallest perceptible wavelength difference is not known, but according to 'The Handbook of Perception' "…a normal human, on the other hand, can, with ease, discriminate, say, a 5-nm wavelength difference between 590 and 595 nm…". (Carterette, Friedman). Just as the smallest perceivable frequency intervals, or 'Just Noticeable Differences' (JND's) in the audible spectrum vary across the spectrum, so does wavelength discrimination vary within the visible spectrum; though, the data of these intervals is presently lacking. David L. MacAdam's diagram (below) in the 'CIE color space' offers a potential insight into these limits of color difference, but no exact figures have been procured as of yet.



The reason for these variations in JND's is due to the color receptors in our eyes, cones, humans have three types of cones referred to Small (S), Medium (M), and Large (L) "These three curves indicate how sensitive the corresponding cone is to each wavelength. The highest point on each curve is called the "peak wavelength", indicating the wavelength of radiation that the cone is most sensitive to." (Wong).



"Receptor curves have overlap in their spectral sensitivity" and "critical information is not extent to which receptors are activated, but the relative activation of the two receptor types." (Carterette, Friedman). Due to this phenomenon, it is the total excited area underneath a cone in the graph above that determines the intensity of stimulation for a cone. So, while the measurement of wavelength intensity for an LCD represented image may differ from one of the physical object, as long as the excited area within a cone's sensitivity is equivalent, the images are perceived as the same. In order to create a more accurate translation it will be crucial to develop a transform based on the sensitivity of these cones, as well as a sufficient graph for the JND's of light and to be able determine the data in terms of wavelength, which needs to be measured. Additionally, just as 'Equal-Loudness Curves' are present in the perception of sound, it will be important to determine an accurate representation of this phenomenon optically (wave amplitude) and apply the necessary transformation in translation by taking into account the inevitable graph differences. The luminosity function (pictured below) shows human's relative brightness sensitivity as a function of wavelength; while this graph lacks an exactness, a transformation is currently being worked on to reconcile the 'Fletcher-Munson Curves' and this photopic relative brightness.



In representing the translated frequencies, using additive synthesis most closely mirrors how our eyes perceive light. White light is all wavelengths of the visible spectrum at equal intensity; color then depends on the varying intensities of amplitude in reflected light. Therefore, the optical information our eyes perceive contains some degree of amplitude at all wavelengths (unless the light is monochromatic e.g. a laser); the activation of the cones in our eyes is a result of the additive synthesis of all frequencies in light. However, when the translated frequencies are presented additively in the audible spectrum, tone beating becomes an identifiable characteristic of the sonic translation, which is not the apparent case in sight. Yet, all wavelengths create beats when interacting with one another. The reason these 'beats' are not perceivable optically is that most visible waves are 'incoherent', and the non-linear processes cause the beat to become a component of the signal. Additionally, due to the rapid oscillation of light waves, sources with a small enough relative frequency difference to be observed by the eye are near impossible. This intrinsic fault of translation seems to be the only quality, which lacks a potential solution at this stage. However, to re-iterate no translations, even those between languages, are truly able to preserve and portray the exactness of the initial message or data.

The music of *colorless green ideas* is derived from the second method of translation using the program 'Theremino'. A strict translation of the incandescent bulb is not audible until the last minute of the piece; beforehand, superimposed octave transpositions as well as EQ automation and harmonic distortion are explored. The music of *on the invisible lips of the dark* makes use of the first method of translation utilizing the HSV values. This piece is fully notated and uses the initial translation as the tape track. All other instruments also tune to the extracted frequencies. The pitch content is derived from the famous image of the earth taken from the 1969 moon landing. A project of translation in the works makes use of a real time hour-long video of the sunset taken in Victoria British Columbia on the light-grating camera. The structure of the piece is thus derived from the varying amplitude relationships of the sine waves throughout the course of the hour.

Works Cited

"Can Humans Hear Transverse Sound Waves?" *Acoustics - Can Humans Hear Transverse Sound Waves? - Physics Stack Exchange*, Jan. 2018, physics.stackexchange.com/questions/378064/can-humans-hear-transverse-sound-waves.

"Can Light Waves Cause Beats?" *Electromagnetic Radiation - Can Light Waves Cause Beats? - Physics Stack Exchange*, 2013, physics.stackexchange.com/questions/56144/can-light-waves-cause-beats.

Carterette, Edward C., and Morton P. Friedman. *Handbook of Perception. Seeing*. 1975.

"Do Sound/Light Waves Literally Travel in a Sinusoidal Wave Pattern or Is That Just How We Depict Them Mathematically? • r/Askscience." *Reddit*, 2013, www.reddit.com/r/askscience/comments/uc6qq/do_soundlight_waves_literally_travel_in_a/.

Jégou, L. "Color Proportions of an Image." *Color Proportions of an Image*, 2013, www.geotests.net/couleurs/frequences_en.html#ce.

Krzywinski , Martin. "Image Color Summarizer." *Image Color Summarizer - RGB and HSV Image Statistics*, 2006, mkweb.bcgsc.ca/color-summarizer/.

Roberson, Walter, and Phillip Dukes. "Prashant Somani (View Profile)." *Color Wave Length and Hue - MATLAB Answers - MATLAB Central*, Sept. 2011, www.mathworks.com/matlabcentral/answers/17011-color-wave-length-and-hue.

Robertson, Lynn C., and Noam Sagiv. *Synesthesia Perspectives from Cognitive Neuroscience*. Oxford University Press, 2005.

"Theremino Spectrometer: Automation." *Theremino*, www.theremino.com/en/downloads/automation.

Wong, Jamie. "Color: From Hexcodes to Eyeballs." *Zero Wind :: Jamie Wong*, 3 Apr. 2018, jamie-wong.com/post/color/#optical-biology.

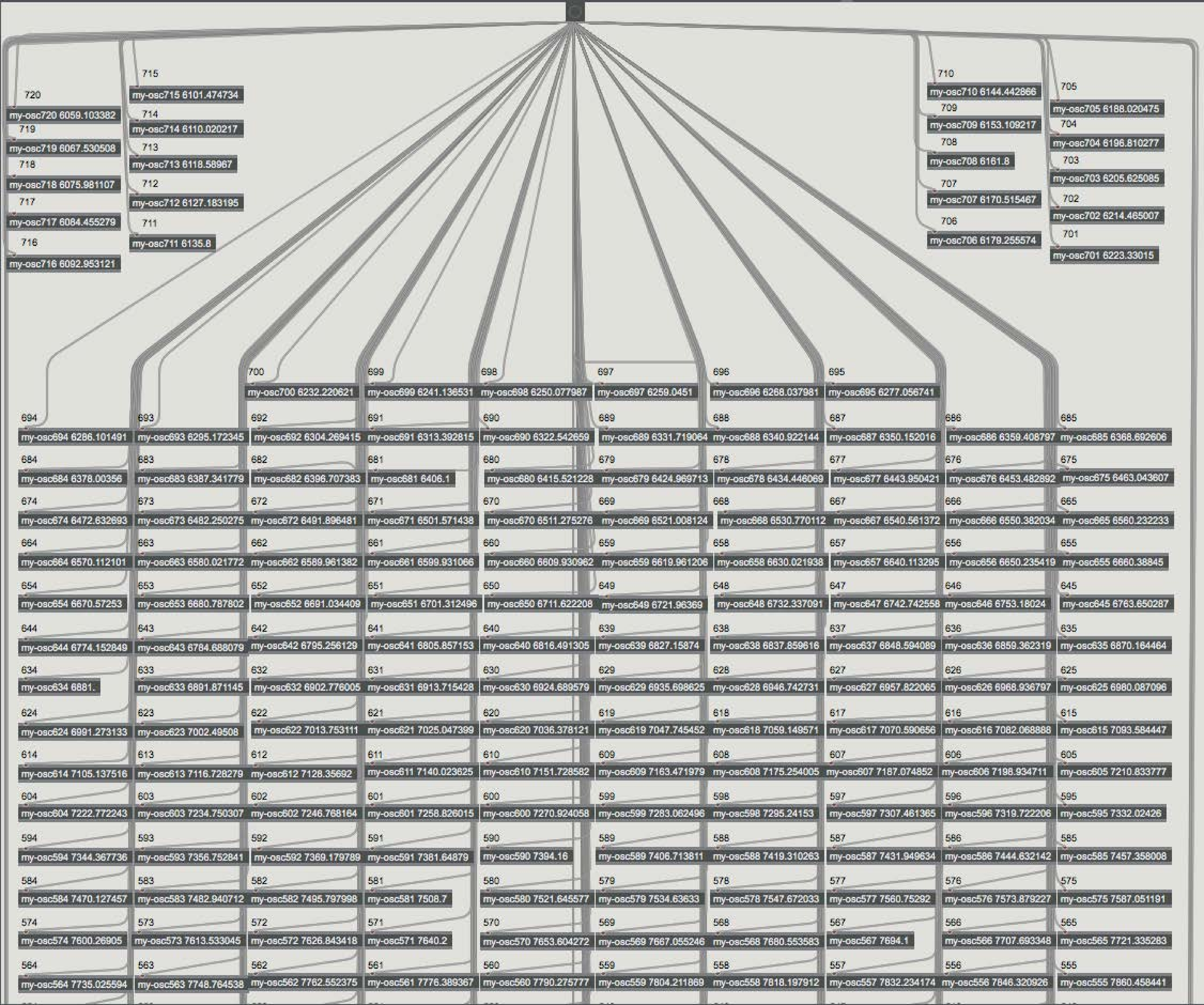
colorless green ideas

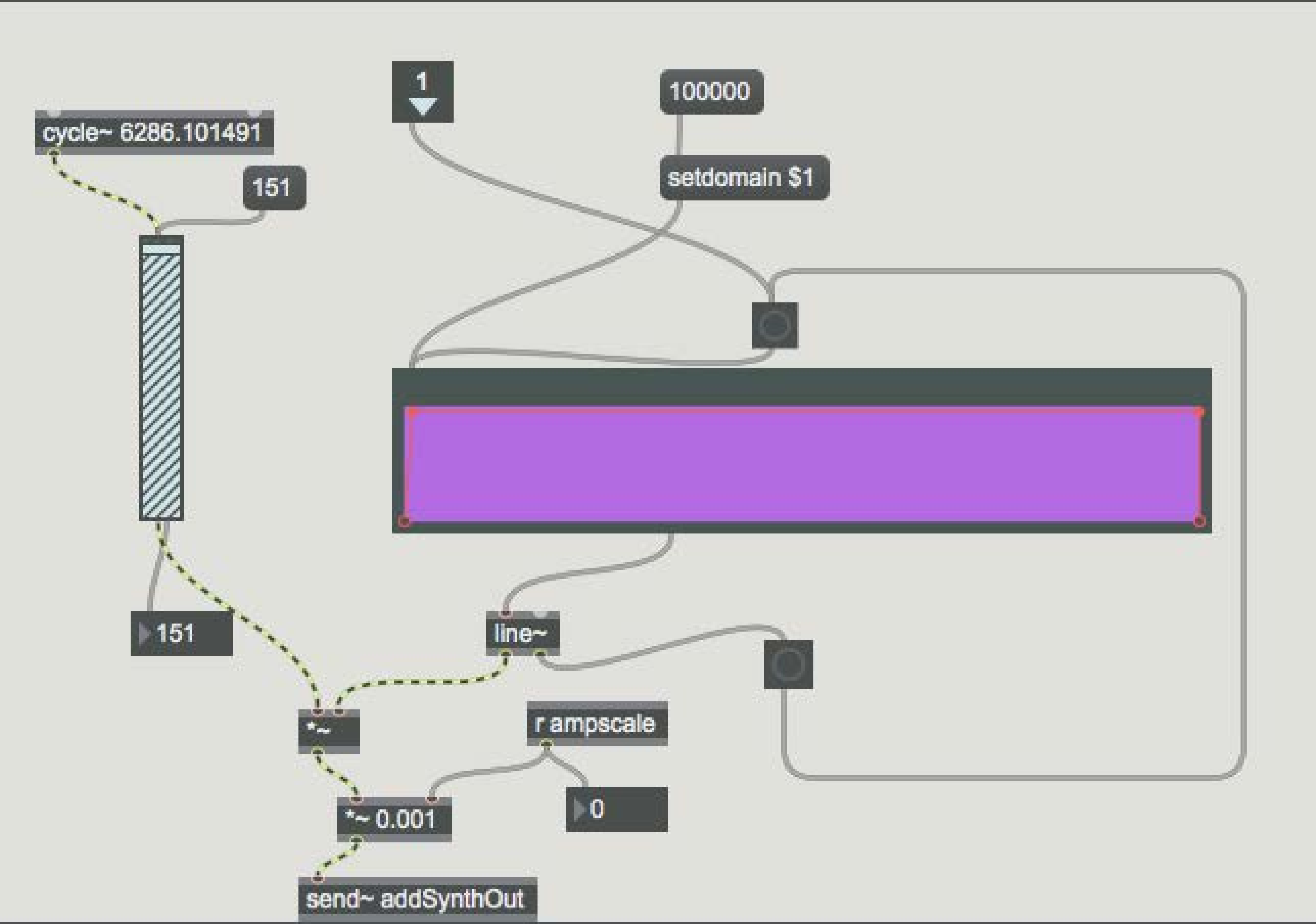
This piece compiled in MAX/MSP includes the discrete frequencies and amplitudes for wavelengths 380nm – 720nm resulting in 420 additively synthesized sine waves.

The amplitudes are derived from the *Theremino* graph of the incandescent bulb detailed above.

The image below is a glimpse of the patch's framework.
All 420 sines are initiated simultaneously.
Each discrete wavelength includes a subpatch, also shown below.
Herein, the amplitude of the given wavelength is set.
The patch also allows for amplitude change over time, and includes a variable time domain. This design is for future projects, which strive to translate video to sound in real time.

The exported .wav file from the additive patch is then re-processed via sampling, EQ automation, harmonic distortion, and reverb for the composition.


720
my-osc720 6059.103382
719
my-osc719 6067.530508
718
my-osc718 6075.981107
717
my-osc717 6084.455279
716
my-osc716 6092.953121
715
my-osc715 6101.474734
714
my-osc714 6110.020217
713
my-osc713 6118.58967
712
my-osc712 6127.183195
711
my-osc711 6135.8
710
my-osc710 6144.442866
709
my-osc709 6153.109217
708
my-osc708 6161.8
707
my-osc707 6170.515467
706
my-osc706 6179.255574
705
my-osc705 6188.020475
704
my-osc704 6196.810277
703
my-osc703 6205.625085
702
my-osc702 6214.465007
701
my-osc701 6223.33015
700
my-osc700 6232.220621
699
my-osc699 6241.136531
698
my-osc698 6250.077987
697
my-osc697 6259.0451
696
my-osc696 6268.037981
695
my-osc695 6277.056741
694
my-osc694 6286.101491
693
my-osc693 6295.172345
692
my-osc692 6304.269415
691
my-osc691 6313.392815
690
my-osc690 6322.542659
689
my-osc689 6331.719064
688
my-osc688 6340.922144
687
my-osc687 6350.152016
686
my-osc686 6359.408797
685
my-osc685 6368.692606
684
my-osc684 6378.00356
683
my-osc683 6387.341779
682
my-osc682 6396.707383
681
my-osc681 6406.1
680
my-osc680 6415.521228
679
my-osc679 6424.969713
678
my-osc678 6434.446069
677
my-osc677 6443.950421
676
my-osc676 6453.482892
675
my-osc675 6463.043607
674
my-osc674 6472.632693
673
my-osc673 6482.250275
672
my-osc672 6491.896481
671
my-osc671 6501.571438
670
my-osc670 6511.275276
669
my-osc669 6521.008124
668
my-osc668 6530.770112
667
my-osc667 6540.561372
666
my-osc666 6550.382034
665
my-osc665 6560.232233
664
my-osc664 6570.112101
663
my-osc663 6580.021772
662
my-osc662 6589.961382
661
my-osc661 6599.931066
660
my-osc660 6609.930962
659
my-osc659 6619.961206
658
my-osc658 6630.021938
657
my-osc657 6640.113295
656
my-osc656 6650.235419
655
my-osc655 6660.38845
654
my-osc654 6670.57253
653
my-osc653 6680.787802
652
my-osc652 6691.034409
651
my-osc651 6701.312496
650
my-osc650 6711.622208
649
my-osc649 6721.96369
648
my-osc648 6732.337091
647
my-osc647 6742.742558
646
my-osc646 6753.18024
645
my-osc645 6763.650287
644
my-osc644 6774.152849
643
my-osc643 6784.688079
642
my-osc642 6795.256129
641
my-osc641 6805.857153
640
my-osc640 6816.491305
639
my-osc639 6827.15874
638
my-osc638 6837.859616
637
my-osc637 6848.594089
636
my-osc636 6859.362319
635
my-osc635 6870.164464
634
my-osc634 6881.
633
my-osc633 6891.871145
632
my-osc632 6902.776005
631
my-osc631 6913.715428
630
my-osc630 6924.689579
629
my-osc629 6935.698625
628
my-osc628 6946.742731
627
my-osc627 6957.822065
626
my-osc626 6968.936797
625
my-osc625 6980.087096
624
my-osc624 6991.273133
623
my-osc623 7002.49508
622
my-osc622 7013.753111
621
my-osc621 7025.047399
620
my-osc620 7036.378121
619
my-osc619 7047.745452
618
my-osc618 7059.149571
617
my-osc617 7070.590656
616
my-osc616 7082.068888
615
my-osc615 7093.584447
614
my-osc614 7105.137516
613
my-osc613 7116.728279
612
my-osc612 7128.35692
611
my-osc611 7140.023625
610
my-osc610 7151.728582
609
my-osc609 7163.471979
608
my-osc608 7175.254005
607
my-osc607 7187.074852
606
my-osc606 7198.934711
605
my-osc605 7210.833777
604
my-osc604 7222.772243
603
my-osc603 7234.750307
602
my-osc602 7246.768164
601
my-osc601 7258.826015
600
my-osc600 7270.924058
599
my-osc599 7283.062496
598
my-osc598 7295.24153
597
my-osc597 7307.461365
596
my-osc596 7319.722206
595
my-osc595 7332.02426
594
my-osc594 7344.367736
593
my-osc593 7356.752841
592
my-osc592 7369.179789
591
my-osc591 7381.64879
590
my-osc590 7394.16
589
my-osc589 7406.713811
588
my-osc588 7419.310263
587
my-osc587 7431.949634
586
my-osc586 7444.632142
585
my-osc585 7457.358008
584
my-osc584 7470.127457
583
my-osc583 7482.940712
582
my-osc582 7495.797998
581
my-osc581 7508.7
580
my-osc580 7521.645577
579
my-osc579 7534.63633
578
my-osc578 7547.672033
577
my-osc577 7560.75292
576
my-osc576 7573.879227
575
my-osc575 7587.051191
574
my-osc574 7600.26905
573
my-osc573 7613.533045
572
my-osc572 7626.843418
571
my-osc571 7640.2
570
my-osc570 7653.604272
569
my-osc569 7667.055246
568
my-osc568 7680.553583
567
my-osc567 7694.1
566
my-osc566 7707.693348
565
my-osc565 7721.335283
564
my-osc564 7735.025594
563
my-osc563 7748.764538
562
my-osc562 7762.552375
561
my-osc561 7776.389367
560
my-osc560 7790.275777
559
my-osc559 7804.211869
558
my-osc558 7818.197912
557
my-osc557 7832.234174
556
my-osc556 7846.320926
555
my-osc555 7860.458441



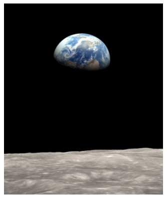
cycle~ 6286.101491
151
1
100000
setdomain $1
151
line~
*~
r ampscale
0
*~ 0.001
send~ addSynthOut

on the invisible lips of the dark (2016)

Using the famous image of the earth taken from the moon landing in 1969, a color proportion analyzer extracts the palette of colors that make up the image.
These color are then individually run through an image color summarizer, which exports a HSV (Hue, Saturation, Value).
The Hue is given as a number from 0 to 400. It is then applied to this formula:
Hue = (650 – wavelength) * 240/(650-475)

The resulting wavelength is then converted into a frequency via f = 1/T, which elicits a frequency in the MHz.
This frequency is then transposed down into the audible range.
This process results in 41 discrete frequencies transposed into octaves of choice.
All frequencies are then superimposed as sine waves, which makeup the tape track.

The music is arranged for 6 synthesizers and a tape track.



Hue = (650 - wavelength)*240/(650-475)

	Hue	Frequency	Transposed	Octave adjustment
	27	475954387704511.7	432.87799390283156	
	24	474308300395256.94	431.38088621640868	
	19	471589978737663.2	428.9085870711126	
	27	475954387704511.7	432.87799390283156	216.43899695141578
	24	474308300395256.94	431.38088621640868	215.69044310820434
	22	473217219873714.94	430.3885542628586	
	27	475954387704511.7	432.87799390283156	865.75598780566312
	214	607338675705261.1	552.37130773572163	
	209	602888842329302	548.32420785651448	
	218	610946117905069.5	555.65225730339944	
	185	582406471145324.5	529.69559978494045	
	21	472673559822747.44	429.89409832693804	
	206	600250104170054.1	545.92428948131247	272.96214474065624

	194	589922163009263.6	536.53108175051886	
	206	600250104170054.1	545.92428948131247	1091.84857896262494
	18	471050049067713.44	428.41752389696328	
	210	603773584905660.4	549.12887654214538	
	211	604660928027186.9	549.93591040982838	
	130	540337711101859	491.43428541525191	
	206	600250104170054.1	545.92428948131247	136.48107237032812
	214	607338675705261.1	552.37130773572163	276.18565386786082
	211	604660928027186.9	549.93591040982838	274.96795520491419
	218	610946117905069.5	555.65225730339944	277.82612865169972
	211	604660928027186.9	549.93591040982838	1099.87182081965676
	208	602006689003478.8	547.52189408052691	
	24	474308300395256.94	431.38088621640868	862.76177243281736
	195	590769230769230.9	537.30148535508388	

	27	475954387704511.7	432.87799390283156	108.21949847570789
	22	473217219873714.94	430.3885542628586	215.1942771314293
	31	478167026424209.5	434.89037709533432	
	27	475954387704511.7	432.87799390283156	1731.51197561132624
	31	478167026424209.5	434.89037709533432	217.44518854766716
	27	475954387704511.7	432.87799390283156	54.10974923785395
	206	600250104170054.1	545.92428948131247	2183.69715792524988
	206	600250104170054.1	545.92428948131247	68.24053618516406
	214	607338675705261.1	552.37130773572163	1104.74261547144326
	194	589922163009263.6	536.53108175051886	268.26554087525943
	200	595041322274708	541.18692994480444	
	188.5	585306371684377.6	532.3330439608777	
	218	610946117905069.5	555.65225730339944	1111.30451460679888
	209	602888842329302	548.32420785651448	274.16210392825724

Frequencies Derived with Relative Pitch Reference

[C#7]
1. 2183 Hz

[A6]
1. 1731 Hz]

[C#6]
1. 1111 Hz
2. 1104 Hz
3. 1099 Hz
4. 1091 Hz

[A5]
1. 862 Hz
2. 865 Hz

[C#5]
1. 541 Hz
2. 547 Hz
3. 549 Hz
4. 549.9 Hz
5. 548 Hz
6. 555 Hz
7. 552 Hz

[C5]
1. 532 Hz
2. 537 Hz

3 529 Hz

[B4]
1. 491 Hz

[A4]
1. 434 Hz
2. 428 Hz
3. 429 Hz
4. 430 Hz
5. 428.9 Hz
6. 431 Hz
7. 432 Hz

[C#4]
1. 274 Hz
2. 277 Hz
3. 274.9 Hz
4. 276 Hz
5. 272 Hz

[C4]
1. 268 Hz

[A3]
1. 217 Hz
2. 215 Hz
3. 215.9 Hz
4. 216 Hz

[C#3]
1. 136 Hz

[A2]
1. 108 Hz

[C#2]
1. 68 Hz

[A1]
1. 54 Hz

In the score, the notation contains only the above 12-ET pitches.
In Appendix 1 the pitch contents' microtonal adjustment is detailed.
The numbers correspond to the microtonal deviation of the relative pitches.

The all caps numbers e.g. ONE refers to the microtonal adjustment number in the appendix. This continues until the next number appears in the score.
Within the appendix itself, each page graphically represents the phrase, which it applies to. It should be read left to right as two lines (upper and lower half), which correspond to score linearly.
For instance, in ONE the first 'line' or upper half of adjustments refer to bars 2 – 13 in the score, while the lower half of the appendix adjustments refers to bars 14 – 27.
The length of the phrase varies in the piece, but the pitch content and general motivic motion will map onto the appendix regardless.

Appendix pages labeled with apostrophes (e.g. ONE') detail the adjustments for the sparser contrapuntal motive in the music notated in synth 3 though 6.

on the invisible lips of the dark

Effects automation for the tape track:

A.
1. Reverb [Room]
2. Reverb [Attack]

B.
1. Delay [Beat]
2. Delay [pitch]

C.
1. Pitch Shift [8 v.a.]
2. Ring shift

D.
1. Auto-filter [drum vocoder]
2. Auto-filter [8 stage dive]

Timecode:

0-0'25" – none

0'25"-0'30" – A[1] B[1] C[1] D[1] A[2] B[2] C[2] D[2] {consecutively}

0'30"-0'40" – A,B [1]

0'40"-0'50" – A,B [2]

0'50"-0'55" - A[1, 2] B[1, 2] C[1, 2] D[1, 2] {consecutively}

0'55"-1'05" – B,C [1]

1'05"-1'15" – B.C [2]

1'15"-1'25" – C,D [1]

1'25"-1'35"- C,D [2]

1'35"-1'45" - A[2] B[2] C[2] D[2] A[1] B[1] C[1] D[1] {consecutively}

1'40"-1'50" – A,C [1]

1'50"- 2'00" – A,C [2]

2'00"- 2'10" – B,D [1]

2'10"- 2'20" – B,D [2]

2'20"- 2'30" – A,D [1]

2'30-2'40" – A,D [2]

2'40"- 2'45" - A[2,1] B[2,1] C[2,1] D[2,1] {consecutively}

2'45"- 3'00" – A,B,C [1]

3'00"-3'15" – A,B,C [2]

3'15"-3'20" - D[1] C[1] B[1] A[1] D[2] C[2] B[2] A[2] {consecutively}

3'20"-3'35" – A,B,D [1]

3'35"-3'50" – A,B,D [2]

3'50"-4'05" – A,C,D [1]

4'05"-4'10" - D[1, 2] C[1, 2] B[1, 2] A[1, 2] {consecutively}

4'10"-4'25" – A,C,D [2]

4'25"-4'40" – B,C,D [1]

4'40"-4'55"- B,C,D [2]

4'55"-5'00" - D[2] C[2] B[2] A[2] D[1] C[1] B[1] A[1] {consecutively}

5'00"-5'20" – A,B,C,D [1]

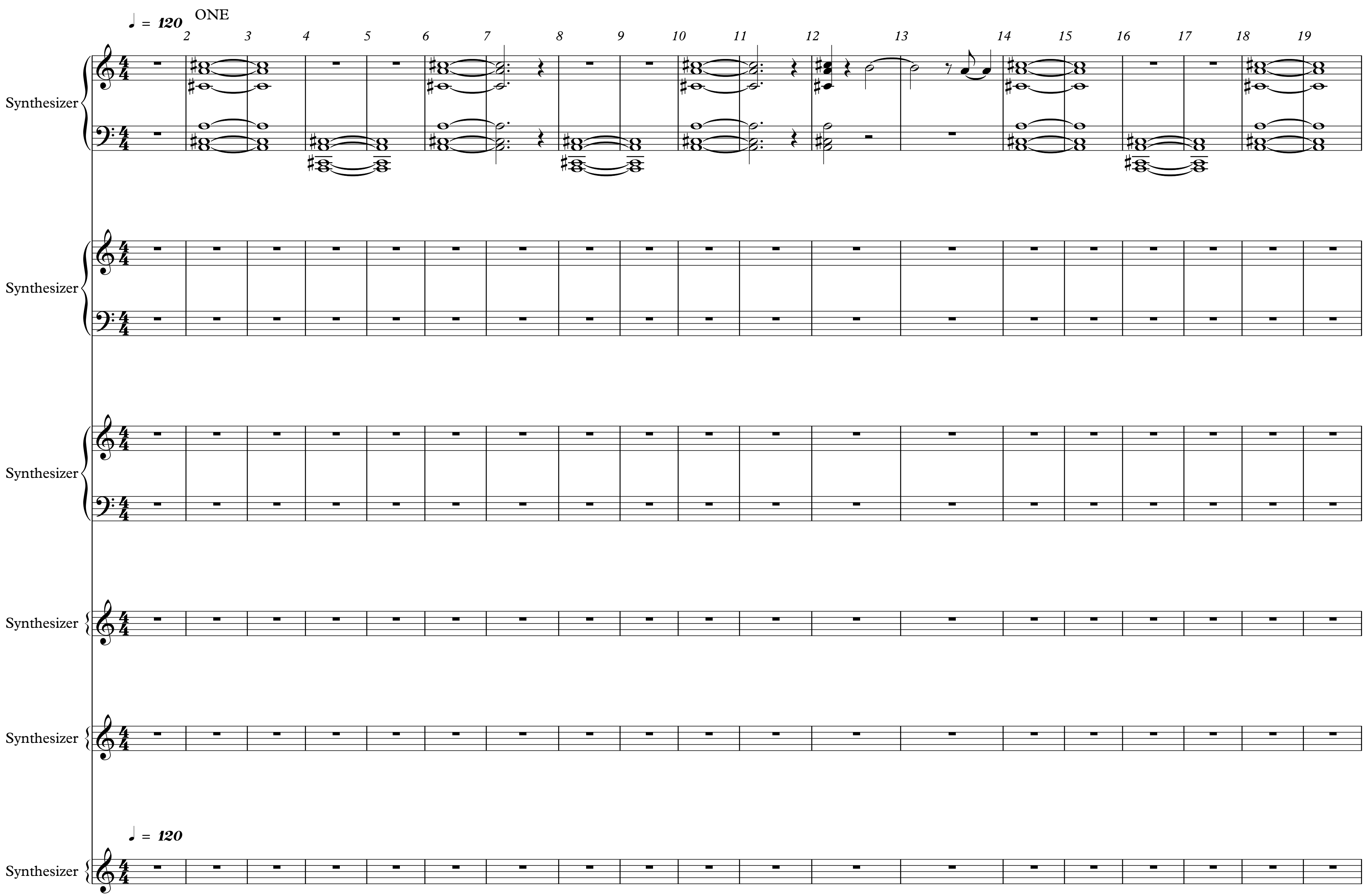
5'20"-5'25" - D[2,1] C[2,1] B[2,1] A[2,1] {consecutively}

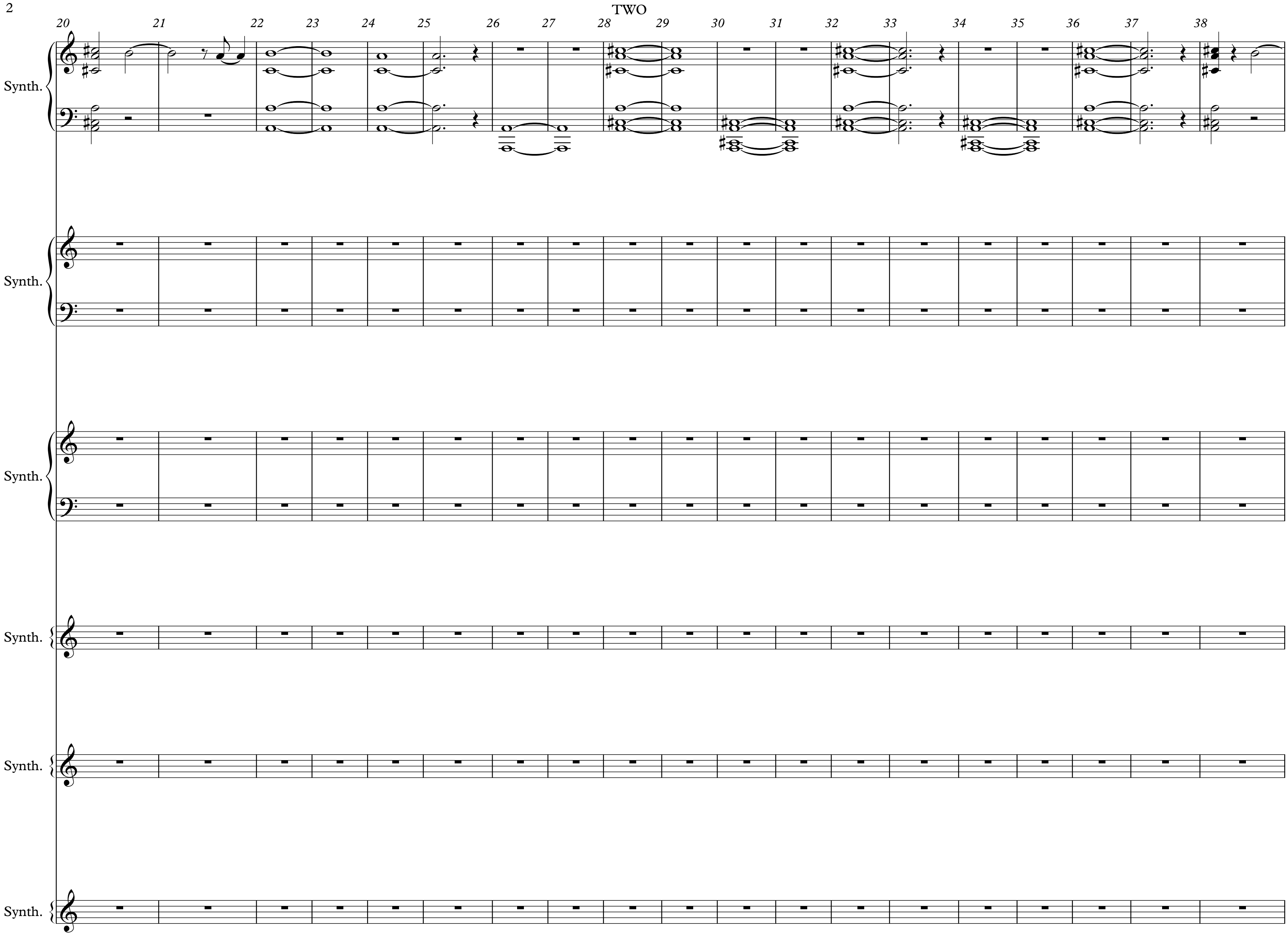
5'25"-5'45" – A,B,C,D [2]

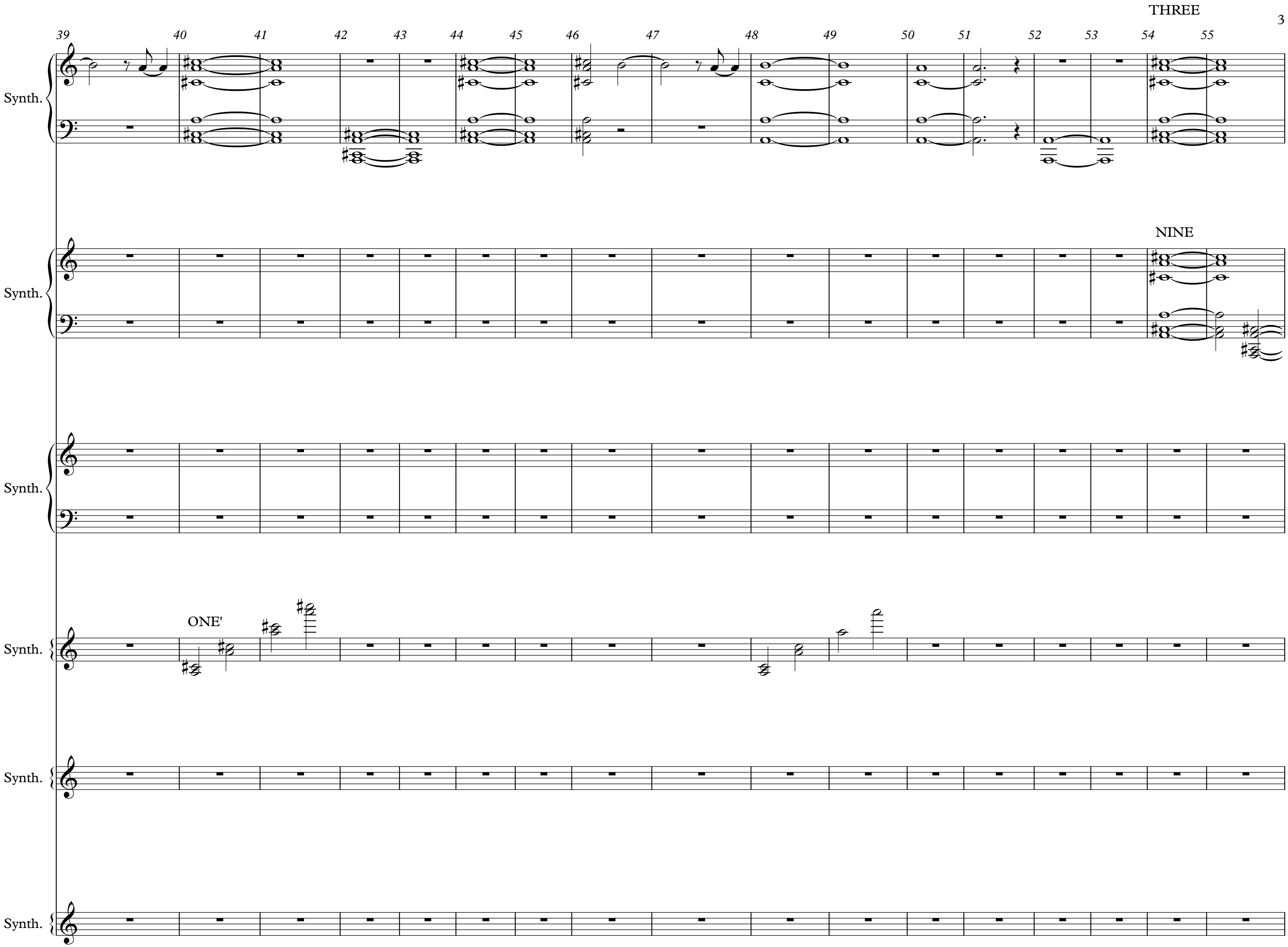
5'45-6'10" – all

6'10"-7'00"- gradually to none

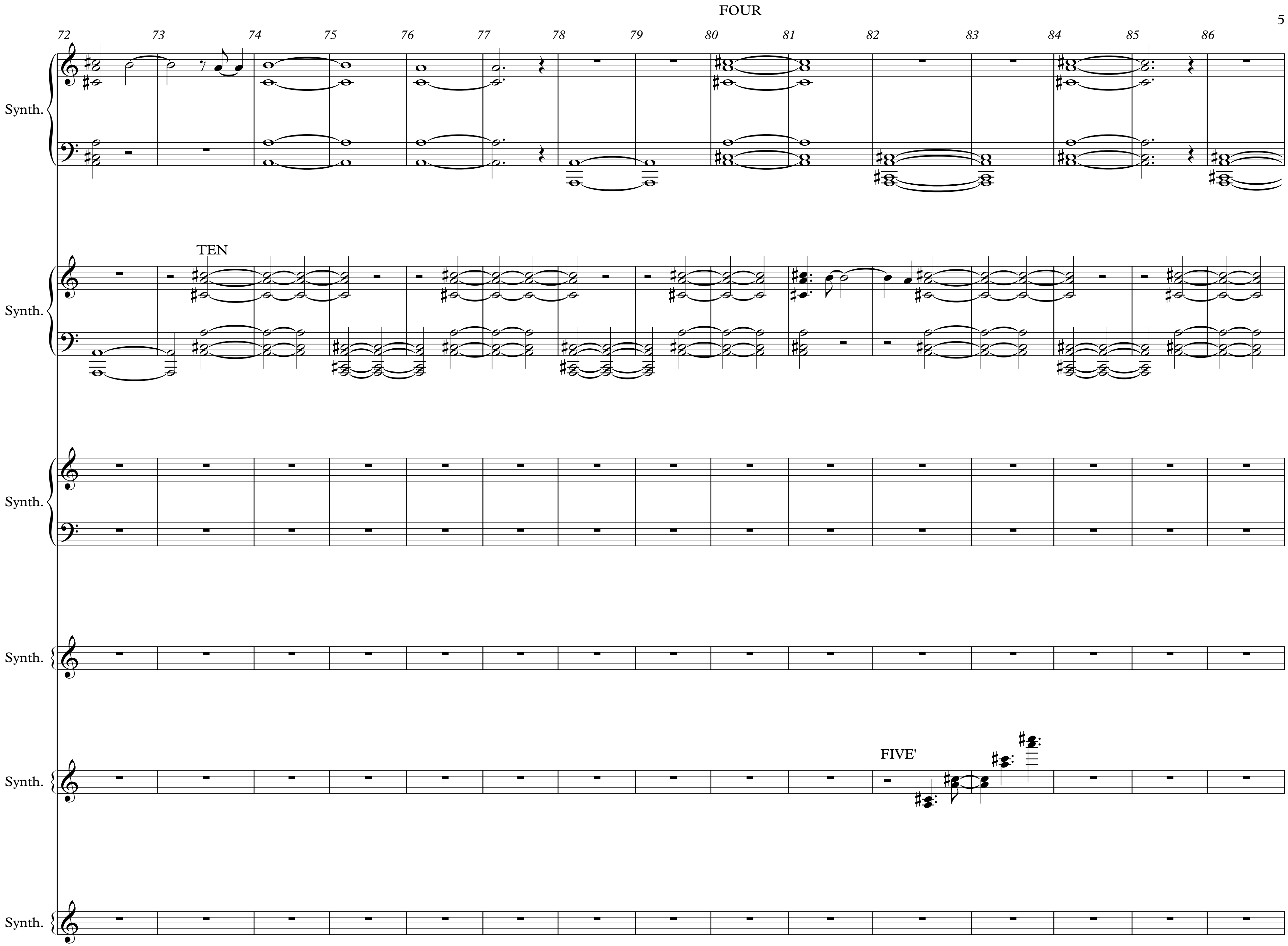
on the invisible lips of the dark



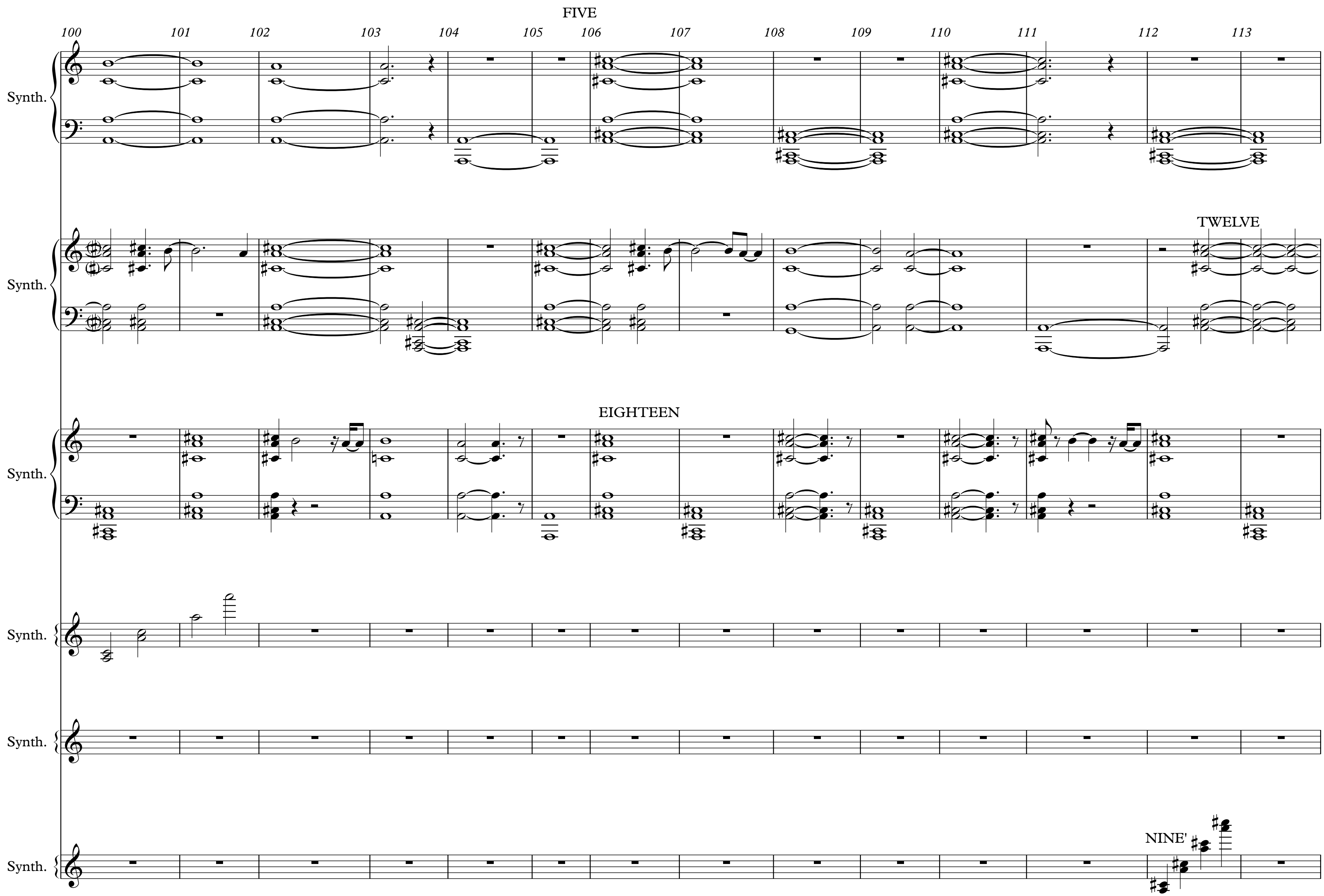

TWO
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
Synth.
Synth.
Synth.
Synth.
Synth.
Synth.


THREE
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
Synth.
NINE
Synth.
Synth.
ONE'
Synth.
Synth.
Synth.


56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
Synth.
Synth.
Synth.
Synth.
Synth.
Synth.


FOUR
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
Synth.
TEN
Synth.
Synth.
Synth.
FIVE'
Synth.
Synth.

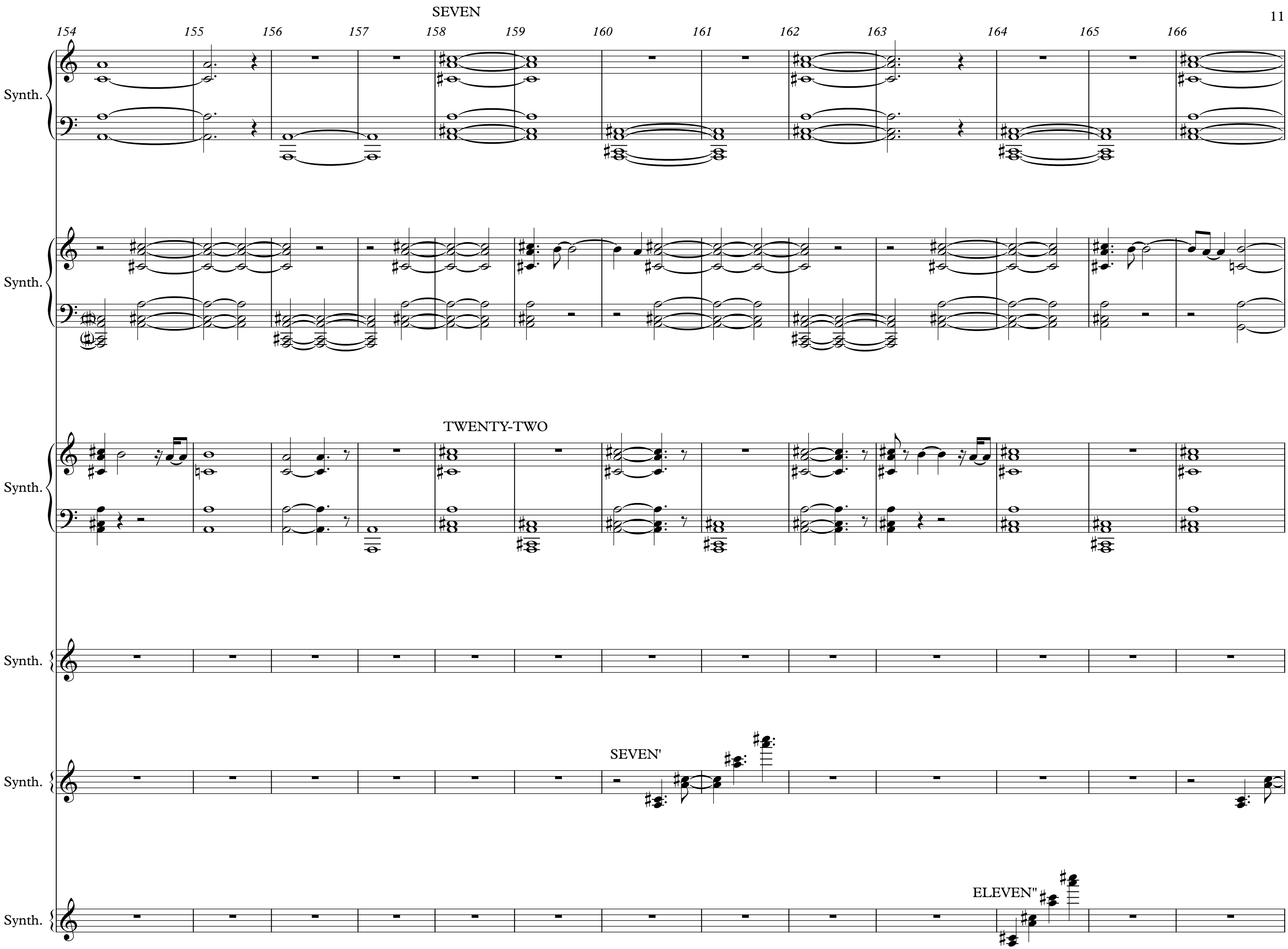

87
88
89
90
91
92
93
94
95
96
97
98
99
Synth.
Synth.
ELEVEN
Synth.
SEVENTEEN
Synth.
TWO'
Synth.
Synth.


FIVE
100 101 102 103 104 105 106 107 108 109 110 111 112 113
Synth.
TWELVE
Synth.
EIGHTEEN
Synth.
Synth.
Synth.
NINE'
Synth.

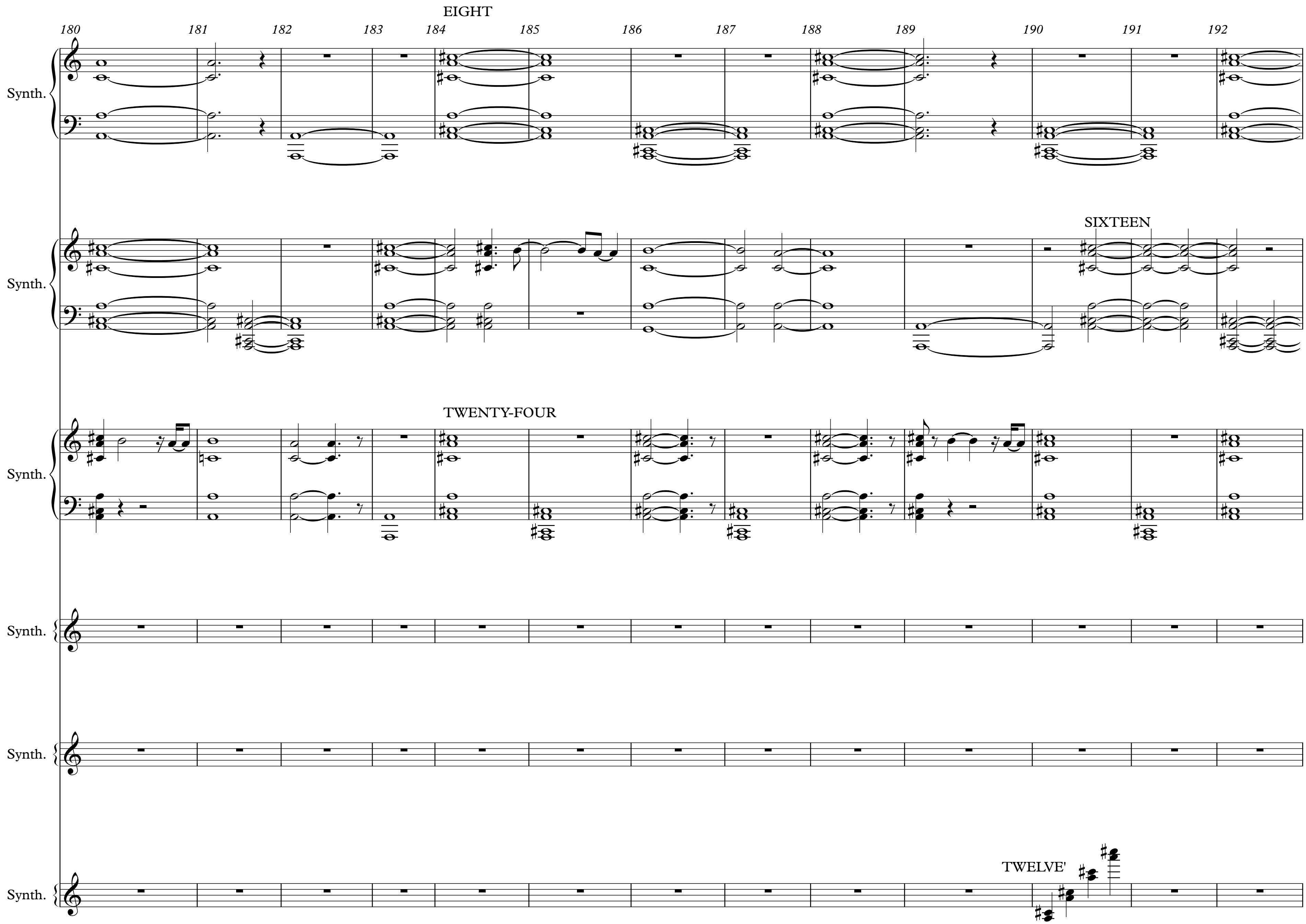

114
115
116
117
118
119
120
121
122
123
124
125
126
Synth.
Synth.
NINETEEN
Synth.
Synth.
SIX'
Synth.
Synth.


SIX
127
128
129
130
131
132
133
134
135
136
137
138
139
140
Synth.
THIRTEEN
Synth.
TWENTY
Synth.
Synth.
Synth.
TEN'
Synth.


141
142
143
144
145
146
147
148
149
150
151
152
153
Synth.
FOURTEEN
Synth.
TWENTY-ONE
Synth.
THREE'
Synth.
Synth.
Synth.


SEVEN
154
155
156
157
158
159
160
161
162
163
164
165
166
Synth.
Synth.
TWENTY-TWO
Synth.
Synth.
SEVEN'
Synth.
ELEVEN''
Synth.


167
168
169
170
171
172
173
174
175
176
177
178
179
Synth.
Synth.
FIFETEEN
Synth.
TWENTY-THREE
Synth.
Synth.
Synth.


EIGHT
180
181
182
183
184
185
186
187
188
189
190
191
192
Synth.
Synth.
SIXTEEN
Synth.
TWENTY-FOUR
Synth.
Synth.
Synth.
TWELVE'


193
194
195
196
197
198
199
200
201
Synth.
Synth.
TWENTY-FIVE
Synth.
FOUR'
Synth.
EIGHT'
Synth.
Synth.


202
203
204
205
206
207
208
209
210
211
Synth.
Synth.
Synth.
Synth.
Synth.
Synth.

APPENDIX 1

ONE:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (1)		A4 (2)		A4 (3)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (4)
A3 (1)		A3 (2)		A3 (3)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (5)		A4 (6)		B4 (1)		B4 (1)	A4 (1)	
C#4 (4)		C#4 (5)			A4 (7)	C4 (1)	C4 (1)	
A3 (4)		A3 (1)				A3 (2)	A3 (3)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

TWO:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (2)		A4 (3)		A4 (4)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (5)
A3 (4)		A3 (1)		A3 (2)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (6)		A4 (7)		B4 (1)		B4 (1)	A4 (1)	
C#4 (4)		C#4 (5)			A4 (1)	C4 (1)	C4 (1)	
A3 (3)		A3 (4)				A3 (1)	A3 (2)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

THREE:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (3)		A4 (4)		A4 (5)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (6)
A3 (3)		A3 (4)		A3 (1)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (7)		A4 (1)		B4 (1)		B4 (1)	A4 (1)	
C#4 (4)		C#4 (5)			A4 (2)	C4 (1)	C4 (1)	
A3 (2)		A3 (3)				A3 (4)	A3 (1)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

FOUR:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (4)		A4 (5)		A4 (6)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (7)
A3 (2)		A3 (3)		A3 (4)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (1)		A4 (2)		B4 (1)		B4 (1)	A4 (4)	
C#4 (4)		C#4 (5)			A4 (3)	C4 (1)	C4 (1)	
A3 (1)		A3 (2)				A3 (3)	A3 (4)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

FIVE:

C#5 (1)		C#5 (2)				C#5 (3)		C#5 (4)		
A4 (5)		A4 (6)				A4 (7)			B4 (1)	
C#4 (1)		C#4 (2)				C#4 (3)				A4 (1)
A3 (1)		A3 (2)				A3 (3)				
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)			C#3(1)				
A2 (1)	A2 (1)	A2 (1)	A2 (1)			A2 (1)				
	C#2 (1)		C#2 (1)							
	A1 (1)		A1 (1)							

C#5 (5)		C#5 (6)	C#5 (7)							
A4 (2)		A4 (3)		B4 (1)			B4 (1)	A4 (5)		
C#4 (4)		C#4 (5)			A4 (4)		C4 (1)	C4 (1)		
A3 (4)		A3 (1)					A3 (2)	A3 (3)		
C#3 (1)	C#3 (1)	C#3 (1)								
A2 (1)	A2 (1)	A2 (1)					A2 (1)	A2 (1)		A2 (1)
	C#2 (1)									
	A1 (1)									A1 (1)

SIX:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (6)		A4 (7)		A4 (1)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (2)
A3 (4)		A3 (1)		A3 (2)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (3)		A4 (4)		B4 (1)		B4 (1)	A4 (6)	
C#4 (4)		C#4 (5)			A4 (5)	C4 (1)	C4 (1)	
A3 (3)		A3 (4)				A3 (1)	A3 (2)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

SEVEN:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (7)		A4 (1)		A4 (2)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (3)
A3 (3)		A3 (4)		A3 (1)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (4)		A4 (5)		B4 (1)		B4 (1)	A4 (7)	
C#4 (4)		C#4 (5)			A4 (6)	C4 (1)	C4 (1)	
A3 (2)		A3 (3)				A3 (4)	A3 (1)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

EIGHT:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (1)		A4 (2)		A4 (3)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (4)
A3 (2)		A3 (3)		A3 (4)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (5)		A4 (6)		B4 (1)		B4 (1)	A4 (1)	
C#4 (4)		C#4 (5)			A4 (7)	C4 (1)	C4 (1)	
A3 (1)		A3 (2)				A3 (3)	A3 (4)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

NINE:

C#5 (1)		C#5 (2)				C#5 (3)		C#5 (4)		
A4 (2)		A4 (3)				A4 (4)			B4 (1)	
C#4 (1)		C#4 (2)				C#4 (3)				A4 (5)
A3 (1)		A3 (2)				A3 (3)				
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)			C#3(1)				
A2 (1)	A2 (1)	A2 (1)	A2 (1)			A2 (1)				
	C#2 (1)		C#2 (1)							
	A1 (1)		A1 (1)							

C#5 (5)		C#5 (6)	C#5 (7)							
A4 (6)		A4 (7)		B4 (1)			B4 (1)	A4 (2)		
C#4 (4)		C#4 (5)			A4 (1)		C4 (1)	C4 (1)		
A3 (4)		A3 (1)					A3 (2)	A3 (3)		
C#3 (1)	C#3 (1)	C#3 (1)								
A2 (1)	A2 (1)	A2 (1)					A2 (1)	A2 (1)		A2 (1)
	C#2 (1)									
	A1 (1)									A1 (1)

TEN:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (3)		A4 (4)		A4 (5)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (6)
A3 (4)		A3 (1)		A3 (2)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (7)		A4 (1)		B4 (1)		B4 (1)	A4 (3)	
C#4 (4)		C#4 (5)			A4 (2)	C4 (1)	C4 (1)	
A3 (3)		A3 (4)				A3 (1)	A3 (2)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

ELEVEN:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (4)		A4 (5)		A4 (6)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (7)
A3 (3)		A3 (4)		A3 (1)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (1)		A4 (2)		B4 (1)		B4 (1)	A4 (4)	
C#4 (4)		C#4 (5)			A4 (3)	C4 (1)	C4 (1)	
A3 (2)		A3 (3)				A3 (4)	A3 (1)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

TWELVE:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (5)		A4 (6)		A4 (7)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (1)
A3 (2)		A3 (3)		A3 (4)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (2)		A4 (3)		B4 (1)		B4 (1)	A4 (5)	
C#4 (4)		C#4 (5)			A4 (4)	C4 (1)	C4 (1)	
A3 (1)		A3 (2)				A3 (3)	A3 (4)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

THIRTEEN:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (6)		A4 (7)		A4 (1)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (2)
A3 (1)		A3 (2)		A3 (3)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (3)		A4 (4)		B4 (1)		B4 (1)	A4 (6)	
C#4 (4)		C#4 (5)			A4 (5)	C4 (1)	C4 (1)	
A3 (4)		A3 (1)				A3 (2)	A3 (3)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

FOURTEEN:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (7)		A4 (1)		A4 (2)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (3)
A3 (4)		A3 (1)		A3 (2)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (4)		A4 (5)		B4 (1)		B4 (1)	A4 (7)	
C#4 (4)		C#4 (5)			A4 (6)	C4 (1)	C4 (1)	
A3 (3)		A3 (4)				A3 (1)	A3 (2)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
								A1 (1)

FIFETEEN:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (1)		A4 (2)		A4 (3)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (4)
A3 (3)		A3 (4)		A3 (1)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (5)		A4 (6)		B4 (1)		B4 (1)	A4 (1)	
C#4 (4)		C#4 (5)			A4 (7)	C4 (1)	C4 (1)	
A3 (2)		A3 (3)				A3 (4)	A3 (1)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

SIXTEEN:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (2)		A4 (3)		A4 (4)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (5)
A3 (2)		A3 (3)		A3 (4)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (6)		A4 (7)		B4 (1)		B4 (1)	A4 (2)	
C#4 (4)		C#4 (5)			A4 (1)	C4 (1)	C4 (1)	
A3 (1)		A3 (2)				A3 (3)	A3 (4)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

SEVENTEEN:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (3)		A4 (4)		A4 (5)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (6)
A3 (1)		A3 (2)		A3 (3)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (7)		A4 (1)		B4 (1)		B4 (1)	A4 (3)	
C#4 (4)		C#4 (5)			A4 (2)	C4 (1)	C4 (1)	
A3 (4)		A3 (1)				A3 (2)	A3 (3)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

EIGHTEEN:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (4)		A4 (5)		A4 (6)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (7)
A3 (4)		A3 (1)		A3 (2)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (1)		A4 (2)		B4 (1)		B4 (1)	A4 (4)	
C#4 (4)		C#4 (5)			A4 (3)	C4 (1)	C4 (1)	
A3 (3)		A3 (4)				A3 (1)	A3 (2)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

NINETEEN:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (5)		A4 (6)		A4 (7)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (1)
A3 (3)		A3 (4)		A3 (1)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (2)		A4 (3)		B4 (1)		B4 (1)	A4 (5)	
C#4 (4)		C#4 (5)			A4 (4)	C4 (1)	C4 (1)	
A3 (2)		A3 (3)				A3 (4)	A3 (1)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

TWENTY:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (6)		A4 (7)		A4 (1)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (2)
A3 (2)		A3 (3)		A3 (4)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (3)		A4 (4)		B4 (1)		B4 (1)	A4 (6)	
C#4 (4)		C#4 (5)			A4 (5)	C4 (1)	C4 (1)	
A3 (1)		A3 (2)				A3 (3)	A3 (4)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

TWENTY-ONE:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (7)		A4 (1)		A4 (2)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (3)
A3 (1)		A3 (2)		A3 (3)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (4)		A4 (5)		B4 (1)		B4 (1)	A4 (7)	
C#4 (4)		C#4 (5)			A4 (6)	C4 (1)	C4 (1)	
A3 (4)		A3 (1)				A3 (2)	A3 (3)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

TWENTY-TWO:

C#5 (1)		C#5 (2)				C#5 (3)		C#5 (4)		
A4 (1)		A4 (2)				A4 (3)			B4 (1)	
C#4 (1)		C#4 (2)				C#4 (3)				A4 (4)
A3 (4)		A3 (1)				A3 (2)				
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)			C#3(1)				
A2 (1)	A2 (1)	A2 (1)	A2 (1)			A2 (1)				
	C#2 (1)		C#2 (1)							
	A1 (1)		A1 (1)							

C#5 (5)		C#5 (6)	C#5 (7)							
A4 (5)		A4 (6)		B4 (1)			B4 (1)	A4 (1)		
C#4 (4)		C#4 (5)			A4 (7)		C4 (1)	C4 (1)		
A3 (3)		A3 (4)					A3 (1)	A3 (2)		
C#3 (1)	C#3 (1)	C#3 (1)								
A2 (1)	A2 (1)	A2 (1)					A2 (1)	A2 (1)		A2 (1)
	C#2 (1)									
	A1 (1)									A1 (1)

TWENTY-THREE:

C#5 (1)		C#5 (2)				C#5 (3)		C#5 (4)		
A4 (2)		A4 (3)				A4 (4)			B4 (1)	
C#4 (1)		C#4 (2)				C#4 (3)				A4 (5)
A3 (3)		A3 (4)				A3 (1)				
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)			C#3(1)				
A2 (1)	A2 (1)	A2 (1)	A2 (1)			A2 (1)				
	C#2 (1)		C#2 (1)							
	A1 (1)		A1 (1)							

C#5 (5)		C#5 (6)	C#5 (7)							
A4 (6)		A4 (7)		B4 (1)			B4 (1)	A4 (2)		
C#4 (4)		C#4 (5)			A4 (1)		C4 (1)	C4 (1)		
A3 (2)		A3 (3)					A3 (4)	A3 (1)		
C#3 (1)	C#3 (1)	C#3 (1)								
A2 (1)	A2 (1)	A2 (1)					A2 (1)	A2 (1)		A2 (1)
	C#2 (1)									
	A1 (1)									A1 (1)

TWENTY-FOUR:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (3)		A4 (4)		A4 (5)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (6)
A3 (2)		A3 (3)		A3 (4)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (7)		A4 (1)		B4 (1)		B4 (1)	A4 (3)	
C#4 (4)		C#4 (5)			A4 (2)	C4 (1)	C4 (1)	
A3 (1)		A3 (2)				A3 (3)	A3 (4)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

TWENTY-FIVE:

C#5 (1)		C#5 (2)		C#5 (3)	C#5 (4)		
A4 (4)		A4 (5)		A4 (6)		B4 (1)	
C#4 (1)		C#4 (2)		C#4 (3)			A4 (7)
A3 (1)		A3 (2)		A3 (3)			
C#3 (1)	C#3 (1)	C#3 (1)	C#3 (1)	C#3(1)			
A2 (1)	A2 (1)	A2 (1)	A2 (1)	A2 (1)			
	C#2 (1)		C#2 (1)				
	A1 (1)		A1 (1)				

C#5 (5)		C#5 (6)	C#5 (7)					
A4 (1)		A4 (2)		B4 (1)		B4 (1)	A4 (4)	
C#4 (4)		C#4 (5)			A4 (3)	C4 (1)	C4 (1)	
A3 (4)		A3 (1)				A3 (2)	A3 (3)	
C#3 (1)	C#3 (1)	C#3 (1)						
A2 (1)	A2 (1)	A2 (1)				A2 (1)	A2 (1)	A2 (1)
	C#2 (1)							
	A1 (1)							A1 (1)

ONE' :

C#7 (1)
A6 (1)

C#6 (1)
A5 (1)

C#5 (1)
A4 (1)

C#4 (1)
A3 (1)

A6 (1)

A5 (2)

C5 (1)
A4 (2)

C4 (1)
A3 (1)

TWO’ :

C#7 (1)
A6 (1)

C#6 (2)
A5 (1)

C#5 (2)
A4 (3)

C#4 (2)
A3 (3)

A6 (1)

A5 (2)

C5 (2)
A4 (4)

C4 (1)
A3 (4)

THREE’ :

C#7 (1)	
A6 (1)	A6 (1)
C#6 (3)	
A5 (1)	A5 (2)
C#5 (3)	C5 (3)
A4 (5)	A4 (6)
C#4 (3)	C4 (1)
A3 (1)	A3 (2)

FOUR’ :

C#7 (1) A6 (1)	A6 (1)
C#6 (4) A5 (1)	A5 (2)
C#5 (4) A4 (7)	C5 (1) A4 (1)
C#4 (4) A3 (3)	C4 (1) A3 (4)

FIVE' :

C#7 (1)	
A6 (1)	A6 (1)
C#6 (1)	
A5 (1)	A5 (2)
C#5 (5)	C5 (2)
A4 (2)	A4 (3)
C#4 (5)	C4 (1)
A3 (1)	A3 (2)

SIX' :

C#7 (1)
A6 (1)

C#6 (2)
A5 (1)

C#5 (6)
A4 (4)

C#4 (1)
A3 (3)

A6 (1)

A5 (2)

C5 (3)
A4 (5)

C4 (1)
A3 (4)

SEVEN' :

			C#7 (1) A6 (1)				A6 (1)
		C#6 (3) A5 (1)				A5 (2)	
	C#5 (7) A4 (6)				C5 (1) A4 (7)		
C#4 (2) A3 (1)				C4 (1) A3 (2)			

EIGHT' :

C#7 (1) A6 (1)	A6 (1)
C#6 (4) A5 (1)	A5 (2)
C#5 (1) A4 (1)	C5 (2) A4 (2)
C#4 (3) A3 (3)	C4 (1) A3 (4)

NINE' :

C#7 (1)
A6 (1)

C#6 (1)
A5 (1)

C#5 (2)
A4 (3)

C#4 (4)
A3 (1)

A6 (1)

A5 (2)

C5 (3)
A4 (4)

C4 (1)
A3 (2)

TEN' :

C#7 (1)
A6 (1)

C#6 (2)
A5 (1)

C#5 (3)
A4 (5)

C#4 (5)
A3 (3)

A6 (1)

A5 (2)

C5 (1)
A4 (6)

C4 (1)
A3 (4)

ELEVEN’ :

C#7 (1)	
A6 (1)	A6 (1)
C#6 (3)	
A5 (1)	A5 (2)
C#5 (4)	C5 (2)
A4 (7)	A4 (1)
C#4 (1)	C4 (1)
A3 (1)	A3 (2)

TWELVE' :

C#7 (1)	
A6 (1)	A6 (1)
C#6 (4)	
A5 (1)	A5 (2)
C#5 (5)	C5 (3)
A4 (2)	A4 (3)
C#4 (2)	C4 (1)
A3 (3)	A3 (4)