Holographic Composition Technique:

Revisiting the Medieval Treatises on Iranian Music

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To Martyna,
For everything

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Abstract

In the field of photography, the term hologram is defined as: "a three-dimensional image reproduced from an interference pattern produced by a split coherent beam of rays." Relating the above statement to the genre of music, the closest we can come to explaining the hologram is to consider the phenomenon of combination tones. Combination tones are the ghost sounds created in the inner ear when two different tones are played simultaneously.

Holographic Composition Technique is a term I coined specifically for my practice of the compositional path. It is a technique based on two main themes in music that interest me most: psychoacoustics, and the world of microtonality, with the biggest influence being the world of Just Intonation and non-Western tuning systems.

As someone fascinated by physics and mathematics, both psychoacoustics and microtonality are very attractive sources of inspiration. My interest in microtonality encompasses all kinds of approaches: different temperament systems, Just Intonation techniques, non-octave subdivisions or the so-called "traditional non-Western" practices. Nevertheless, I will focus on Iranian microtonality, especially the tuning systems written by Persian polymaths between the 9th and 15th centuries, with a focus on the works of Fārābi (10th century), Ibn Sinā (10th century) and Safiaddin Ormavi (13th century).

This research intends to connect the world of psychoacoustics, the medieval Iranian tuning systems, and the *Radif* of classical Iranian music, in an attempt to combine them as material for compositional practice. I categorise various tunings of the medieval thinkers and polymaths who were active in the vast territories of the Middle East, and show ways in which this material can be used in contemporary music to create a personal fusion of the manifestations of the Orient and Occident in music.

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Glossary

List of Treatises Quoted in the Text

Al-Aghāni	(The Book of Songs), by Abū al-Faraj al-Iṣbahānī
Al-Aghāni al-Kabir	(The Great Book of Songs), by Ishāq al-Mawsili
Dorrat al-Tāj fi ḡorrat al-Dabbāj	(The Pearly Crown), by Qutb al-Din al-Shirāzi
Ikhwān Al-Ṣafā	(The Brethren of Sincerity), by Ikhwān Al-Ṣafā
Ketāb al-Advār also Kitāb al-Adwār[1]	(The Book of Circles), by Safiaddin Ormavi
Kitāb al-Lahw wa-l-Malāhi	(On Music and Musical Instruments), by Ibn Khordādbeh
Kitāb al-Musiqā al-Kabir	(The Great Book of Music), by Abu Nasr Fārābi
Kitāb al-Nagham fi al-Musicā	(The Book of Melodies in Music), by Ibn al-Munajjim
Kitāb al-Shifā	(The Book of Cure), by Ibn Sinā
Resāla fi'l-Mūsīqī	(Treatise on Music), by Ibn al-Munajjim
Risāla al-Sharafiyya	(The Sharafiya Treatise), by Safiaddin Ormavi
Risāla fi hubr Ta'lif al-'Alhān	(On the Composition of Melodies), by Al-Kindi

[1] Respective transliteration from Farsi and Arabic.

Names of Intervals

Apotome Pythagorean chromatic semitone, with the ratio 2187/2048 or 113.6¢

Baghiyeh Arabic for the Pythagorean limma, interchangeable with Fazleh depending on the author

Fazleh Arabic for the Pythagorean limma, interchangeable with Baghiyeh depending on the author

Limma Pythagorean diatonic semitone, with the ratio 256/243 or 90¢

Major Limma A syntonic comma away from the Apotome with the ratio 135/128 or 92.2¢

Mujannab 1) neutral second with various ratios (explained in the text) 2) Mujannab as a fret position, translated as "interior"

Mujannabāt Plural form of Mujannab (see Mujannab)

Pythagorean Comma Or Ditonic comma, is the small interval existing in Pythagorean tuning between two enharmonically equivalent notes such as C and ♯B, with the ratio 531441⁄524288 or 23.5¢

Schisma The difference between a Pythagorean comma and a syntonic comma with the ratio 32805/32768 or 2.0¢

Syntonic Comma Difference between a Pythagorean major third (81/64) and a just major third (5/4), with the ratio of 81/80 or 21.5¢

Tanini Arabic for the Pythagorean whole tone (9/8)

Zu'l al-Arba Arabic for the just perfect fourth (4/3)

Zu'l al-Khams Arabic for the just perfect fifth (3/2)

Zu'l al-Kol Arabic for the octave (2/1)

Instruments

Do'Nāy	Double reed instrument made of two tubes that are connected in parallel
Nāy	End-blown woodwind instrument
Oud	A short-necked, plucked string instrument. The main instrument of Arab and Iranian musicians in ancient and medieval times
Robāb	Bowed string instrument
Santur	A hammered dulcimer; santur is considered to be one of the oldest instruments in Iran. Historically, this instrument can be found in iconographic documents from ancient Babylon (1600-911 BCE) and Neo-Assyria (916-912 BCE).
Sornāy	Double reed instrument
Tanbur Baghdad	A long-necked, plucked string historical instrument described in *Kitāb al-Musiqā al-Kabir* (The Great Book of Music) by Fārābi. It has different tuning than *Tanbur Khorasan*
Tanbur Khorasan	A long-necked, plucked string historical instrument described in *Kitāb al-Musiqā al-Kabir* (The Great Book of Music) by Fārābi that has different tuning than *Tanbur Baghdad*
Tār	A long-necked, plucked string instrument. Iranian national instrument since the Safavid Dynasty (15th century)

General Terms

Abād Plural form of Bo'd (see Bo'd)

Ajnās Plural form of Jins (see Jins)

Al'hān Plural form of Lahn (see Lahn)

Anf Arabic for nut, on a stringed musical instrument

Āvāz 1) in the contemporary classical music of Iran regarded as a small and concise Dastgāh that can be performed alongside or independently of its related Dastgāh (see Dastgāh); 2) In the historical context, a collection of two different modes that have an internal modal relationship

Bensir Arabic for the ring finger

Bo'd Arabic for interval

Bozorg Farsi for large

Dastgāh Collection of melodic patterns traditionally gathered on the basis of an internal modal logic; a set of several Dastgāh, which forms the Radif of classical Iranian music (see Radif)

Do'r Term used by Safiaddin Ormavi for a mode, singular form of Advār (see Maqām)

Emād Arabic for mainstay

Epimeric A superpartient ratio. $\frac{n+a}{n}$ Where *a* is greater than 1, and shares no primes with *n*

Epimoric A superparticular ratio. $\frac{n+1}{n}$ Or $1+\frac{1}{n}$, where *n* is a whole number greater than 0

Ghavi Arabic for strong, used to describe diatonic tetrachords

Gusheh The smallest part of Dastgāh; a melodic pattern that may be accompanied by a specific rhythmic pattern or without a specific rhythm.

Gusheh-ha Plural form of Gusheh (see Gusheh)

Harmonic Space Harmonic space in this thesis refers to the unlimited world of the harmonic/subharmonic series of a fundamental frequency and the distance between them

HEJI The Helmholtz-Ellis JI Pitch Notation (HEJI) accidentals are developed by Marc Sabat and Thomas Nicholson from Plainsound Music Edition

Jins In old music treatises, the word is used to describe tetrachords or small pitch sets (consisting of three to five notes) that are the smallest components of different musical scales; probably derived from the Greek word γένος (genos)

Khensir Arabic for the little finger

Koron An accidental lowering the pitch by a quarter-tone, designed by Ali-Naqi Vaziri (1886-1979) for distinguishing microtones of the Iranian music

Kouchak Farsi for small

Lahn In the historical context, referring to a melody, song or a tune

La'yyen Arabic for soft

Majrā Arabic for trajectory; a starting point for creating melodic modes in Ibn al-Munajjim's treatises

Maqām A type of musical classification that has been used to classify Iranian, Turkish and Arabic modal music in different periods of history, including the present day

Mola'vvan Arabic for enharmonic tetrachords

Molāyem Farsi for consonant

Motevaset Farsi for medium

Mutlaq Term used for the open string, the translation from Arabic means absolute

Nā-Molāyem Farsi for dissonant

Par'deh Term used for mode by Persian musicians (see Maqām)

Parthian An extinct language from the Northwestern Iranian language family, also known as Arsacid Pahlavi

Qinā Arabic for singing

Radif Short term for the Radif of classical Iranian music; a collection of traditional Iranian melodies divided into different categories, with a specific order

Rāsem Arabic for chromatic tetrachords

Sabbābeh Arabic for the index finger

Sayr Complete performance of Radif, translates as journey from Persian

Sho'beh A collection of two different modes that have an internal modal relationship; equivalent meaning of Āvāz

Shodōd Term used for mode by Arab musicians

Sori An accidental raising the pitch by a quarter-tone, designed by Ali-Naqi Vaziri (1886-1979) for distinguishing microtones of the Iranian music

Ta'lifi Arabic for enharmonic tetrachords

Wustā Arabic for middle finger

Regions

Baghdad The largest city and capital of Iraq. Baghdad is one of the historical and cultural cities in the Arab world and the Middle East. The history of Baghdad begins with the Abbasid period

Bukhara Second capital of the Samanid Empire, located in present-day Uzbekistan

Ctesiphon One of the three Sasanian education centers, located in Salman Pak, south of Baghdad in today's Iraq

Gorganaj The name of an ancient city in the northeast of Turkmenistan and in the south of the Uzbekistan border

Gundeshapur One of the three Sasanian education centers, located in present-day Khuzestan province of Iran

Hamedan One of the oldest cities in Iran, has been one of the country's ancient capitals

Merv One of the major centers of Persian and Iranian civilization, located near present-day Mary, Turkmenistan

Ray Or Rey, is one of the oldest cities in the world in central Iran. The settlement in this city dates back to 8000 BCE

Rhesaina One of the three Sasanian education centers, located near present-day Ceylanpınar, Turkey

Samarkand First capital of the Samanid Empire, located in present-day Uzbekistan

Transoxiana A land located between the two rivers Amu Darya and Syr Darya, considered one of the cradles of the ancient civilizations. Corresponds to present-day eastern Uzbekistan, western Tajikistan, parts of southern Kazakhstan, parts of Turkmenistan and southern Kyrgyzstan

Urmia A city in the northwest of Iran; it is believed that Urmia was founded as early as 2000 BCE

Preface

The Holographic Composition Technique is a term I coined for my musical practice several years ago. It attempts to explain my artistic path, which stands at a crossroads of the regional and classical music of Iran, colliding with contemporary Western music aesthetics and methods. The result of this collision can be seen in my music as a rare and ambiguous blend of traditions. In a general but broad understanding, The Holographic Composition Technique is a research method to find a personal approach to the fields that interest me the most: the world of microtonality and psychoacoustics. In this paper, I will depict what I am searching for and how I apply various nuances to my music in reference to the research subject. I will focus on the origin of the sound world I am passionate about and draw a path toward reshaping Iranian music's legacy in my compositional language.

In my approach and understanding of The Holographic Composition Technique, Iranian classical music is divided into two historical sections of interest:

- Old tuning and modal systems of Iran
- Contemporary classical music of Iran

According to the western academic method, present-day Iranian music can be divided into three categories. The first category, the *Radif* system, is referred to as "Iranian classical music", with the first evident fragments dating back to the beginning of the 18th century. It does not belong to any one region of Iran, however from a musical perspective, it is a relatively complete collection of all the cultures living in Iran over thousands of years. According to the Western academic method, the second category of present-day Iranian music is known as "regional music", which belongs, and is historically tied, to the culture and traditions of each ethnic group living in Iran. The third category is characterised as "Western European classical music", introduced to Iranians by French musicians in approximately 1850 with the aim of establishing a military music tradition in the country (During, Zia Mirabdolbaghi, & Dariush Safvat, 1991).

My education within academic institutions, both in Iran and abroad, consists of Western European classical music, though I have also had private tuition in the *Radif* music system. These experiences, combined with my upbringing in a household not indifferent to the Regional music of Iran, have resulted in my interests oscillating between classical Iranian and folk music, as well as contemporary Western music practices.

As an Iranian-born artist, I have consistently tried to merge the musical past and present of my home country with the world I live and work in as an internationally active contemporary musician, in order to find my own unique and personal language in music. This endeavour has led me to discover the fascinating world of my country's centuries-old tuning systems which have disappeared in the vortex of time. The aspect of my project that focuses on the past is a personal investigation through the medieval Iranian treatises on music, particularly those created between the 9th and 15th centuries, which I will discuss in more detail throughout the first and second chapters. Aided by the musical mathematics and language of rational intonation, I will examine the intervals and modal structures of Iranian music to create my own sonic galaxy in the endless universe of Harmonic Space[2]. It is important to note that this is neither ethnomusicological research nor an attempt to revive or recreate the old music. The Holographic Composition Technique demonstrates how I tune in to the world through different holographic lenses.

Considering the sustained focus of the artistic research programme at the Norwegian Academy of Music is on creation, recording the artistic research process, and building a new discourse in academia, I have strived to stay on this path throughout the duration of my studies. Nevertheless, I have had to oscillate between artistic, ethnomusicological, historical, and scientific approaches in order to forge the basis for my compositional processes as well and as accurately as possible. The Holographic Composition Technique: Revisiting the Medieval Treatises on Iranian Music, is divided into three main chapters. The language of the first two chapters borrows from ethnomusicological and historical practice and documents the findings from the perspective of Just Intonation analysis. The third chapter, containing my critical reflections on the artistic research process, reinvents the literary style to some degree, a decision made by necessity in order to show the different layers of my personal striving within the academic content of this endeavour, and my artistic interpretation of it. It presents each step of this research in its purest form, from the use of the scientific material to the way it is translated into artistic work, and finally in the compositional processes of my musical production. With a more personal voice, moderately removed from the standard academic discourse, it allows me to take the reader of this text on a journey between the scientific and the artistic world, providing a possible justification and method for combining scientific and artistic investigations within the field of academic artistic research.

[2] See glossary.

The thesis will address the following inquiries:

- What is the accurate intonation of Iranian classical music, and how can it be found and used in my own artistic language?
- Is there any relation between the old tuning systems, classical Iranian music, and Iranian regional music? If yes, is there one general tuning system that could work for both the classical and regional music of Iran?
- What is the simplest method to accurately communicate what I hear with the musicians?
- How does my background, my music, and my aesthetics, affect who I am as an artist?
- What knowledge can this research add to the academic field of music?

The development of this technique is a means to understand the roots of Iranian music and the possibilities and potentials of these theoretical materials. Born out of a personal endeavour to discover my sonic voice, the result is not only for my own use but for other musicians interested in the theoretical results of my research in contemporary music composition.

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Chapter 1

A Brief Introduction to the Music and History of Iran

1.1 On Language and Legacy

My point of departure into the world of microtonality lies in the traditional music of Iran, specifically the tuning systems proposed by Iranian polymaths between the 9th and 15th centuries. Mehrdad Fallahzadeh referred to this period as "the Golden Age of Persian writings on music" (2005, p.9). According to Mohammad Taghi Masoudieh's (1927-1999) book, *Manuscrits persans concernant la musique*, more than 200 treatises are written in Persian[3] between the 11th and 20th centuries.

There are several vital treatises written between the 8th and 11th centuries by Iranians in Arabic, which was the scientific and *lingua franca* during the first centuries following the arrival of Islam to Iran[4]. In addition to Masoudieh's book, there is another crucial publication by Mehrdad Fallahzadeh (1961) called *Persian Writing on Music: A Study of Persian Musical Literature from 1000 to 1500 AD*, which extensively discusses this issue. Both of these books focus only on the medieval writings by the Iranian polymaths documented in Farsi. It should be stressed, however, that since Arabic was the scientific language of Iran for several centuries, studying treatises written in the original Arabic version could offer a better understanding and broader view of the evolution of the tuning system(s) in Iranian music. That is why the notion of language and legacy, which followed specific documentation of various treatises, played an essential role in my attempt to depict, compare, and draw connections between the sources of my research.

History does not always allow us to comprehensively discover its details and blurs the evolutionary timeline. In this case, there are unfortunately no existing texts about Iranian music theory before the Muslim conquest of Iran (633–654 CE). One of the most important reasons is that there were no scientific or systematic approaches to music and art during that historical period. The share of musical knowledge was based on the oral tradition, and the musical craft passed from master to pupil (Hajarian, 2014).

What we do know about music from the classical antiquity era in Iran is possible to discover through the writings of famous historians, such as Herodotus and Xenophon. They document in detail the festive, martial, and religious music during the first two Persian empires: The

[3] Persian or Farsi has been the language of Iran since the 8th century.
[4] The Arab-Islamic conquest of Iran in 650 CE introduced Islam to the country.

Achaemenid Empire (550-330 BCE), led by Cyrus the Great; and the Hellenistic state of the Seleucid Empire (312 BCE - 63 CE). The latter led to a deep connection and interweaving between the music and culture of ancient Iran and Greece. This cultural connection continued and deepened during the Parthian Empire (247 BCE - 224 CE), reestablishing Iranian rule, and was finally succeeded by the rise of the Sasanian Empire (224 - 651 CE). This was the last pre-Islamic Persian empire, and a new era for Persian art and culture which saw the establishment of three Sasanian education centres (Ctesiphon, Resaina, Gundeshapur)[5] making them one of the most important and influential civilizations in the ancient world. The impact of the knowledge transferred from the Sasanian Empire to what is known today as the 'Golden Age of Islam' in science, philosophy, art, architecture, and music, is irreplaceably evident. The Sassanid Dynasty was the first in which there were enough written documents about the status of music, so it is clear to state that music had a high position among the people and the court at that time. There are many detailed descriptions of famous musicians from the court during the reign of Khosrow II (590 - 628), among them Bamshad, Nakisa, Sarkash and Ramtin (Daryaee, 2014).

In his book, *Short Study on the Masters of Iranian Music and Musical Modes of Iran*, master musician, philosopher, and ethnomusicologist, Dariush Safvat (1928-2013) extracts valuable data from several sources, providing the names and descriptions of thirty musical modes existing during Khosrow II's reign. The creation of the *Si Lahn-e Bārbad*[6] is attributed to Barbad, the principal musician of Khosrow II's court, and is mentioned in various literary stories, sayings, and depictions of past centuries. Contemporary researchers have extracted the names of 171 *Lahn* from the Sasanian era. The names of many of these modes, also called *Al'hān*[7] in the ancient scripts, still exist in Iran's contemporary classical music or *Radif* (Safvat, 1971/2014).

After the fall of the Sasanian Empire in the middle of the 7th century, Iran was under the rule of Arab dynasties for several centuries, followed by a critical change in religion and language. Between 632-661, during the *Rashidun Caliphate* (Rightly Guided Successors [of Muhammad]),

[5] For exact location, see glossary.
[6] The Thirty Tunes of Bārbad.
[7] The plural form of *Lahn*, which means a melody or a tune.

the country's official religion changed from Zoroastrian to Islam, and the official language from Middle Persian[8] (Pahlavi) to Arabic during the Umayyad Caliphate (661–750) (Cahen, 1975).

The consequence of redefining language and religion throughout the region significantly changed the future developments of Persian culture. Between the 8th and 9th centuries, the new form of the Persian language arrived in the eastern parts of Iran (Greater Khorasan region). New Persian emerged as an independent literary language through the adaptation of the spoken form of the Sasanian Middle-Persian court language, called *Pārsi-ye Dari*. This is the language we know today as Persian or Farsi. In the same period, due to the change of the official and scientific language of the country from Pahlavi to Arabic, the Pahlavi script was also changed to Arabic, and remains the official script of the Persian language (Paul, 2013).

1.2 On Language and Persian Poetry

Following a revolution in the middle of the 7th century, Eastern Iran became part of the Abbasid Caliphate (750-1257), however by the 9th century, the military and political power of the caliphate was transferred to the west of Iran, known today as Iraq and Syria. With the rise of the Samanid Dynasty (819-1005), the eastern part of Iran, which had achieved relative freedom from the Abbasid Caliphate, became a centre for the rebirth of Persian culture and language. As a language for poetry, Persian especially blossomed in Bukhara, the centre of the Samanid kingdom.

Iranian writers and translators transcribed historical, scientific, and literary texts from Arabic and Pahlavi into New Persian during this time. The Persian language fully developed and established itself as the scientific and administrative language of Iran during the reign of the Turco-Persian dynasties: Ghaznavids (977-1186); Seljuk Empire (1037–1194); and the Khwarazmian Empire (1077–1231) (ibid).

Even after the Mongol invasion of Persia between 1219 and 1256, seeing the end of the Iranian dynasties in the east of Iran (the Abbasid Caliphate in the west and the rise of the Mongol Empire), the Persian language never disappeared. It continued to be used as a literary and scholarly language

[8] Also known as Pahlavi, belonged to a group of Western Middle Iranian languages and served as the literary language of the Sasanian Empire until its fall.

during the Turkish-Mongol dynasties of the 12th and 15th centuries. The geographical expansion of the language began in the 12th century as it became a medium for introducing the Turks of Central Asia to Islam and urban culture. Modern Farsi was widely used as a transregional intermediary language from the western parts of China to the western parts of the Middle East. This language was very suitable for the task due to its relatively simple morphological structure, and the approach continued through until the 19th century (Lars Johanson, 2006).

In the 15th century, after hundreds of years under the rule of non-Iranian rulers and empires, Iran became unified for the first time during the Safavid Empire, which lasted between 1501-1736. The Safavid Empire is often referred to as the beginning of modern Iranian history. Persian was also the country's official language during this period, and writing literary and religious works in the mother tongue reduced the need for Iranians to understand Arabic.

One of the most important events during the Safavid period was the religious conversion of Iranians from Sunni to Shia, occurring between the 16th and 18th centuries. One of the reasons for the formalisation of the Shia religion by the Safavids was to create unity among the people of Iran, and distinguish them from other Islamic countries (Jackson & Lockhart, 1986). Nader Shah Afshar (1688-1747) overthrew the Safavid Empire, and the Afsharid Empire (1736—1796) was established in the first half of the 18th century. During the reign of Nader Shah, Iran reached its largest territory since the fall of the Sassanid Empire. With his death, the realm quickly disintegrated and was divided among different tribes. Finally, in 1796, Agha Mohammad Khan Qajar (1742-1797) reunified Iran and established a new Iranian empire.

During the Qajar Empire (1789[9]-1925), familiarisation with Western civilization, and the signing of the influential political and commercial covenants between Iran and Western countries, led to the beginning of the Constitutional Revolution (1905-1911). In 1851, Dar al-Funun was established as the first modern university and institute of higher education in Iran. This is also when European music education was introduced to Iranians by the military musician and composer Alfred Jean-Baptiste Lemaire (1842 –1907) as a part of the curriculum at Dar al-Funun.

[9] Note that the official date indicates the establishment of the Qajar dynasty and their growing influence over the territories of the Afsharid Empire until the final overthrow from power in 1796.

The Persian language experienced difficulties in the eastern half of its territory during the 20th century but flourished again in the western half (the country of Iran). The British removed Persian from India through colonisation and replaced it with English, while in Central Asia, the Russians conquered large areas of Persian-speaking lands. The region's three major centers of Persian and Iranian civilization, however, Samarkand, Bukhara, and Merv, all refused the takeover and were subjected to an intense Russian process of de-Persianization and de-Iranization.

"Classical Persian" loosely refers to the standard language of Iran in the Middle Ages, used primarily in Persian literature. As mentioned earlier, this language was a manifestation of writings between the 10th and 12th centuries, which were later used as a literary language during the reign of the "Iranized" Turkish and Mongol dynasties, as well as the Iranian dynasties that followed. During the last thousand years, Persian literature, specifically Persian poetry had several standards or "styles" established by classical writers such as Ferdowsi (940-1020), Saadi Shirazi (1210-1291), and Hafez (d.1390).

In the stylistics of Persian poetry, there are three main classes: Khorasani, Iraqi, and Indian. Khorasani (10th to 12th centuries) is associated with the Greater Khorasan region, now part of Iran, Afghanistan, and Uzbekistan. The most crucial author representing this style is Ferdowsi (940-1020). His masterpiece, *Shahnameh* (Book of Kings), includes the myths and history of Iran from the beginning of time to the Arab invasion of Iran in the 7th century. The Iraqi style (12th to 15th centuries) is associated with the historical region of Persian Iraq, which is located along the western coast of Iran. While it has the same basis as the Khorasani style, the shift of power centers from the eastern to the western parts of Iran led to the use of Arabic words by poets of this style as it became the scientific, philosophical, and religious language of the period. Saadi Shirazi (1210-1291) and Hafez (d.1390) are two examples of poets and writers employing this style. The Indian style (15th to 19th centuries) flourished in these territories after a group of Persian-speaking poets migrated to India. Due to the positive reception of these poets by the Indian rulers, and the lack of attention paid to poetry by the Safavid kings, they were able to lay the ground for establishing this style, whose characteristics include excessive allegory, aphorism, and proverbs (Bahar, 2006).

Besides the three styles of Persian poetics used in the development of language, there is a primary thought in the domain of all the mentioned styles that characterises most of present-day Persian in the evolutionary context of the language – Sufism. A mystic tradition of religious practice found

within Islam, Sufism is one of the most essential branches of Persian literature characterised by a focus on spirituality, ritualism, asceticism, and esotericism. The end of the 11th century is one of the most critical periods in the history of this tradition in Iran. The Sufis were free to express their beliefs, and in addition to their influence among the people, they quickly found supporters among the nobles, resulting in a land filled with Sufi scholars and shrines, a situation that continued until the Mongol invasion. Although the Mongols killed many Sufis, they ultimately added to the tradition's prosperity to a great extent, as Sufism became the Iranian people's most prominent spiritual and intellectual refuge during times of destruction and calamity.

Ironically, the rulers of the Mongol Empire became fascinated by the Sufi beliefs and turned to support the shrines as shelters of mysticism and spiritualism. That is why the period of the Mongol Empire is the most significant period for Persian Sufi literature. Sufi writings took a more constructive approach and the prose matured. Many writings developed from purely didactic and narrative content and evolved into theoretical and logical discourses. It was then praised and often placed high among the ranks of other sciences, especially philosophy.

Significant changes occurred in the Sufi poetry tradition, starting with the works of Sanāi (1080-1131), and reaching its peak with celebrated masterpieces by Omar Khayyām (1048-1131), Attār of Nishāpur (1145-1221), Shams Tabrizi (1185-1248) and Rumi (1207-1273). The allegories created by these masters of Persian Sufi literature continue to illuminate the path of wisdom for their readers today (Pazouki, 2014).

The further development of the Persian language and its poetry has proved to keep it vibrant and construct certain national poetic traditions which incessantly grow and transform the face of modern-day Farsi used in everyday communication. Regarding the contemporary history of Iran, the development of literature reaches far beyond the scope of this research, which focuses mainly on the medieval and classical achievements relevant in time to the treatises on music under my research compass. The hidden relations between poetry and music will become material for discussion in the third part of my paper. However, perhaps the reason for the musicality and implementation of the alphabet in the development of medieval music theory proves its inseparable bond through the meanders of art and science.

1.3 On Treatises on Music

One of the essential facts about the old treatises written in Iran is that they were created over a span of several centuries. Some were formulated under the patronage of Arab rulers in the western part of Iran, hence the language of these books being in Arabic, while others are written in Persian in the eastern or central parts of the country. Iranian dynasties ordered these works intending to emphasise the Persian language and spread Persian culture over the territory during their reign. Other treatises were originally written in Turkish from the northern and northwest parts of Iran, another completely distinct linguistic sphere of words, meanings, and understandings. What is most fascinating about this is that all the scholars describe the music from the perspective of their own time and, even more importantly, the geographical territory they lived and worked in.

As mentioned, during the six centuries I have chosen to focus on while investigating the medieval Persian treatises on music, Iran had several different dynasties as rulers: Arabs, Turks, Persians, and Mongols. Each had their official court language, *lingua franca*, and even different religions. Most of the music treatises created by Iranian scholars were never translated into modern notation systems, never gathered and compared to each other, nor combined into a single collection of all the tuning systems and modes of Iran. It must be addressed that some translations of treatises, perhaps for the sake of simplification or lack of the authors' knowledge, are notated in 12-tone equal temperament (12-TET). In the best scenarios, they are notated in the 24-tone equal temperament (24-TET) system, however, these translations are generalised, blurred interpretations of how the original Iranian tunings would have sounded and are therefore not a reliable source. As a result, I rely solely on the original versions and have spent much time finding the authentic sounds of medieval Iranian tunings.

Conversely, several western theoreticians studying the music of Iran disregarded the cultural and political differences between the times and places of all these treatises, instead placing them all under one large generalised category of Iranian music. Worse again, if a book was written in Arabic, it was immediately assumed to be Arabic music. Therefore, most people in the modern West have yet to learn that Iranian and Arabic music are distinct worlds, even though they have some common roots.

Since the Arab conquest in the 7th century, we have seen a change in the terminology of music theory in books and essays written by polymaths, philosophers, and musicians in Iran. In addition, there is a visible change in the modal music system from the *Maqām*[10] to the *Dastgāh* system. Theoretically, the birth of the *Maqām* system can be traced back to the reign of the Turks and Mongols in Iran, specifically between the 12th and 13th centuries (Lucas, 2019).

The *Maqām* system consists mostly of 12 primary modalities that are the core of the *Maqām* music of these centuries, which covers the music of Iran, the Arab countries, and Turkey.

In most Arabic or modern European sources, the origin of the *Maqām* system is attributed to Safiaddin Ormavi (1211 - 1294), which is undoubtedly one of the complete sources of music from the 13th century. It is worth mentioning that about a century before Ormavi, Muhammad bin Muhammad bin Muhammad Nishāburi (b.1087 or 1088) wrote a simpler treatise on music in Persian in which he gave an overview of music's modal structure and listed the names of 12 *Maqām* and 6 *Āvāz* for the first time[11]. In contrast to many treatises of his time, Nishāburi wrote the treatise in Persian and used the word *Par'deh* instead of *Maqām*, and *Sho'beh* instead of *Āvāz* (Dżumajew & Morawska, 1990).

In the treatise, he introduces the 12 main *Par'deh* in the following order:

- *Rāst*
- *Mokhālef-e Rāst or Zir'Afkand*
- *Arāq*
- *Mokhālefak*
- *Hassani*
- *Rāhavi*
- *Esfahān*
- *Mādeh*
- *Bousalik*
- *Navā*

[10] The term *Maqām* was used for the first time by Qutb al-Din al-Shirāzi (1236-1311). Before him, Safiaddin Ormavi (1211 -1294) used the word *Advār*. In the older treaties, Iranians used the word *Par'deh*, and the Arabs used the word *Lahn* to depict a mode.

[11] The complete explanation of the difference and the inner connection between *Maqām* and 6 *Āvāz* will happen in chapter two.

- *Nahāvand*
- *Ushshāq*

In the second chapter, he describes the structures of the six *Sho'beh*[12] as follows:

- *Zirkesh*, that consists of *Hassani* and *Mādeh* modes
- *Basteh*, that consists of *Mokhālefak* and *Rāhavi* modes
- *Ozzal*, that consists of *Navā* and *Ushshāq* modes
- *Negārin*, that consists of *Bousalik* and *Esfahān* modes
- *Hejāz*, that consists of *Nahāvand* and *Arāq* modes
- *Sepehri*, that consists of *Rāst* and *Mokhālef-e Rāst* modes

What distinguishes Nishāburi's treatise from those written earlier is that they were all influenced by treatises translated from Greek and Syriac into Arabic, so while Nishāburi based his work on these earlier literary outcomes, he emphasised the influence of Persian culture and the literature of the Sassanid era.

Due to the lack of explanations on the structure of musical intervals and modes, however, this treatise received less attention. Fortunately, there are many treatises written during the medieval time that contain detailed explanations of the tuning systems of their time. The works of Al-Kindi (801-873), Fārābi (870-950), Ibn Sinā (980-1037), and the Encyclopedia of the Ikhwān Al-Ṣafā (9th to 10th centuries) are all written before Nishāburi's work, and influenced by the ancient Greek theory of tetrachords as well as the mathematical and scientific approach of the Greek polymaths.

During the peak of the Graeco-Arabic translation movement in Baghdad between the 8th and 10th centuries, many scientific and philosophical books from Greek, Syriac, Indian, and Pahlavi languages were translated into Arabic. This movement caused the Muslims to inherit Greece's scientific and philosophical culture. Following the path of ancient Greece, music was considered a part of the four sciences: arithmetic, astronomy, music, and geometry (Khalidi & Dajani, 2015).

In principle, the details of tunings implemented in these books are written in two ways:

[12] It should be noted that in Iranian modal music, *Sho'beh* or *Āvāz*, as known in the work of Ormavi, represent a combination of two modes that are similar in their tetrachord or pentachord structure.

- With the help of mathematical proportions and ratios
- With the help of a specific system called *Abjad*

1.4 *Abjad* System

During the medieval Islamic era, writers used a unique system known as the *Abjad* in order to represent music in their writings. According to theoreticians of this period, each finger position on the fretboard was associated with a letter from the alphabet, while the exact distance between the finger positions was expressed as rational numbers (Alizadeh, 2012).

There are twenty-eight Arabic letters in the *Abjad* system, which are arranged according to the order of the Phoenician alphabet. The primary purpose of this system was to serve as a mathematical tool called Hisab al-Jummal in Arabic, used mainly for solving mathematical equations of the era (Krotkoff, 1982).

These letters have been organised into a word so that they are easier to remember:

اَبجَد – هُوز – حُطی – کَلَمَن – سَعفَص – قَرَشَت – ثَخَذ – ضَظِغ

Abjad - Huwaz - Huṭṭī - Kalaman - Saʿfaṣ - Qarashat - Thakhadh - Ḍaẓagh

Al-Kindi is considered the most important Arab philosopher and the first to write about music theory in the Islamic world. Indeed, several writers before him wrote about music, but their writings were limited to the topics of melody and poetry and, in general, had more focus on the oral tradition of culture than the philosophical-scientific approach, known as "the old school of *Qinā*" (the Arabic word for singing) (Hosseini, 2015).

As a philosopher and polymath, Al-Kindi approached music scientifically. He wrote about different aspects of music and acoustics, such as the explanation of sound, intervals, tuning, and even music's therapeutic properties. Most importantly, he used the Abjad system for notating the music (Shehadi, 1995).

Value	Letter	Name	Transliteration
1	ا	ʾalif	a
2	ب	bāʾ	b
3	ج	jīm	j
4	د	dāl	d
5	ه	hāʾ	h
6	و	wāw	w / ū
7	ز	zayn	z
8	ح	ḥāʾ	ḥ
9	ط	ṭāʾ	ṭ
10	ي	yāʾ	y / ī
20	ك	kāf	k
30	ل	lām	l
40	م	mīm	m
50	ن	nūn	n
60	س	sīn	s
70	ع	ʿayn	ʿ
80	ف	fāʾ	f
90	ص	ṣād	ṣ
100	ق	qāf	q
200	ر	rāʾ	r
300	ش	shīn	sh
400	ت	tāʾ	t
500	ث	thāʾ	th
600	خ	khāʾ	kh
700	ذ	dhāl	dh
800	ض	ḍād	ḍ
900	ظ	ẓāʾ	ẓ
1000	غ	ghayn	gh

Table 1.1. The *Abjad* system chart of values, letters, names and their transliterations.

Al-Kindi was not the first person to use the Abjad system for the notation of music. Contemporaneously, Ibn al-Munajjim (855/6–912) was also using the same system in his book *Kitāb al-Nagham fi al-Musicā* (The Book of Melodies in Music). The most significant difference between the two is that Al-Kindi's approach was complete and used letters for each pitch, whereas Ibn al-Munajjim omitted some steps of the gamut (Zabihifar & Mohseni, 2022). Names of the frets

or the finger positions are based on the Arabic terminology for the fingers and continue to be used in Iranian traditional music: *Sabbābeh* for the index finger; *Wustā* for the middle finger; *Bensir* for the ring finger; and *Khensir* for the little finger (Sawa, 2015).

It is theoretically proven in all the different treatises written since the 9th century, that the intervals between these four positions and the open string always had the same proportion. The positions are as follows:

- Starting from the *Mutlaq*[13] (Open string) 1/1
- *Sabbābeh* 9/8 (+203.9 cents) – major whole tone
- *Wustā* 32/27 (+294.1 cents) - Pythagorean minor third
- *Bensir* 81/64 (+407.8 cents) – Pythagorean major third
- *Khensir* 4/3 (+498.0 cents) – Perfect fourth

The interval set between the intervals mentioned above often differ between the various treatises. In the case of Al-Kindi, there is one extra finger position called *Mujannab*, which refers to an interval anterior to the index finger, and sets between the *Sabbābeh* and *Mutlaq* (1/1 & 9/8).

For a 12-tone chromatic scale, Al-Kindi used the first twelve letters from the *Abjad* system as a method for the notation of music and, more specifically, to represent the positions of the fingers on the fretboard. It is worth mentioning that he also uses a Pythagorean approach in presenting the interval proportions which I will address in chapter 2 (Shawki, 1969):

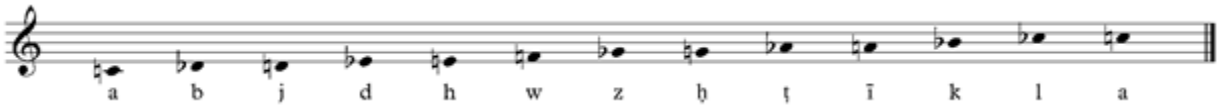

Figure 1.1. Al-Kindi's gamut with *Abjad* system transliteration, notated with HEJI accidentals.

Note that due to the difference in the size of the intervals in the structure of the first tetrachord on the lowest string (*Bamm*), the fret position for the *Mujannab* on the two lower strings is not in the exact place as the three other strings above it.

[13] See glossary for all term explanations.

The critical flaw of Al-Kindi's *Abjad* notation was that he designated the letters A to L exclusively for one octave. In the higher octaves, the same letters were duplicated. As a consequence of this decision, it is hard to comprehend the position of the pitches in the different octaves. This issue was fixed by Fārābi (870-950), who employed the rest of the *Abjad* letters to show the position of the pitches in different octaves.

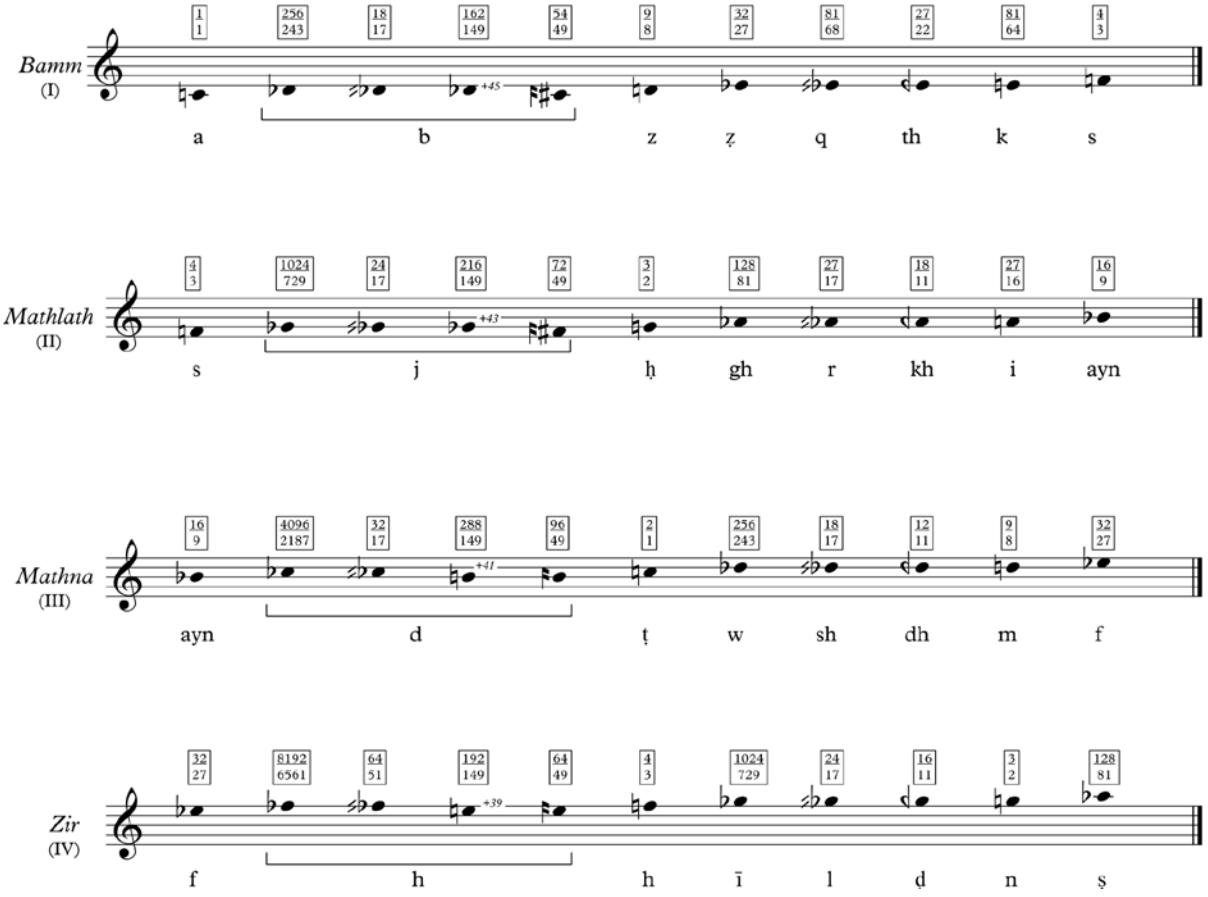

Figure 1.2. Fārābi's gamut with *Abjad* system transliteration, notated with HEJI accidentals.

Fārābi's invention solved the problem of Al-Kindi's system, however another issue arose. Both systems work very well with the letters "A" to "Y," representing the numbers one to ten, which fits with the degrees one to the tenth of the scale. The contradiction appeared when they used the letters beyond "Y", which represented numbers 10, 20, 30, and on; for example, after the tenth pitch, "Y" comes "K", which equals 20.

Ibn Zaila (d.1048), a prominent disciple of Ibn Sinā, solved this logical problem. He did this by paying attention to the numerical meaning instead of the sequence in *Abjad* letters, and after "Y" (= 10), he used the combination of the letters "A" to "Y" as follows:

Y + A = Ya or 11

Y + B = Yab or 12

Y + J = Yaj or 13 (which is the degree for the octave in Zaila's system)

Y + D = Yad or 14

Y + H = Yah or 15

Y + w = Yaw or 16

Y + Z = Yaz or 17

Y + Ḥ = Yaḥ or 18

Y + Ṭ = Yaṭ or 19

For the pitches beyond 20, he uses the combinations of the letter "K" with the "A" to "Y".

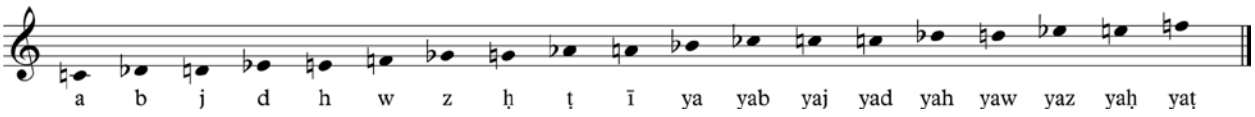

Figure 1.3. Ibn Zaila's gamut with *Abjad* system transliteration, notated with HEJI accidentals.

Two centuries later, in his manuscript, *Ketâb al-Advâr* (The book of circles), Safiaddin Ormavi proposed seventeen pitches per octave for Islamic music (Iranian, Arabic, and Turkish), resulting from the developments of his predecessors. Ormavi's notation system was similar to Ibn-Zaila's, except that the octave degree for Ormavi's gamut was duplicated on the 18th rather than on the 13th; hence the *Abjad* system was as follows (Binesh, 1998):

Y + A = Ya or 11

Y + B = Yab or 12

Y + J = Yaj or 13

Y + D = Yad or 14

Y + H = Yah or 15

Y + w = Yaw or 16

Y + Z = Yaz or 17

Y + Ḥ = Yaḥ or 18 (which is the degree for the octave in Ormavi’s system)

Y + Ṭ = Yaṭ or 19

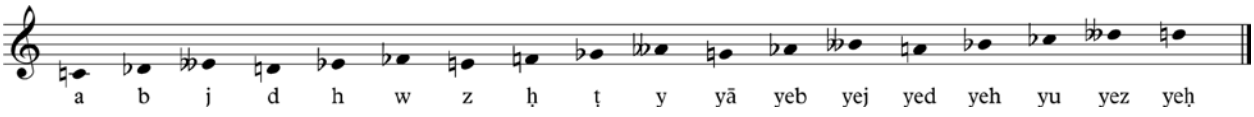

Figure 1.4. Ormavi’s gamut with *Abjad* system transliteration, notated with HEJI accidentals.

As mentioned above, all the calculations and logical dilemmas on how to deal with the transcription of medieval notes are scientific. At the same time, however, there are artistic disputes on how to grasp the essence of the interval and preserve its actual size in a descriptive way. The *Abjad* system also proves the continuity and evolutionary development of the era's musical theories, presenting the system's growth and perfection from its beginning in Al-Kindi's invention, towards the final polishing in Ormavi's masterpiece. Even though the system itself dissolves amid the sands of time by the end of the 15th century, which I will discuss further in chapter two, it continuously represents a rich source of knowledge on the state of Persia's music in the Middle Ages. The lack of further existing treatises on music in the region's history does not necessarily mean that the connection with the past ended abruptly. Based on my research, there is evidence to suggest that the path towards the identity and exact modal characteristics of Persian music can be found in both written and oral traditions, and whose manifestation lies in the core concept of *Radif*.

1.5 A Brief Introduction to *Radif* and the Evolution of *Maqām* to *Dastgāh*

In Persian music culture, the *Radif* forms a core repertoire of classical music in Iran, comprehended holistically. A complex network of more than 250 melodic patterns called *Gusheh*, organised according to their modal relationships into twelve main groups, carries the name *Dastgāh*. Each *Dastgāh* is associated with a unique tonal space, and it is precisely this network which connects all twelve *Dastgāh*, called *Radif* (Farhat, 2004). The origin of the term *Dastgāh* comes from the old method of describing the pitches' position on the instrument by assigning the fingers on the fretboard. It translates literally as "the position (gāh) of the hand (dast)" (During, 1994).

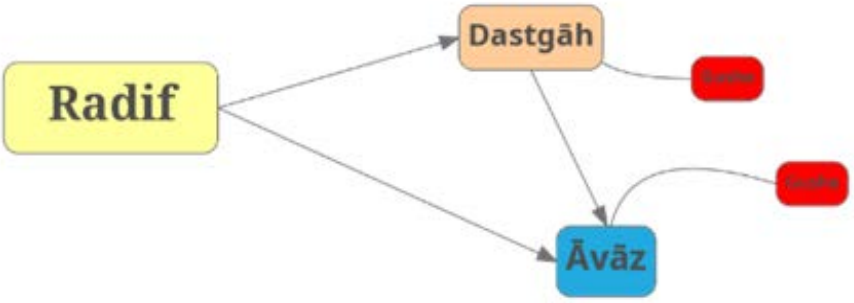

Figure 1.5. Visualisation of *Radif* and its components

It is critical to understand that many versions of *Radif* have been interpreted and performed by prestigious masters of Persian music. Essentially, there are two types of *Radif*: *Āvāzi* (vocal) and *Sāzi* (instrumental), which change depending on the various instruments' technical possibilities. Some performance approaches vary slightly, but each *Radif* version generally retains the same foundation in both modal and structural principles (Khaleqi, 1938).

The practice of *Radif* is, *sensu stricto*, an expression of aesthetic practice and the study of Persian culture's philosophy. The process of learning *Radif*, which includes gaining knowledge of classical and contemporary Persian poetry and prose, takes a significant amount of time and self-devotion. The students are required to memorise the *Radif* repertoire and go through a process of self-discipline that helps them open the doors to creativity.

In the tradition passed down by Mirza Abdollah (1843-1918), a prominent *Tār*[14] master and organiser of *Radif*, the classification of which is claimed to be a collection of seven *Dastgāh* along with five *Āvāz* (Persian: آواز, songs). *Āvāz-ha* (plural of *Āvāz*) are to be found in the general structure of *Dastgāh-e Shūr* and *Dastgāh-e Homāyūn* as their subset (Khaleqi, 1938). Below is the list of the seven *Dastgāh* and five *Āvāz*:

- Shūrشور
    - Bayāt-e tork بیات ترک
    - Dashti دشتی
    - Abū‘atā ابوعطا

[14] A plucked string instrument, for detailed information check the glossary.

        - Afshāri افشاری
- Segāh سه‌گاه
- Navā نوا
- Homāyūn همایون
    - Āvāz-e bayāt-e Esfahān (also called Esfahān) اصفهان
- Chahārgāh چهارگاه
- Māhūr ماهور
- Rāst-Panjgāh راست پنجگاه

A performance of *Radif* is referred to as *Radif Navazi*. It has a tradition of its own, of which choosing a *Dastgāh* or *Āvāz* is the first step. With respect to the rule that the complete *Radif* performance is called *Sayr* (a journey), one must perform all the *Gusheh-ha* (plural form of *Gusheh*) of the specified *Dastgāh* in order to complete it.

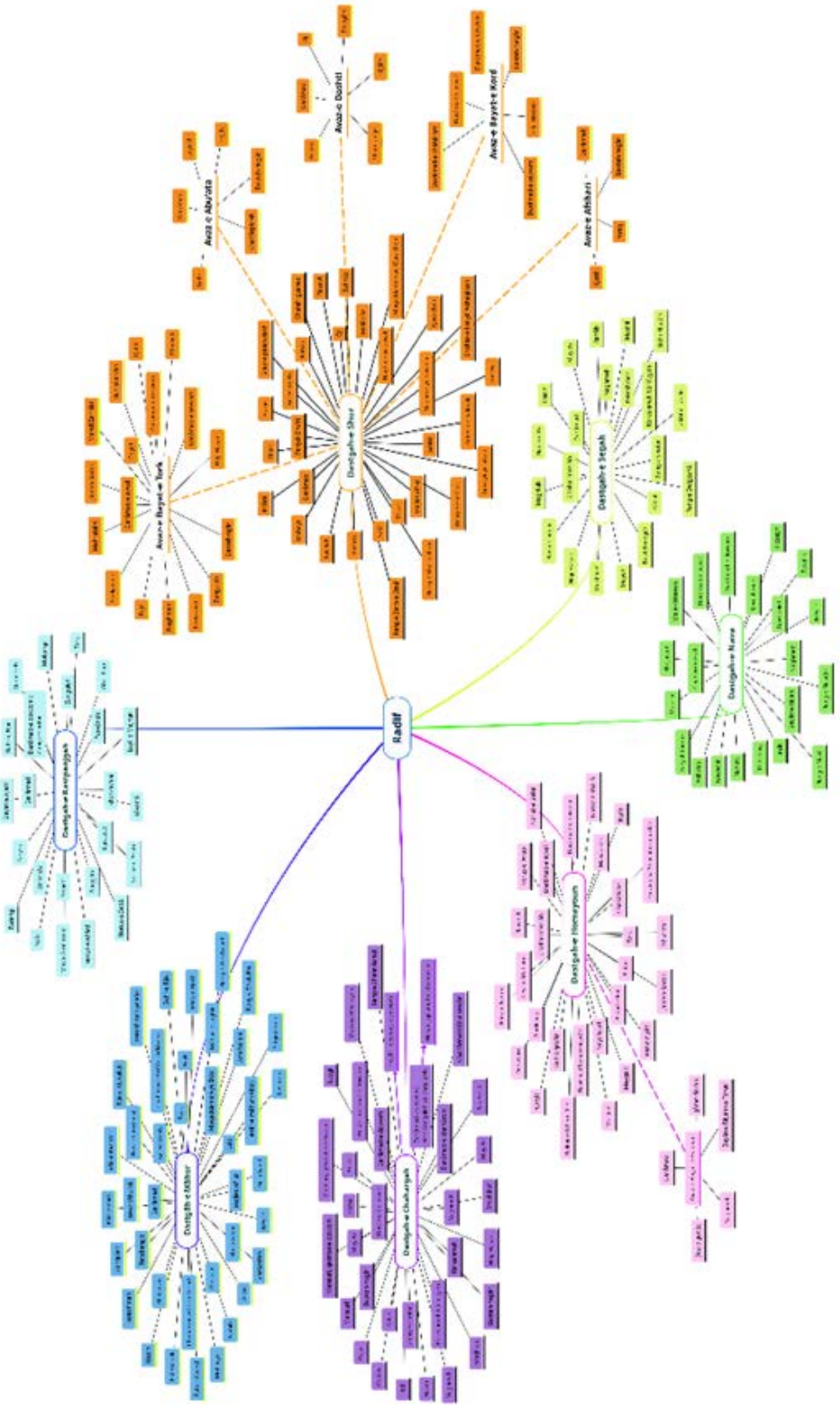

Figure 1.6. A detailed visualisation of *Radif* and its components.

Ali-Naqi Vaziri (1886 - 1979) was the first scholar to transcribe *Radif* and write about Iranian music theory and his book *The Harmony of the Music of Iran or Quarter-tone Music* (1935), offered the first solution for harmonising Iranian monophonic modal music. Vaziri describes many intervals not found in Western classical music and defines them as the harmonic and subharmonic series components of a central pitch, primarily based on the seventh, eleventh, and thirteenth (sub)harmonics. This means that these intervals have different sizes compared to those known in Europe, however, based on equal division of the intervals per octave in Western classical music, he proposes to apply the same concept to microtones one may find in Iranian classical music. The idea of tempered intervals led him to suggest 24 equally spaced microtones per octave with tempered intervals of 50 cents. This system was supplemented by two accidentals representing Iranian music's microtones being continuously used by scholars and musicians working on Iranian music. Listed below are two accidentals, *Sori* and *Koron* (Vaziri, 1935/2016).

𝄲 – *Sori* raises the pitch by a quarter-tone

𝄳 – *Koron* lowers the pitch by a quarter-tone

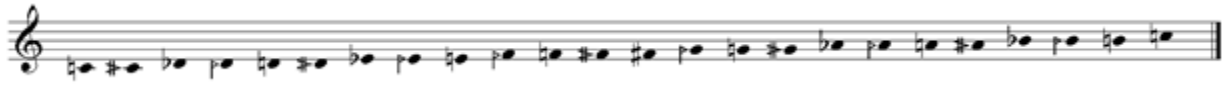

Figure 1.7. The 24-tone equal division of the octave (24edo) of Vaziri.

The following terminology should be employed to analyse *Radif* in classical Persian music (Farhat, 2004):

Foroud is a pitch that functions as a melodic cadence's goal or destination tone and creates a conclusory feeling. The term "tonic" is also sometimes used, but some authors avoid using it because it is associated with Western music theory.

Āqāz (beginning), the pitch with which a *Dastgāh* is usually initiated. In some *Dastgāh*, it is different from the *Foroud*, while in others they are the same pitch.

Ist (stop) is a pitch that often serves as the ending note for phrases, other than the final cadences.

Šāhed (witness) represents a remarkably prominent pitch.

Moteqayyer (changeable) is a variable note consisting of two distinct pitches that can be used at the performer's choice.

Based on Vaziri's notation system, it is possible to identify the main modal space and the internal relationship of the seven *Dastgāh* by using the following notation (Alizadeh, 2000):

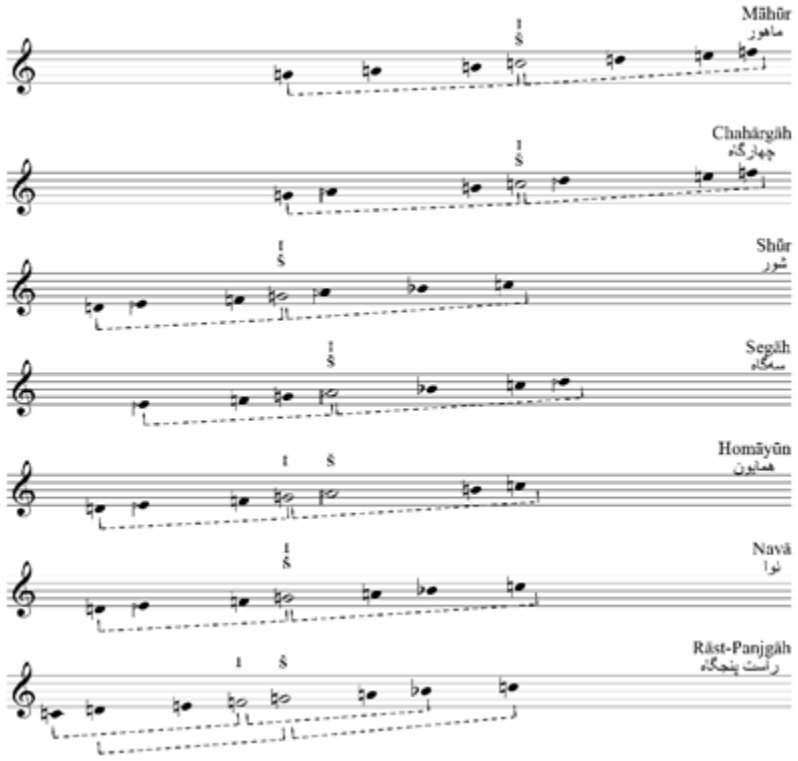

Figure 1.8. The internal relations between seven *Dastgāh*.

While *Radif* itself had its origins during the late Qajar era (1785-1925), the presence of *Dastgāh*, as the component of *Radif*, can be traced back to the mid-Safavid period (1501-1722) when the old *Maqām* system was gradually developing into multi-modal structures called *Dastgāh*. The word *Maqām* first appeared in the *Dorrat al-Tāj fi ḡorrat al-Dabbāj* (roughly translated as The Pearly Crown) circa 1306 by Qutb al-Din al-Shirāzi (1236–1311) (Asadi, 2001), referring to the twelve main musical modes of the medieval era. *Dorrat al-Tāj fi ḡorrat al-Dabbāj* is a philosophical encyclopedia covering natural sciences, theology, logic, public policy, ethics, mysticism, mathematics, arithmetic, and music. In the music section, Shirazi explains Ormavi's modal theories with emphasis on his later book, *Risāla al-Sharafiyya* (The Sharafiya Treatise) (Nasehpour, 2008).

Ormavi proposed 84 different musical modes, organised into two groups: consonance and dissonance. According to his system, only twelve out of 84 modes can be considered consonances and are simultaneously the primary modes for creating instrumental music.

Ormavi illustrates modes in the form of circles and calls them *Do'r* (meaning "circle" while *Advār* represents the plural form). In *Ketab al Advār*[15], he explains that *Advār* have the same meaning as *Shodōd* and *Par'deh*, used in his time by Arabs and Persians, respectively.

Based on Ormavi's 17-tone scale, not equally divided, these twelve *Maqām* could be notated as follows: (NB the finalis of each *Maqām* is marked red)

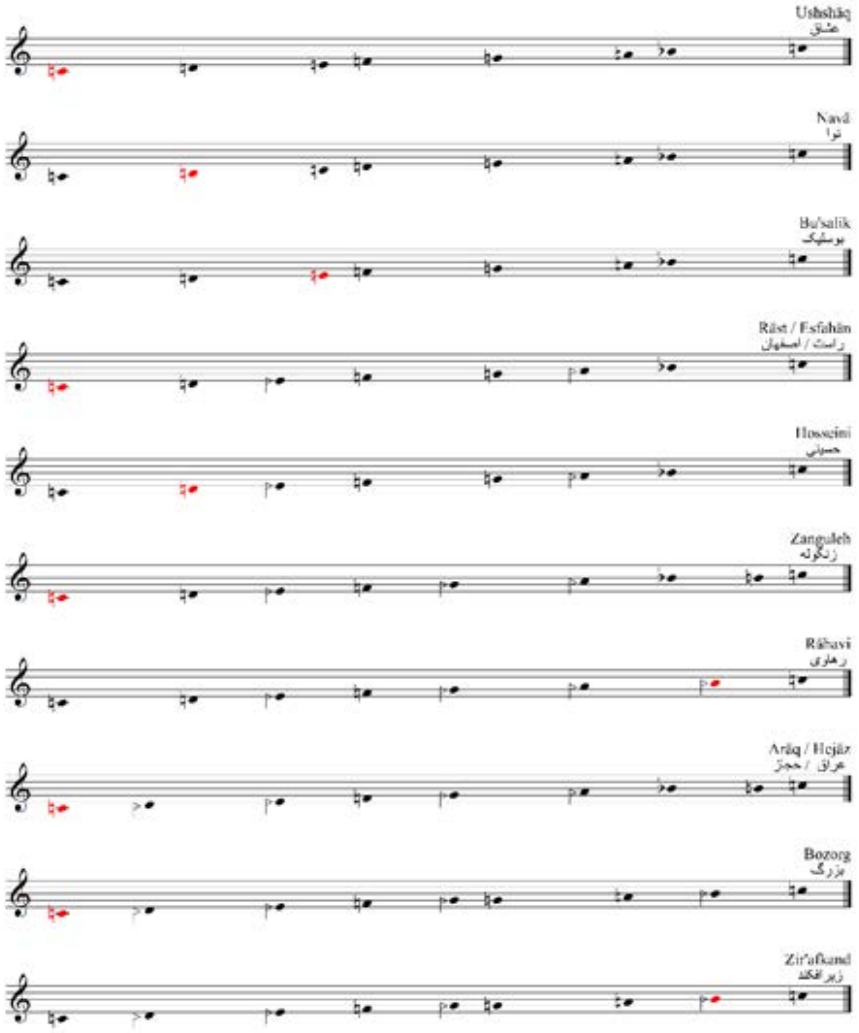

Figure 1.9. The twelve *Maqām* in 17-tone gamut by Ormavi, notated with HEJI.

[15] Exact information is provided in section 2.5.

Moreover, Ormavi introduced six secondary modes. These modes were called *Āvāz*, and they were referred to as *Gavāsht*, *Gardāniā*, *Salmak*, *No`ruz*, *Māyeh*, and *Shahnāz* (‘abd Al-Mu’min Ibn Yūsuf Urmawī & Āryū Rustamī, 2001).

Although most of the *Maqām* have survived through hundreds of years and exist as *Gusheh* or *Dastgāh* in the *Radif* of Persian classical music, the intervallic structure of some of them is not the same as in medieval times.

According to the tetrachord analysis of the *Radif* by Dariush Tala'i (b.1953), one could conclude that, for example, *Maqām-e Ushshāq* is precisely the same as the main modal space of *Dastgāh-e Māhūr*. This relation occurs between *Maqām-e Navā* and *Āvāz-e Dashti*, as well as between *Maqām-e Bozorg*, which exists as a *Gusheh* within *Dastgāh-e Shūr* (Tala'i, 2001, pp. 894–903 / Farhat, 2004 / Fakhreddini, 2013). Ultimately, traces of the tetrachords or *Maqām* that survived for thousands of years still exist in the works of Ibn Sinā and Fārābi.

Chapter 2

On the Music Treatises

2.1 Introduction

More than 200 treatises in Farsi and Arabic were written about music between the 6th and 15th centuries. Many of these books, or treatises, do not contain detailed descriptions of the tuning systems, instead more concerned with other aspects of music, such as philosophy, its relations to poetry, religious use, or commentaries on other treatises. In this chapter, I will focus on the surviving works of three of the most influential polymaths. Each has a unique and detailed description of the tuning system of their time, discussing modes and rhythmic patterns, along with other aspects of music, such as its healing powers or philosophical understanding. What is of particular interest is that all the scholars are describing music from the perspective of their own time, and even more importantly, their geographical region.

Although many treatises have been written on these tuning systems, I will focus on extracting and translating information from the most notable works by Fārābi (872-950), Ibn Sinā (980-1037), and Safiaddin Ormavi (1216-1294). Each of these scholars introduced a completely new approach to the tuning system and modes of their time and place. In order to study and understand the hidden relationship between their works, however, it was necessary to analyse the treatises written both before and after, as well as the commentaries of the other polymaths on these works. This especially includes the treatises and works of the followers of Ormavi, Qutb al-Din Shirazi (1236-1311), Abd al-Qadir Maraghi (1360-1435) and Abd ar-Rahman Jami (1414-1492).

The analysis and interpretation of the differences and similarities between the works of Ormavi and his successors could be another research topic. Following the tradition of orientalists and musicologists, I will divide the authors of these works into two groups, those before and those after Safiaddin Ormavi. Ormavi attempted to synthesise many critical aspects of Greco-Arabic writings in relation to musical practice, as well as to find a method that could present Arabic, Persian and Turkish music. Henry George Farmer (1882-1965), a British musicologist and Arabist, called Ormavi the founder of the Systematist School (Farmer, 1924/2002, p.229). Shirazi and Maraghi, two of Ormavi's leading followers, wrote their treatises based on Ormavi's renowned book, *Ketāb al-Advār* (The Book of Circles) as a crucial aspect of their musical practice.

Philosophers and polymaths, Fārābi, Ibn Sinā, and Omar Khayyām, tried to find a scientific solution to explain the music of their time. Many musicologists refer to them and their practice as the scholastic school, in contrast to the school of the systematists of Ormavi. All three focused their treatises on the musical theories of ancient Greece and attempted to find a way to complete the writings of their predecessors, especially Al-Kindi (801-873), whose works were limited only to explaining diatonic intervals. Considered one of the crucial sources of this movement, "The Great Book of Music" by Fārābi, is one of the most

comprehensive books on music theory, acoustics and instrumentation in the Middle East, to the extent that many later authors based their theories on Fārābi's works. Among the many varied works attributed to Ibn Sinā, five are entirely devoted to music: three as complete treatises, and two as encyclopedic entries on musical subjects. A fascinating observation of Ibn Sinā's writings is that the musical intervals depicted in his books are still considered pleasing to the ears of Iranians. Given the geographical location of Ibn Sinā's residence in the east and centre of Iran, this contemporary notion has a particular anthropological and cultural connotation. Since some of the intervals derived from Ibn Sinā's theories can still be heard in Iranian classical music today, the persistence of listening habits through centuries of cultural development proves the importance of musical tunings and their embeddedness in regional and national tradition.

Many treatises written between the 9th and 15th centuries contain a chapter on the notable instruments of the period and their geographical location. For example, Fārābi's *Kitāb al-Musiqā al-Kabir* (The Great Book of Music), is one of the essential sources for us to learn about the instruments of the time, covering the acoustics and tuning systems of various plucked, stringed, and wind instruments. Of significant note is that each treatise introduces the oud, the main instrument of Arabic-Iranian-Turkish music, as the main instrument for reference, regardless of the author's geographical location or historical timeline. Each work I have come across in my research has described the proportions of the intervals of their scales based on the divisions of the oud string, and the position of the fingers on the fingerboard. Although knowledge of the different tuning systems among various instruments in medieval Iran is vital to me in this study, I will focus only on the oud and describe and compare the types of tunings that the authors of the treatises mention in specific regard to this instrument.

Since the focus of this research is to uncover the intervals of Iranian music for the future possibility of creative use in contemporary art, rather than from a musicological or historical approach, my research method will be divided into three parts: the intervals; translation of the intervals; and the artistic interpretation of the results.

Following a brief introduction of the authors and the selected treatises, I will present the intervals each author has reported on in relation to the oud. I will reflect this information in the form of tables with ratios and their transcription into the Western notation system. After introducing the method of finding the intervals, I will translate them into the Helmholtz-Ellis JI Pitch Notation (HEJI)[16], since all the musical intervals recorded in these treatises are written in the form of rational ratios or the *Abjad* system. The HEJI system was developed by Marc Sabat (b. 1965) and Thomas Nicholson (b. 1995) with revised symbols for

[16] For further reading about the HEJI system, please visit: https://marsbat.space/pdfs/HEJI2legend+series.pdf.

prime numbers and is based entirely on modifications of Pythagorean notes, i.e., standard Western 12-TET accidentals (sharp, flat, neutral). The exceptionally high coverage of rational intervals in the series (up to 47 overtones), enables a considerable number of details from the tuning system to be transcribed into musical notation. As the HEJI system is based on conventional Western notation, it becomes accessible for all musicians, allowing them to read and interpret, by definition, 'complicated music' without additional effort. The final phase of my research method involves the artistic interpretation of the results gathered so far by employing various compositional practices in the creative use of medieval Persian scales in my own works. Each composition that I have written during the last three years of this research project will be presented as part of my critical artistic reflection, constituting the final and conclusive part of this research.

2.2 Early Treatises – Early Arabian Tunings

The treatises here define the proportions of intervals by describing the placement of the fingers on the oud's fingerboard using a perfect fourth with the ratio of 4/3 as the largest possible interval on a string. In relation to the first string, exact intervals are then tuned on the consecutive strings by the interval of a perfect fourth until they reach the octave of the first string. While each of the authors had their own method of creating and extending the structure of the scale and the interval proportions, the above example provides a general and straightforward explanation from which to open up the deliberations on interval measuring.

The earliest treatise on music written in Arabic dates back to the Arab philosopher Al-Kindi and his book *Risāla fī hubr Ta'lif al-'Alhān* (On the Composition of Melodies). Though only a few fragments survive today, it contains a detailed description of the finger positions along the neck of the oud, consisting of twelve chromatic scale steps based on the circle of perfect fifths. He describes the distances between the fingers in a very precise way, including the exact ratios of the string divisions for each finger position. In one example he explains that to find the location for the little finger (*Khensir)* on the lowest string (*Bamm*), it is necessary to divide the string into four equal parts and place the finger at a quarter distance from the open string. In this case, the position for a perfect fourth with a ratio of 4/3 to the open string is found. In the same way, Al-Kindi describes the location of the other fingers on the fingerboard, which present the following proportions:

- *Mutlaq* (Open string) 1/1 – the starting point of tuning
- *Sabbābeh* (Index) 9/8 (+203.9 cents) – major whole tone

- *Wustā* (Middle) 32/27 (+294.1 cents) – Pythagorean minor third
- *Bensir* (Ring) 81/64 (+407.8 cents) – Pythagorean major third
- *Khensir* (Little) 4/3 (+498.0 cents) – Perfect fourth

He goes on to explain that the following string (*Mathlath*) should be tuned on the basis of the position of the fourth finger and that the distance between the two strings is 4/3, with the same ratio applying to the other strings. The distances of the strings from lowest to highest are, therefore:

- *Bamm* 1/1
- *Mathlath* 4/3
- *Mathna* 16/9
- *Zir.I* 64/27 (32/27)
- *Zir.II* 256/81 (128/81)

He then applies the exact same tuning pattern to each string. To achieve the same intervals in the different octaves, thereby eliminating the Pythagorean comma (531441:524288) that naturally occurs during the circle of perfect fifths, Al-Kindi adds to his scale two frets between the open string and the position of the first finger. These are called *Mujannab* (interior), with the ratios 256/243 and 2187/2048, where the second ratio (2187/2048) is used only on the two lower strings and the first ratio only on the upper three strings (Forster, 2010).

The result of Al-Kindi's scale construction could be considered as a Limit-3 harmonic series scale, which according to composer and theoretician Harry Partch, is based on the fact that the whole interval can be expressed as multiples of the primes 2 and 3 (Partch, 1949).

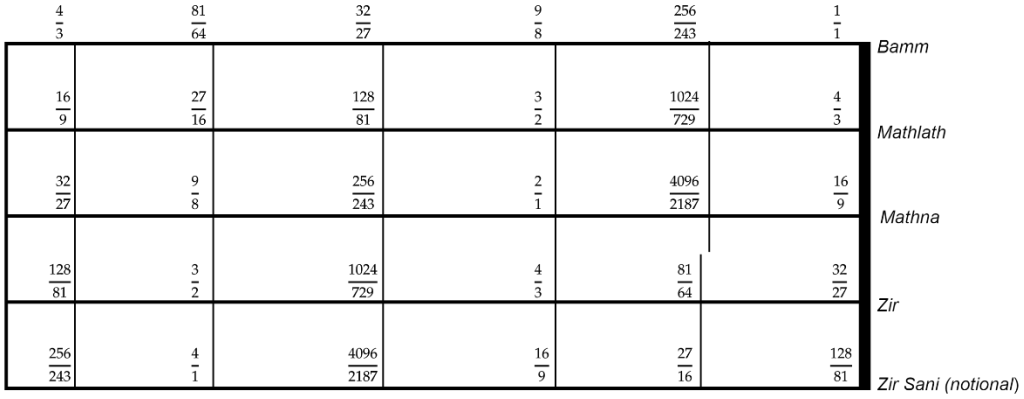

Figure 2.1. Al-Kindi's gamut represented as finger positions on oud.

HEJI	Ratio	Distance from 1/1	*Abjad* system
𝄮B	81/64	408 ¢	H
𝄮E	27/16	906 ¢	Ī
𝄮A	9/8	204 ¢	J
𝄮D	3/2	702 ¢	Ḥ
𝄮G	1/1	0 ¢	A
𝄮C	4/3	498 ¢	W
𝄮F	16/9	996 ¢	K
𝄭B	32/27	294 ¢	D
𝄭E	128/81	792 ¢	Ṭ
𝄭A	256/243	90 ¢	B
𝄭D	1024/729	588 ¢	Z
𝄭G	4096/2187	1086 ¢	L

Table 2.1. Al-Kindi's gamut in the HEJI notation system, rational intonation ratios and *Abjad* system.

Another significant source of music theory before Fārābi was the book *Al-Aghāni al-Kabir* (The Great Book of Songs) by Ishaq al-Mawsili (767 or 772-850), which has unfortunately not survived. His theories, however, and in particular his tuning system, have been found in the books of the important authors who succeeded him: Yaḥyá ibn 'Alī Ibn al-Munajjim (855-912), and Abū al-Faraj al-Iṣbahānī (897 or 8-967). The title of al-Iṣbahānī's treatise, *Al-Aghāni* (The Book of Songs), strongly resembles Al-Mawsili's work. Comprising more than 10,000 pages of selected songs, it is an encyclopaedia of Arabic and Persian poetry, and music from the period of the Jahiliyyah (before Islam), the Umayyad Caliphate (661-750) and the Abbasid Caliphate (750-1517). Each song has been documented with the biography of the poet, singer, musician, and composer, complemented by a description of the scale, the poetic meter, historical relations, and connected anecdotes. The scales for each tune are described in reference to the starting tone, defined by the finger position and the name of the string. Al-Iṣbahānī did not, however, illustrate the details of the scales' structure or the instruments' tuning systems; it is the work of Ibn al-Munajjim that includes a highly detailed explanation of the tuning system of the period (Sawa, 1985).

Another treatise from this era is by Ibn Khordādbeh (820 or 825-913), a direct disciple of Al-Mawsili. Although his treatise *Kitāb al-Lahw wa-l-Malāhi* (On Music and Musical Instruments) is written in Arabic, it contains essential information about Iranian music and poetry before Islam,

especially about Bārbad and his thirty tunes[17]. Unfortunately, this book only specifies the number of strings on the oud and the relationship between them, with no explanation of the tuning or fretting system of the instrument (Mallah, 1999).

According to the renowned work of Ibn al-Munajjim, *Resāla fi'l-Mūsīqī* (Treatise on Music), the first note from which to tune the instrument is the third string (called *Mathna*, in Arabic). The musician determines the intensity of this string and tunes the instrument according to this note. Ibn al-Munajjim explains that this is the same note Al-Mawsili called *Emād*, which means 'mainstay', emphasising the importance of this note as that which provides support for everything else. Since the strings and the intervals between them are proportional in Al-Mawsili's order, it is assumed that all ratios are based on the *Emād* note. It could be argued, therefore, that this led to the root note equivalent in the early iterations of Western contemporary music theory practices (Shawki, 1976). As can already be seen, the main difference between the theories of Al-Kindi and Al-Mawsili is the exact position of the *Emād* note. According to Al-Kindi, *Emād* is the open string that plays the lowest possible note of the oud, whereas for Al-Mawsili, *Emād* is the third string (Hosseini, 2015). Another difference between these two systems is that Al-Mawsili's tuning has fewer steps than that of Al-Kindi, with no pitches occuring at all between the index and the open string (Wright, 1966).

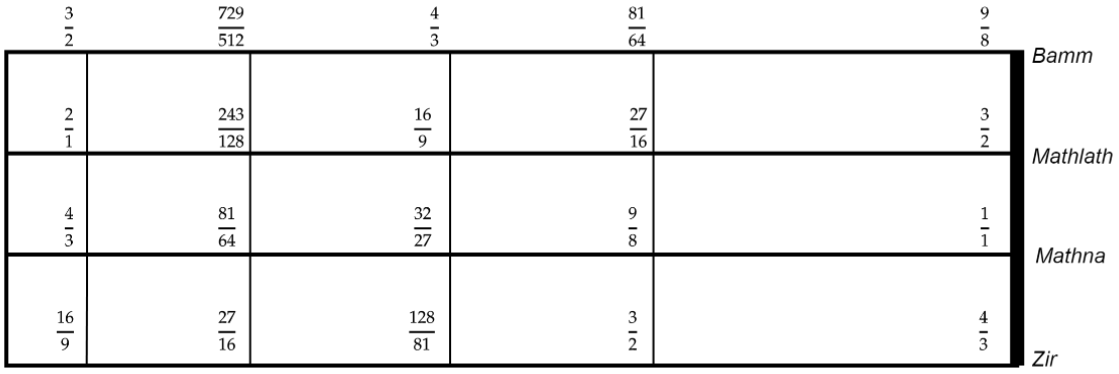

Figure 2.2. Ibn al-Munajjim's gamut represented as finger positions on oud.

[17] For more information, refer to previously mentioned in section 1.1, *Short Study on the Masters of Iranian Music and Musical Modes of Iran* by Dariush Safvat.

To facilitate the reading, the sizes of the five main steps of the tetrachord are listed once more below. These represent the primary size of the intervals of the gamut and the prominent position of the fingers on the instrument in all the tuning systems documented in the works of Arab and Iranian writers.

- *Mutlaq* (Open string) 1/1 – the starting point of tuning
- *Sabbābeh* (Index) 9/8 (+203.9 cents) – major whole tone
- *Wustā* (Middle) 32/27 (+294.1 cents) – Pythagorean minor third
- *Bensir* (Ring) 81/64 (+407.8 cents) – Pythagorean major third
- *Khensir* (Little) 4/3 (+498.0 cents) – Perfect fourth

HEJI	Ratio	Distance from 1/1	*Abjad* System
♯F	243/128	744 ¢	Ī
𝄮B	81/64	408 ¢	D
𝄮E	27/16	906 ¢	Ḥ
𝄮A	9/8	204 ¢	B
𝄮D	3/2	702 ¢	W
𝄮G	1/1	0 ¢	A
𝄮C	4/3	498 ¢	H
𝄮F	16/9	996 ¢	Ṭ
♭B	32/27	294 ¢	J
♭E	128/81	792 ¢	Z

Table 2.2. Ibn al-Munajjim's gamut in the HEJI notation system, rational intonation ratios and *Abjad* system.

Ibn al-Munajjim goes on to describe eight other possible modal structures based on the *Abjad* system[18] and defines the finger position for the starting point of each mode. He states that using *Wustā* (32/27) and *Bensir* (81/64) in the same melodic mode is incorrect, and therefore classifies the melodic modes according to the involvement of each of these intervals, or as he calls them, *Majrā* (Hosseini, 2015).

Majrā-e Wustā : A B J H W Z Ṭ A

1/1 - 9/8 – 32/27 – 4/3 – 3/2 – 128/81 – 16/9 – 1/1

𝄮G – 𝄮A – ♭B – 𝄮C – 𝄮D – ♭E – 𝄮F - 𝄮G

Majrā-e Bensir : A B D H W Ḥ Ī A

1/1 - 9/8 – 81/64 – 4/3 – 3/2 – 27/16 – 243/128 – 1/1

𝄮G – 𝄮A – 𝄮B – 𝄮C – 𝄮D – 𝄮E – ♯F - 𝄮G

[18] For the information about the *Abjad* system, refer back to section 1.4.

Each of these two melodic modes could begin with the second, third or fourth degree. By this calculation, the author arrives at a total of eight modes:

Name	*Abjad* System	HEJI
Mutlagh fi al Majrā-e Wustā	A B J H W Z Ṭ A	♮G – ♮A – ♭B – ♮C – ♮D – ♭E – ♮F - ♮G
Sabbābeh fi al Majrā-e Wustā	B J H W Z Ṭ A B	♮A – ♭B – ♮C – ♮D – ♭E – ♮F – ♮G - ♮A
Wustā fi al Majrā-e Wustā	J H W Z Ṭ A B J	♭B – ♮C – ♮D – ♭E – ♮F – ♮G – ♮A - ♭B
Khensir fi al Majrā-e Wustā	H W Z Ṭ A B J H	♮C – ♮D – ♭E – ♮F – ♮G – ♮A – ♭B - ♮C
Mutlagh fi al Majrā-e Bensir	A B D H W Ḥ Ī A	♮G – ♮A – ♮B – ♮C – ♮D – ♮E – ♯F - ♮G
Sabbābeh fi al Majrā-e Bensir	B D H W Ḥ Ī A B	♮A – ♮B – ♮C – ♮D – ♮E – ♯F – ♮G - ♮A
Bensir fi al Majrā-e Bensir	D H W Ḥ Ī A B D	♮B – ♮C – ♮D – ♮E – ♯F – ♮G – ♮A - ♮B
Khensir fi al Majrā-e Bensir	H W Ḥ Ī A B D H	♮C – ♮D – ♮E – ♯F – ♮G – ♮A – ♮B - ♮C

Table 2.3. Eight modes in classification by Ibn al-Munajjim, represented in the *Abjad* system and HEJI notation.

The *Ikhwān Al-Ṣafā*, meaning 'The Brethren of Sincerity', was a secret philosophical and mystical group formed by Iranians in Basra and Baghdad during the 9th and 10th centuries. They believed there was no conflict between Islamic law and Greek philosophy, and that a person could use both as light on the path to wisdom. Their encyclopedia of the same name contains 52 treatises on various sciences, the fifth of which is about music. In addition to the philosophical matters related to music, acoustics, and instrumentation, this treatise is another vital source of knowledge about the oud's tuning and fretting system. Interestingly, the views described in this source fully reflect the thoughts of Pythagoras and his followers. In defining the musical system, the Pythagoreans relied on the science of numbers and mathematics, however in its metaphysical analysis, they attributed music to the heavens and the reflection of its movement. This opinion, which neglected the scientific and technical foundations of music, was criticised by such authors as Fārābi and Ibn Sinā. Despite this, the mystical beliefs of the Pythagoreans strongly influenced the *Ikhwān Al-Ṣafā* with regard to music (Binesh, 1992, pp. 31-47). By analysing the structure of their fretting system on the oud, one realises that their approach, like many before them, was a pure Pythagorean tuning system of the circle of perfect fifths. Like Al-Kindi, *Ikhwān Al-Ṣafā's* tuning system also began with the lowest oud string, which he used as a reference tone for tuning the remainder strings and marking finger positions on the fingerboard (Wright, 2011).

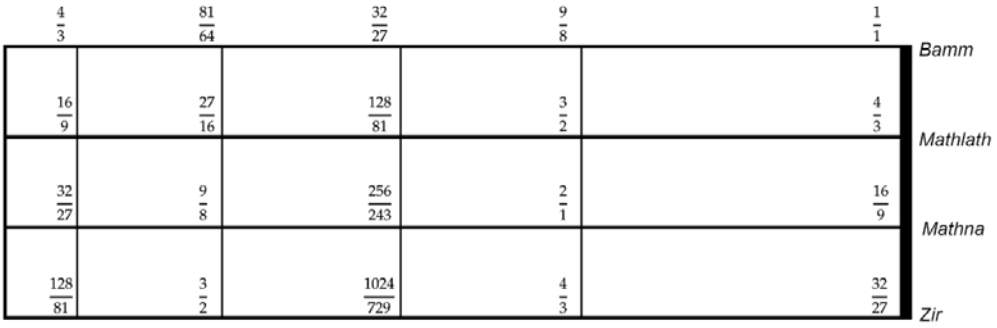

Figure 2.3. The gamut of *Ikhwān Al-Ṣafā* represented as finger positions on oud.

HEJI	Ratio	Distance from 1/1	*Abjad* System
𝄮B	81/64	408 ¢	-
𝄮E	27/16	906 ¢	-
𝄮A	9/8	204 ¢	-
𝄮D	3/2	702 ¢	-
𝄮G	1/1	0 ¢	-
𝄮C	4/3	498 ¢	-
𝄮F	16/9	996 ¢	-
𝄭B	32/27	294 ¢	-
𝄭E	128/81	792 ¢	-
𝄭A	256/243	90 ¢	-
𝄭D	1024/729	588 ¢	-

Table 2.4. *Ikhwān Al-Ṣafā*'s gamut in the HEJI notation system, rational intonation ratios. Note that *Ikhwān Al-Ṣafā* did not assign an *Abjad* system to their gamut.

2.3 Fārābi (872-950)

A considerable number of treatises written in Arabic on music between the 8th and 11th centuries shaped its development for the entire Middle Eastern region. The aforementioned, *Kitāb al-Musiqā al-Kabir* (The Great Book of Music), is one of the most important treatises in Arabic written by the

philosopher and polymath Fārābi[19]. Abu Nasr Fārābi (872-950), often known in the West as Al-Fārābi, was born into a family of Persian descent. There is no consensus on the whereabouts of his birthplace, however, the two cities of Farab (one in present-day Kazakhstan) and Faryab (in present-day Afghanistan) have been cited as his babyhood by several historians of his time. From a young age, Fārābi studied and then taught in Baghdad, an important centre for science, culture, and philosophy, eventually spending the last years of his life in Damascus. As he worked during the Abbasid Caliphate and the Golden Age of Islam, when the scientific and official language was Arabic, there was no exception to creating writings in any other language (Gutas, 1999).

The Great Book of Music consisted of two volumes and is the most essential and complete writing on music theory, modal systems, description of instruments, acoustics, and philosophy of music, created in the 10th century. While sadly only the first volume survived, fortunately it is that which covers all the theoretical facts we need to understand the origins of Iranian, Arabic, or even Turkish music theory. This treatise, in addition to Fārābi's extensive knowledge of ancient Greek music theory and philosophy, is therefore imperative to my research. Of equal significance was his understanding of the imperfections in the works of his peers, such as Al-Mawsili or Ibn al-Munajjim; these comparative attempts to find the crucial elements shaping the music of the region combine to make this work so unique and valuable. Fārābi not only researched the essays in the encyclopedia of the *Ikhwān Al-Ṣafā*, but was also familiar with translations of the ancient Greek theories applied in the writings of Al-Kindi.

Seyyed Hossein Nasr and Mehdi Aminrazavi state:

> *"his Kitāb al-Musiqā al-Kabir (The Great Book on Music), known in the West as a book on Arabic music, is in reality a study of the theory of the Persian music of his day as well as presenting certain general philosophical principles about music, its cosmic qualities, and its influence on the soul"* (Nasr & Aminrazavi, 2007, p. 135).

Farabi's detailed explanation of the tuning systems refers to plucked string instruments such as oud, *Tanbur Baghdad* and *Tanbur Khorasan*, wind instruments such as *Nāy*, *Do'Nāy*, *Sornāy,* and eventually the bowed

[19] Philosopher, the founder of Islamic Neoplatonism and a Polymath who, without any doubt, is among the most outstanding figures in early Islamic philosophy and science in the medieval Islamic world. In Islamic philosophy tradition, many often referred to him as "the Second Teacher", following Aristotle as the first teacher.

string instrument *Robāb*[20], all of which were used in Iraq, Persia and Transoxiana[21]. As my focus is centred on the tuning system of the oud, I will look at the two different classifications Fārābi gives for the oud's fret position. One is theoretical, while the other is based on interpretations of the intervals used by musicians of his time.

Fārābi was against the Pythagorean view regarding the relationship between musical intervals and the rotation of the stars, mentioning that what the followers of Pythagoras said about the origin of sounds, namely that planets and stars produce musical notes as they move, was invalid and that such a phenomenon was physically impossible. According to Fārābi, the act of music springs from natural human emotions, and the principles of music from experiment and practice. Following this postulate, musical intervals can be divided into two groups: *Molayem* and *Na-Molayem*, which means consonance and dissonance, respectively. Looking at the classification more closely, the consonance intervals can be divided into three groups: large (*Bozorg*), medium (*Motevaset*) and small (*Kouchak*).

In Fārābi's system, the octave (2:1), the double octave (4:1), and generally successive octaves, are called large intervals, while the perfect fifth (2:3), the perfect fourth (4:3), the octave plus the fifth (3:1), and the octave plus the fourth (8:3), are considered as the medium intervals. The major second (9:8), and generally all intervals smaller than the perfect fourth, are considered small consonant intervals, or in Fārābi's own words, *Abād-e Lahni*, which translates to 'melodic intervals'.

These intervals are obtained by dividing "large" and "medium" intervals, and there is an epimoric[22] relationship between them. All are superparticular ratios $(1+1/n)$[23], except for the minor second, or as Fārābi called it, *Baghiyeh* (256:243) and the ratio of 81/75 (normalised as 27/25), which results from the combination of "small" consonance intervals. (Azarnush, 1996)

[20] See glossary.

[21] was a region and civilisation located in lower Central Asia. For more information refer to the glossary.

[22] See glossary.

[23] is the ratio of two consecutive integers, where n is a positive integer.

Ratio	Cents from Reference	HEJI	Prime Factorization
1/1	0 ¢	♮G	-
5/4	386 ¢	𝄲B	5^1 / 2^2
6/5	316 ¢	𝄬B	2^1*3^1 / 5^1
7/6	267 ¢	𝄭B	7^1 / 2^1*3^1
8/7	231 ¢	𝄮A	2^3 / 7^1
9/8	204 ¢	𝄳A	3^2 / 2^3
10/9	182 ¢	𝄲A	2^1*5^1 / 3^2
11/10	165 ¢	𝄩𝄬A	11^1 / 2^1*5^1
12/11	151 ¢	𝄯A	2^2*3^1 / 11^1
13/12	139 ¢	𝄰A	13^1 / 2^2*3^1
14/13	128 ¢	𝄱𝄭A	2^1*7^1 / 13^1
15/14	119 ¢	𝄮♯G	3^1*5^1 / 2^1* 7^1
16/15	112 ¢	𝄬A	2^3 / 3^1*5^1
19/18	94 ¢	𝄫A	19^1 / 2^1*3^2
20/19	89 ¢	𝄪G	2^2*5^1 / 19^1
21/20	84 ¢	𝄭𝄬A	3^1*7^1 / 2^2*5^1
22/21	81 ¢	𝄩𝄮A	2^1*11^1 / 3^1*7^1
24/23	74 ¢	𝄩♭A	2^3*3^1 / 23^1
25/24	71 ¢	𝄲G	5^2 / 2^3*3^1
28/27	63 ¢	𝄭♭A	2^3*7^1 / 3^3
31/30	57 ¢	𝄰𝄬A	31^1 / 2^1*3^1*5^1
32/31	55 ¢	𝄪G	2^5 / 31^1
36/35	49 ¢	𝄮𝄲G	2^2*3^2 / 5^1*7^1
46/45	38 ¢	𝄭𝄲G	2^1*23^1 / 3^2*5^1
49/48	36 ¢	𝄲♭A	7^2 / 2^4*3^1
81/75 (27/25)	133 ¢	𝄬A	3^4 / 3^1*5^{12}
256/243	90 ¢	♭A	2^8 / 3^5

Table 2.5. The chart of *Abād-e Lahni* (melodic intervals) by Fārābi.

One of the most important facts for my research is that Fārābi was the first to describe the position of neutral third intervals on the oud, such as the *Wustā Furs* interval, which roughly translates as the Persian middle with the ratio of 81/68 (+302.9 cents), and *Wustā Zalzal* with the ratio of 27/22 (+354.5 cents), which translates as the *Zalzalian* middle. The latter is also known as the neutral third interval and was introduced by Mansur Zalzal al-Darib (d. 791 CE), an oud player born in an Iranian family in Kufa (Barkeshli, 1978/2012).

When it comes to finding the intervals on the oud, Fārābi explains that there are four distinct fret positions located on the fingerboard where one can easily place the fingers, and they are called *Sabbābeh*, *Wustā*, *Bensir,* and *Khensir*. The first note is the open string, and its name is *Mutlaq;* the second is the *Sabbābeh*, which is 1/9 of the entire string length; the third, *Wustā*, will be analysed in detail below. The fourth note is *Bensir*, which is at the 1/9 point between the *Sabbābeh* and the bridge, and the last one is *Khensir*, which is at the distance of 1/4 of the whole string.

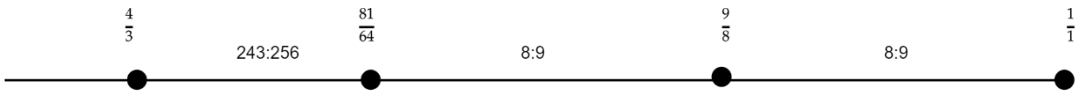

Figure 2.4. The distances of *Sabbābeh*, *Wustā*, *Bensir* and *Khensir* on oud's fingerboard according to Fārābi.

The interval between these frets is as follows:

- The interval between *Mutlaq* to *Khensir* is 4/3 (Zu'l al-Arba)
- The interval between *Mutlaq* to *Sabbābeh* is 9/8 (Tanini)
- The interval between *Sabbābeh* to *Bensir* is 9/8 (Tanini)
- The interval between *Bensir* and *Khensir* is 256/243 (Baghiyeh or Fazleh)

The next step is to tune the remaining oud strings by tuning each one with the previous *Khensir* of the strings. In doing this, it is clear that the distance between the strings is 4/3 (*Zu'l al-Arba*). We can then assign each string a letter from the *Abjad* system and the fret positions as shown in the graph below. If we assume that the letter "a" of the *Abjad* system is assigned to the nut as the starting point for each string, the frets look like this:

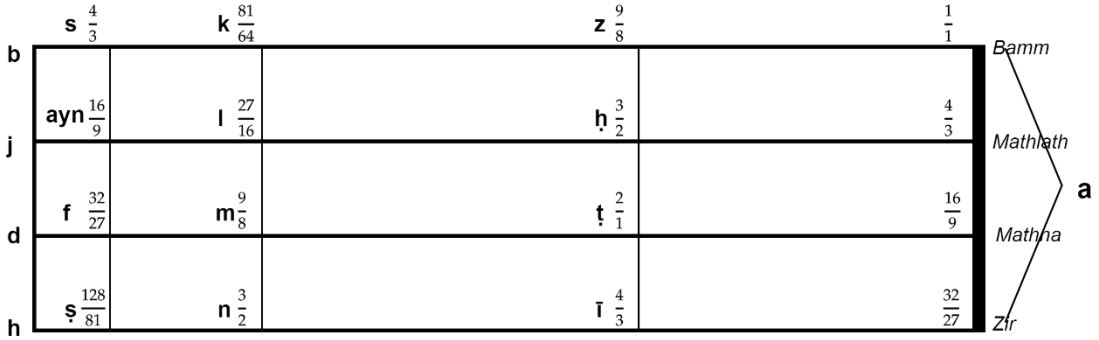

Figure 2.5. Fārābi's gamut represented as finger positions on oud.

The next step is to find the mathematical position for the *Wustā* and *Mujannabāt*. Fārābi writes that some people considered the position of the *Wustā* to be the point where the distance between it and *Khensir* is 1/8 of the distance between *Khensir* and the bridge, i.e. 27/32 of the whole string. He adds that some musicians place this *Wustā* between *Sabbābeh* and *Bensir*, which is called *Wustā-e Furs* (27/22) (The Persian middle), and its exact position is between the 9/8 and 81/64, with the melodic step of 8:9 (17:18*16:17).

He goes on to describe another interval between *Wustā-e Furs* and *Bensir* and calls it *Wustā-e Zalzal*, which lies midway between 81/64 and 81/68 with the melodic step of 16:17 (33:34*33:32). He points out, however, that during his time, the position of the *Wustā* with the ratio 32/27 (294¢) was called *Mujannab-e Wustā* (anterior to *Wustā*) and the *Wustā* was called either *Wustā-e Furs* or *Wustā-e Zalzal*. As a final step to completing his tuning system, Fārābi explains that some musicians place additional frets between the *Sabbābeh* (9/8) and the open string, which he calls *Mujannabāt-e Sabbābeh*.

One of these frets corresponds to the retrograde structure of the diatonic tetrachord of *Mutlaq - Sabbābeh - Bensir* and *Khensir*, with the melodic steps of 8:9 - 8:9 - 243:265, but starting from the point of *Khensir* (4/3). Note that the exact position *Mujannab-e Wustā* (32/27) is also outlined in this procedure. To complete all the musical intervals on the tetrachord, Fārābi also states that in addition to *Mujannab-e Sabbābeh I* (2546/243), which he previously described how to find, there are three other proportions for *Mujannabat*, whose exact position can be found as follows:

- *Mujannab-e Sabbābeh II* is obtained by dividing a tone into two parts (17:18*16:17).
- *Mujannab-e Sabbābeh III*, between nut (1/1) and *Wustā-e Furs* (81/68)
- *Mujannab-e Sabbābeh IV*, between nut (1/1) and *Wustā-e Zalzal* (27/22)

With the following ratio, he calculates their exact location in the form of a number relative to the total length of the open string (Barkeshli, 1978/2012):

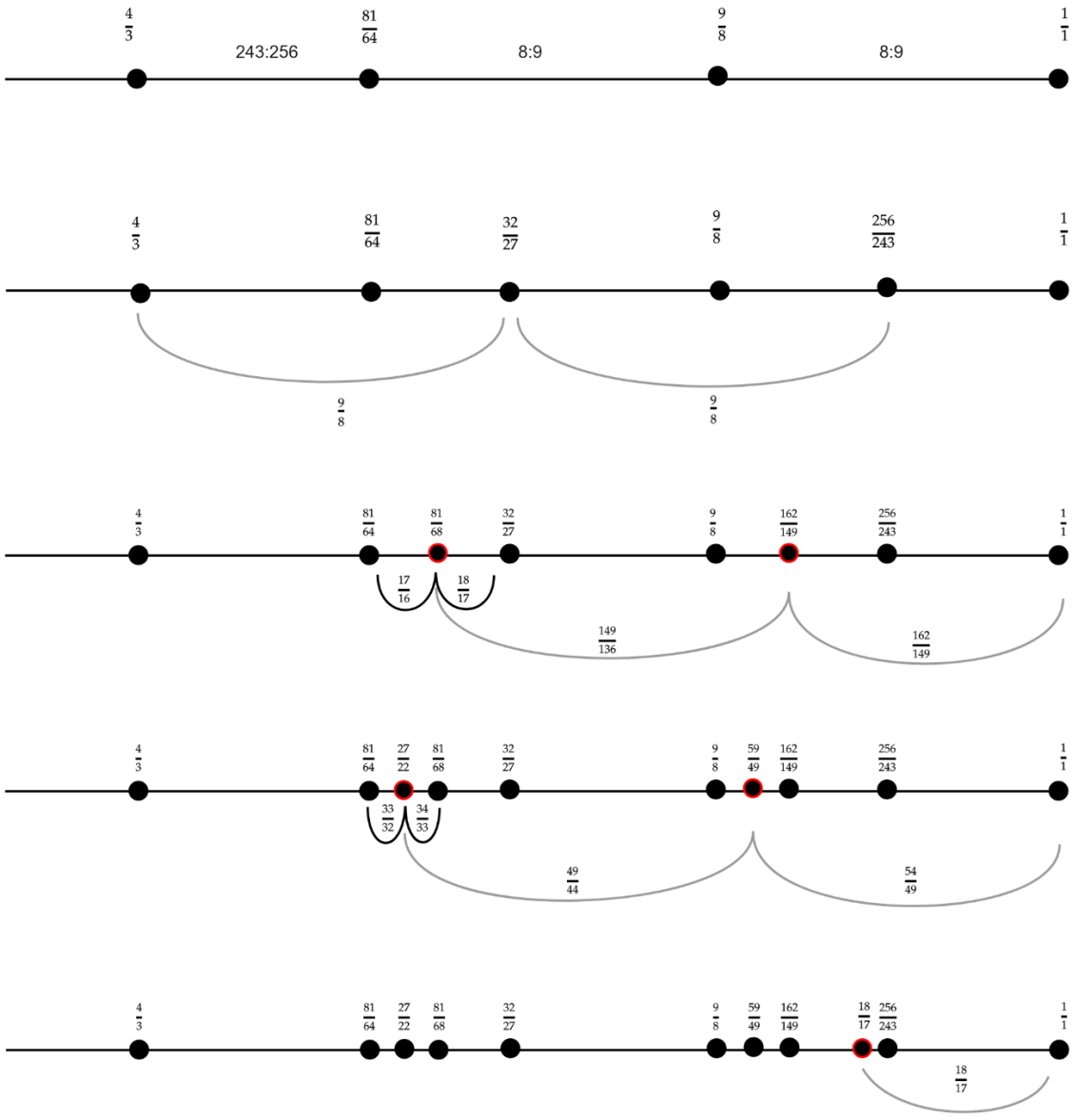

Figure 2.6. Fārābi's finger positions within the tetrachord movements.

He then assigned the other letters of the *Abjad* system to the new positions:

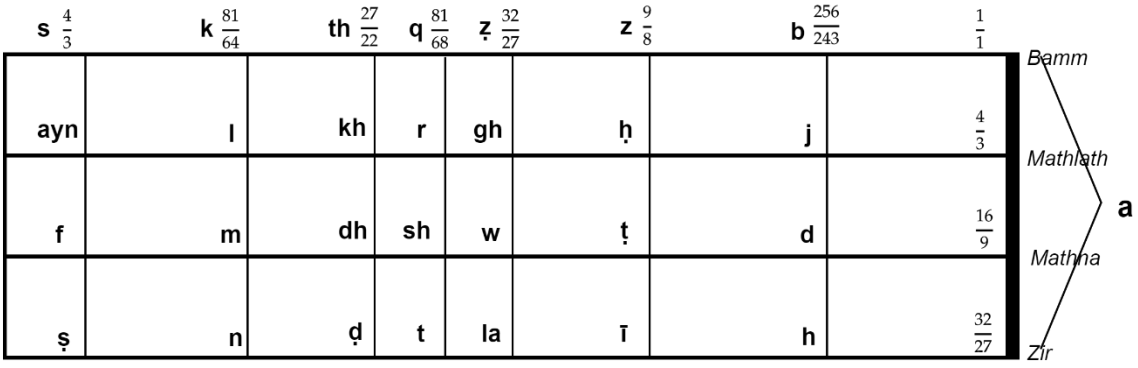

Figure 2.7. Fārābi's finger reconfigured positions on oud fingerboard with *Abjad* representation.

Name	HEJI	Ratio	Cents from Reference	*Abjad* System
Mutlaq	𝄮G	1/1	0 ¢	a
Mujannab-e Sabbābeh I	𝄭A	256/243	90 ¢	b^1
Mujannab-e Sabbābeh II	𝄳𝄭A	18/17	99 ¢	b^2
Mujannab-e Sabbābeh III	𝄭$A^{+55¢}$	162/149	145 ¢	b^3
Mujannab-e Sabbābeh IV	𝄲♯G	54/49	168 ¢	b^4
Sabbābeh	𝄮A	9/8	204 ¢	z
Mujannab-e Wustā	𝄭B	32/27	294 ¢	ẓ
Wustā-e Furs	𝄳𝄭B	81/68	303 ¢	q
Wustā-e Zalzal	𝄩B	27/22	355 ¢	th
Bensir	𝄮B	81/64	408 ¢	k
Khensir	𝄮C	4/3	498 ¢	s

Table 2.6. Fārābi's "Ten fret division of the tetrachord".

Until now, we have dealt with the empirical analysis of the concept of interval notion in Fārābi's fret division of the oud. It was connected to the interval concept based on the musical interpretations used by musicians of his time. The second classification of fret positions on the oud relating to theoretical analysis develops as follows:

- Fārābi assumes that we have found the position of the three frets *Sabbābeh*, *Bensir* and *Khensir* in advance. The lowest tone is set to the open string *Bamm* and the strings are tuned in perfect fourths with the help of the position *Khensir*. The octave equivalent of the *Bamm* is the note at the position of the index finger on the *Mathna* string
- Consecutively, Fārābi explains that because the oud has only four strings, it is impossible to create another octave based on the *Mathna* string. As a solution, he suggests adding a fifth string on the oud, which he calls the *Hadd*. In this way we can find the second octave at the position of the ring finger of the *Hadd*, or fifth string.

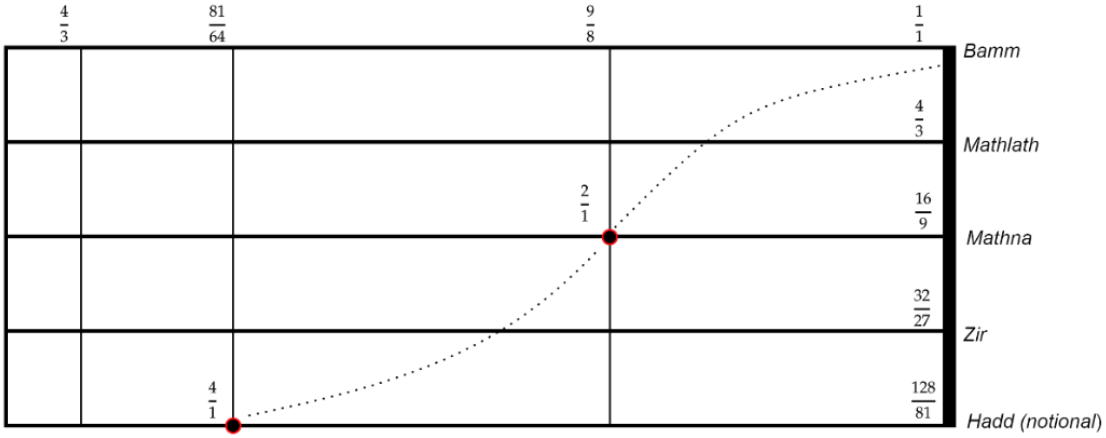

Figure 2.8. Fārābi's reasoning for adding the fifth string on oud.

He goes on to say that the number of notes in both octaves should be equal. For example, if we compare the notes of the first octave with the notes of the second octave, we find that the pitch produced by the index finger in *Mathna* (2/1) is equal to the sound of the *Bamm* (1/1). Furthermore, if we move from the open bass string to the position of the index finger (*Sabbābeh*) (9/8), a match to this pitch in the second octave would be on the position of the ring finger (*Bensir*) on the *Mathna* string. From this, we can conclude that the distance between the notes produced by the open bass string and the index finger fret position (*Sabbābeh*) corresponds to the distance between the position of the index finger (*Sabbābeh*) in *Mathna* and the placing of the ring finger (*Bensir*).

However, of the three positions of the middle finger (*Wustā*), it is sufficient to pay attention to the most important one, *Wustā-e Zalzal* (27/22) of the *Bamm* string. There is no note corresponding to it in the second octave. The position of the ring finger (*Bensir*) on *Bamm* (81/64) is the same. If we were to create equivalents for it in the second octave, the pitch of the ring finger on *Bamm* would be found interior to the position of the index finger, near the *Anf* (nut) on the *Zir* string. The note identical to that produced by the

middle finger (*Wustā*) on the *Bamm* is slightly higher than that placed near the index finger, near the *Sabbābeh* position on the *Zir* string (Azarnush, 1996).

Fārābi precisely outlines the position of all the fingers that are not repeated in the second octave, or that have arisen through the expansion of the octave but are not present in the first octave. Finally, he arrives at a 22-tone scale that is extended in two octaves.

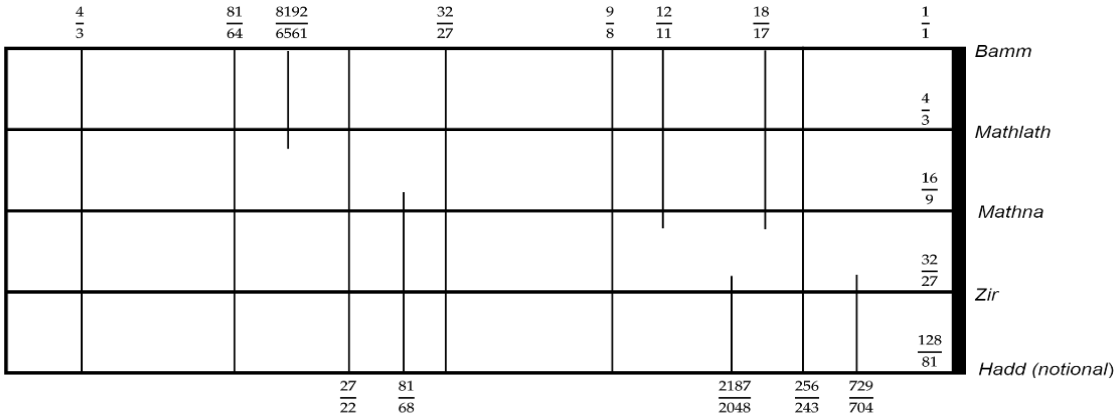

Figure 2.9. Additional irregular positions of Fārābi's 22-tone scale.

Name	HEJI	Ratio	Cents from Reference
Mutlaq	𝄮G	1/1	0 ¢
Mujannab-e Sabbābeh	𝄳♯G	729/704	60 ¢
Mujannab-e Sabbābeh	♭A	256/243	90 ¢
Mujannab-e Sabbābeh	𝄬♭A	18/17	99 ¢
Mujannab-e Sabbābeh	♯G	2187/2048	114 ¢
Mujannab-e Sabbābeh	𝄳A	12/11	151 ¢
Sabbābeh	𝄮A	9/8	204 ¢
Mujannab-e Wustā	♭B	32/27	294 ¢
Wustā-e Furs I	𝄬♭B	81/68	303 ¢
Wustā-e Zalzal	𝄳B	27/22	355 ¢
Wustā-e Furs II	♭C	8192/6561	384 ¢
Bensir	𝄮B	81/64	408 ¢
Khensir	𝄮C	4/3	498 ¢

Table 2.7. Fārābi's "Twelve fret division of the tetrachord" (Azarnush, 1996).

2.4 Ibn Sinā (980-1037)

Another outstanding and important figure for me in the study of Iranian tuning systems is Abdallah Ibn Sinā (980-1037), more commonly known in the West as Avicenna. Ibn Sinā was an Iranian polymath who is considered one of the most accomplished physicians, astronomers, thinkers, and writers of the Golden Age of Islam. He is also credited as the father of early modern medicine (Gutas, 2016).

In addition to his fundamental writings on various sciences, Ibn Sinā wrote five books on music, of which unfortunately only three survived; two being written in Arabic and one in Farsi. One of them is a complete chapter in his scientific and philosophical encyclopedia, *Kitāb al-Shifā* (The Book of Cure), published in 1027. In his book, Ibn Sinā classified the sciences according to the tradition of Aristotle:

- Logic, with a purely Aristotelian approach
- Theoretical philosophy (physics, mathematics, metaphysics)
- Practical philosophy

Following the ancient Greek tradition, he placed music in the category of mathematics, among geometry, arithmetic, and astronomy. The general approach in the *Kitāb al-Shifā* is similar to that of Fārābi's *Kitāb al-Musiqā al-Kabir*, beginning with a detailed discussion about the source and nature of sound, acoustics, and the production of sound and pitch, followed by definitions of intervals (Bo'd/Ab'ad[24]) and genus (Jins/Ajnās) (Gutas, 2016). Following the footsteps of ancient and medieval polymaths, Ibn Sinā organised the musical intervals in terms of mathematical ratios and ranked them into two distinct groups of *Molāyem* (consonances) and *Nā-Molāyem* (dissonances), dividing the consonant intervals into three groups:

- Large (*Bozorg*) with the ratios of the octave and its repetitions 2/1, 4/1, 8/1
- Medium (*Motevaset*), for the perfect fifth 3/2 and the perfect fourth 4/3
- Small (*Kouchak*), series of superparticular ratios or 1+1/n, smaller than a perfect fourth (4/3)

[24] Plural form of *B'od*, an Arabic word for distance or in the musical language for the intervals.

Ibn Sinā then went one step further than Fārābi and divided the small intervals into three categories:

- Large-Small consonances (*Mālayem-e Kouchak-e Bozorg*)
- Medium-Small consonances (*Molāyem-e Kouchak-e Motevaset*)
- Small-Small consonances (*Molāyem-e Kouchak-e Kouchak*)

Ratio	Cents from Reference	HEJI	Prime Factorization
1/1	0 ¢	𝄮G	-
5/4	386 ¢	𝄲B	$5^1 / 2^2$
6/5	316 ¢	𝄬B	$2^1*3^1 / 5^1$
7/6	267 ¢	𝄭B	$7^1 / 2^1*3^1$
8/7	231 ¢	𝄮A	$2^3 / 7^1$
9/8	204 ¢	𝄮A	$3^2 / 2^3$
10/9	182 ¢	𝄲A	$2^1*5^1 / 3^2$
12/11	151 ¢	𝄯A	$2^2*3^1 / 11^1$
13/12	139 ¢	𝄯A	$13^1 / 2^2*3^1$
14/13	128 ¢	𝄪𝄭A	$2^1*7^1 / 13^1$
15/14	119 ¢	𝄮𝄰G	$3^1*5^1 / 2^1* 7^1$
16/15	112 ¢	𝄬A	$2^3 / 3^1*5^1$
19/18	94 ¢	𝄩𝄬A	$19^1 / 2^1*3^2$
20/19	89 ¢	𝄩𝄰G	$2^2*5^1 / 19^1$
21/20	84 ¢	𝄭𝄬A	$3^1*7^1 / 2^2*5^1$
22/21	81 ¢	𝄱𝄮A	$2^1*11^1 / 3^1*7^1$
25/24	71 ¢	𝄰G	$5^2 / 2^3*3^1$
26/25	68 ¢	𝄯𝄲A	$2^1*13^1 / 5^2$
28/27	63 ¢	𝄭𝄬A	$2^3*7^1 / 3^3$
31/30	57 ¢	𝄰𝄲A	$31^1 / 2^1*3^1*5^1$
32/31	55 ¢	𝄱G	$2^5 / 31^1$
36/35	49 ¢	𝄮𝄲G	$2^2*3^2 / 5^1*7^1$
40/39	44 ¢	𝄪𝄲G	$2^3*5^1 / 3^1*13^1$
49/48	36 ¢	𝄫𝄬A	$7^2 / 2^4*3^1$

Table 2.8. The chart of consonant melodic intervals by Ibn Sinā.

The first group are the intervals that start with 5/4 to 14/13, the second group starts with 15/14 and ends with 29/28, and the last group is between 30/29 and 46/45, giving a total of 43 intervals. However, as can be seen in the table below, he only used 23 of these 43 intervals to form 16 tetrachords, which he introduced in his book.

Ibn Sinā described in detail how he used these specific consonant intervals and combined them into 16 tetrachords. He then categorised these tetrachords into two groups: *Ghavi* (strong or diatonic) and *La'yyen* (soft). He then continued to divide soft into two further groups– *Rāsem* (chromatic) and *Ta'lifi/Mola'vvan* (enharmonic):

Name	Steps	Harmonic Space	HEJI
Ghavi I	8/7 - 8/7 - 49/48	64:56:49:48	𝄪G - 𝄢A - 𝄫B - 𝄪C
Ghavi II	9/8 - 8/7 - 28/27	36:32:28:27	𝄪G - 𝄪A - 𝄢B - 𝄪C
Ghavi III	8/7 - 10/9 - 21/ 20	80:70:63:60	𝄪G - 𝄢A – 𝄢𝄲B - 𝄪C
Ghavi IV	8/7 - 13/12 - 14/13	104:91:84:78	𝄪G - 𝄢A - 𝄩𝄢B - 𝄪C
Ghavi V	9/8 - 9/8 - 256/243	324:288:256:243	𝄪G - 𝄪A - 𝄪B - 𝄪C
Ghavi VI	10/9 - 9/8 - 16/15	20:18:16:15	𝄪G - 𝄲A - 𝄲B - 𝄪C
Ghavi VII*[25]	13/12 - 9/8 - 12/11	26:27:33:32	𝄪G - 𝄩A - 𝄩B - 𝄩𝄩C
La'yyen I (a)	16/15 - 15/14 - 7/6	16:15:14:12	𝄪G - 𝄬A - 𝄢A - 𝄪C
La'yyen I (b)	7/6 - 12/11 - 22/21	28:24:22:21	𝄪G - 𝄬B - 𝄬C - 𝄪C
La'yyen II	10/9 - 36/35 - 7/6	40:36:35:30	𝄪G - 𝄲A - 𝄢A - 𝄪C
La'yyen III	20/19 - 19/18 - 6/5	20:19:18:15	𝄪G - 𝄎G - 𝄲A - 𝄪C
La'yyen IV	6/5 - 15/14 - 28/27	36:30:28:27	𝄪G - 𝄬B - 𝄢B - 𝄪C
La'yyen V	6/5 - 25/24 - 16/15	60:50:48:45	𝄪G - 𝄬B – 𝄲B - 𝄪C
Ta'lifi/Mola'vvan I	5/4 - 32/31 - 31/30	40:32:31:30	𝄪G - 𝄲B - 𝄫𝄲B - 𝄪C
Ta'lifi/Mola'vvan II	40/39 - 26/25 - 5/4	80:78:75:60	𝄪G - 𝄯G – 𝄬A - 𝄪C
Ta'lifi/Mola'vvan III	36/35 - 5/4 - 28/27	36:35:28:27	𝄪G - 𝄢𝄲G - 𝄢B - 𝄪C

Table 2.9. The chart of 16 tetrachords by Ibn Sinā.

[25] In various Farsi resources, this interval is referred to as "near to 12/1". The result of using this ratio is a tetrachord lesser than a perfect fourth, as shown in the table. Cris Forster (b. ~~1966~~) suggested using the ratio of 128/117 instead of 12/11 to solve this problem. (Forster, 2010, p.676) The difference between these two ratios is the melodic ratio 351:352 or 4.9¢. (b. 1948)

The total number of tetrachords is 48, as the content of each tetrachord can be permuted flexibly. For example, the tetrachord *Ghavi V* could be written as follows:

9/8 - 9/8 - 256/243 (♮G - ♮A - ♮B - ♮C)
9/8 - 256/243 - 9/8 (♮G - ♮A - ♭B - ♮C)
256/243 - 9/8 - 9/8 (♮G - ♭A - ♭B - ♮C)

In the last part of his book, Ibn Sinā wrote about the instruments of his time and described in detail the fretting and tuning system of the oud. His system consisted of seven fret positions producing two 17-tone octaves on a five-stringed instrument (Barkeshli, 1981).

In this section, as with his predecessors, he arrives at a tetrachord by indicating the exact position of the fingers on the lowest string of the oud, which when extended to the other strings, produces a two-octave scale.

Ibn Sinā starts his work by defining the position of the little finger (*Khensir*), or perfect fourth (4/3), and dividing the string into four equal parts. The string is then divided into nine equal parts, marking the position of the index finger (*Sabbābeh*) at a distance of 1/9 from the nut (9/8). The distance between the *Sabbābeh* and the bridge is also divided into nine parts and the position of the ring finger (*Bensir*) (81/64) is marked. The distance between the third and fourth fingers is obtained by specifying these three leading frets, which is a *Limma* (256/243).

To find the *Wustā-e Furs*, we divide the distance between the bridge and the little finger into eight parts and proceed from the little finger towards the nut, equal to one of these distances. This gives us a ratio of 32/27. There should be an interval of one tone (9/8) between this fret and the position of the little finger.

Ibn Sinā describes how to find the position of the *Wustā-e Zalzal* by placing it roughly halfway between the index finger and the little finger. More specifically, he is directing the musician to find the location of the ratio 1+1/12 from the index finger towards the middle finger (*Wustā-e Furs*), which is 39/32. The approximate ratio between this fret and the little finger should be 1+1/11 or 128/117. He further explains that if we move a tone (9/8) from 39/32 or the position of *Wustā-e Zalzal* towards the nut, we will reach point 13/12, which is the place of *Mujannab-e Zalzal*. Finally, he writes that there is yet another fret above this position called *Mujannab*. To find it, one has to move from the position of the *Wustā-e Zalzal* (39/32) by 1+1/8 (8/7) towards the nut, and the ratio for this position would be 273/256 (Forster, 2010).

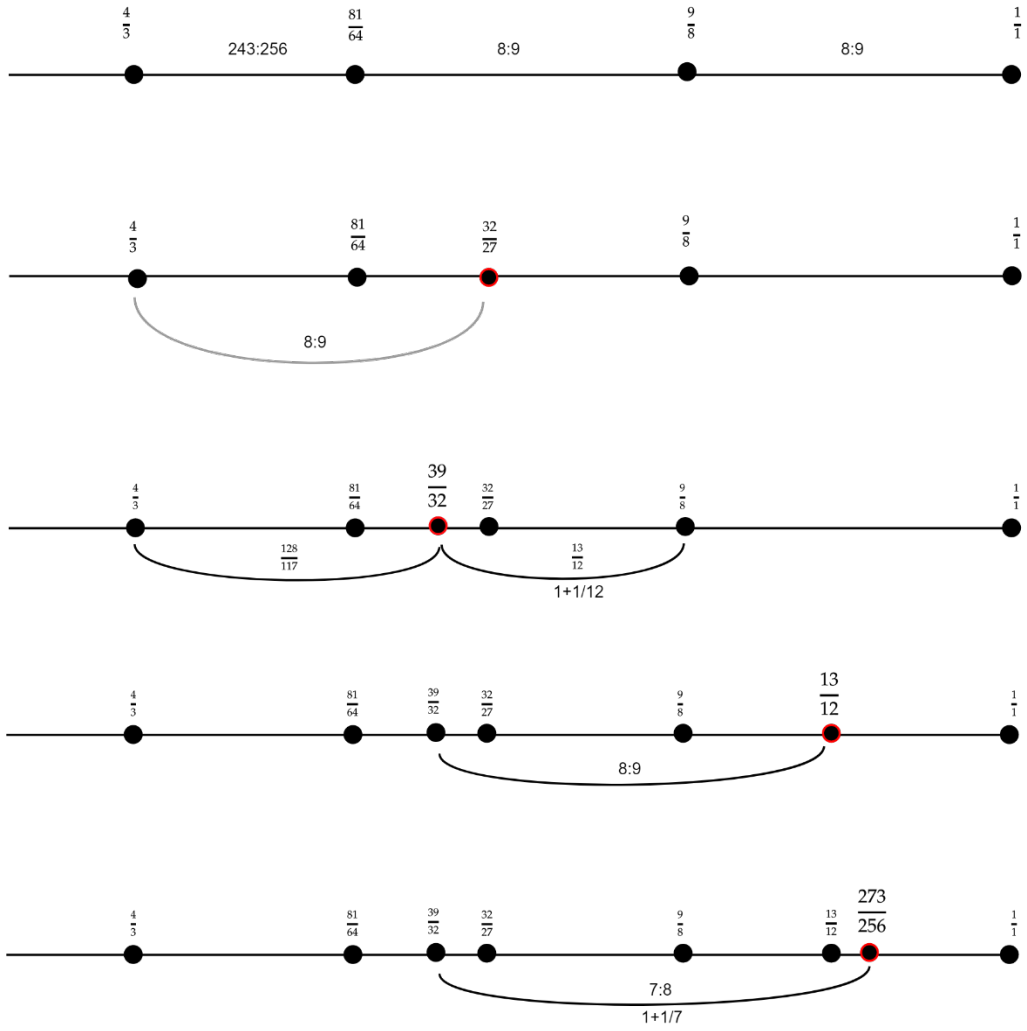

Figure 2.10. Ibn Sinā's finger positions within the tetrachord movements.

There are some differences between the ratios for fretting in the systems of Fārābi and Ibn Sinā. These differences are due to the fact that both authors lived in different places, and each referred to the music of their own time and region.

For example, the size of the *Wustā-e Zalzal* (the *Zalzalian* neutral third) is described by Fārābi as having a ratio of 27/22 (354.5¢). At the same time, Ibn Sinā calculates it as a ratio of 39/32 (342.5¢)[26].

[26] Difference between them is the melodic ratio *144:143* or 12.1¢.

Another difference in ratio occurs within the positions of the *Mujannab-e Zalzal* (middle second), which in Fārābi's treatise is 12/11 (+150.6¢), while in Ibn Sinā's system it is 13/12 (+138.6¢)[27].

Name	HEJI	Ratio	Cents from Reference	*Abjad* System
Mutlaq	𝄮G	1/1	0 ¢	-
Mujannab	𝄳A	273/256	111 ¢	-
Mujannab II (from Wustā-e Zalzal)	𝄳A	13/12	138 ¢	-
Sabbābeh	𝄮A	9/8	204 ¢	-
Wustā-e Furs	♭B	32/27	294 ¢	-
Wustā-e Zalzal	𝄳B	39/32	342 ¢	-
Bensir	𝄮B	81/64	408 ¢	-
Khensir	𝄮C	4/3	498 ¢	-

Table 2.10 Ibn Sinā's seven fret division of the tetrachord.

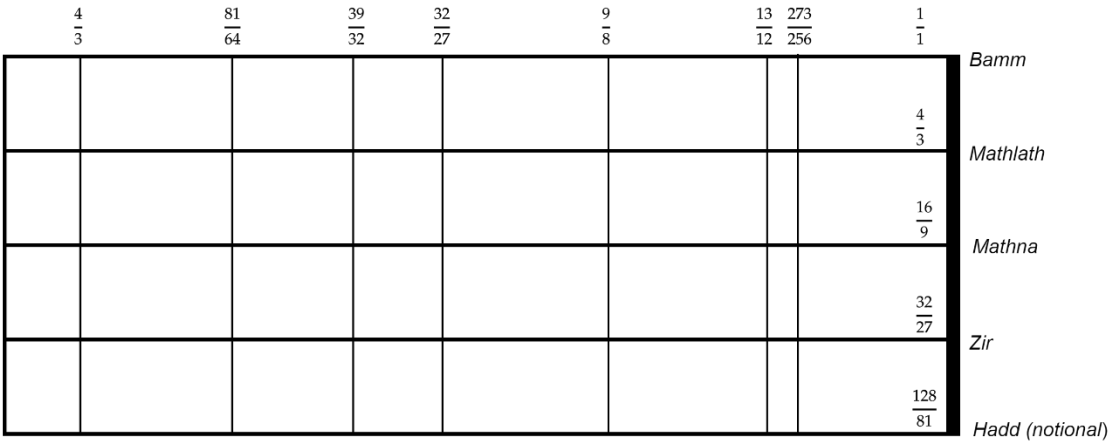

Figure 2.11. Ibn Sinā's gamut represented as finger positions on oud.

Fārābi lived almost his entire life in Baghdad under the patronage of the Abbasid Caliph Al-Radi (reigned 934-940), to whom he dedicated his *Kitāb al-Musiqā al-Kabir*. To analyse these differences from another perspective, it is important to know that Ibn Sinā lived in the eastern parts of the Abbasid territory, where the rise and resonance of the new Persian language, art, and culture, were born. He lived under the patronage of different dynasties, such as the Samanid Empire, the Buyid Dynasty and the Khwarazmian Dynasty. He

[27] Difference between them is the melodic ratio *144:143* or 12.1¢.

also travelled between different regions, such as Bukhara, Ray, Gorganaj and Hamedan, which formed the basis for his scientific research on music, covering completely different areas than those of Fārābi.

In comparing the tetrachords of Fārābi and Ibn Sinā, many similarities can be found, as any differences are mostly very small details. For example, the second *Jins* of Fārābi and the seventh *Jins* of Ibn Sinā, both cases involving the *Zalzalian Wustā* (neutral third), have the following melodic steps:

- Fārābi: 9:8-12:11-88:81 (1/1 - 9/8 - 27/22 - 4/3) (♮G ♮A 𝄲B ♮C)
- Ibn Sinā: 9:8-13:12-128:117 (1/1- 9/8 - 39/32 - 4/3) (♮G ♮A 𝄳B ♮C)

No.	Ratio	HEJI	Cents from Reference	Melodic Ratio (from the previous ratio)	Melodic Step in Cents
1	1	♮G	0 ¢	-	-
2	273/256	𝄳𝄾A	111 ¢	256 : 273	111 ¢
3	13/12	𝄳A	138 ¢	63 : 64	27 ¢
4	9/8	♮A	204 ¢	26 : 27	65 ¢
5	32/27	♭B	294 ¢	243 : 256	90
6	39/32	𝄳B	342 ¢	1024 : 1053	48
7	81/64	♮B	408 ¢	26 : 27	65 ¢
8	4/3	♮C	498 ¢	243 : 256	90
9	91/64	𝄳𝄾D	609 ¢	256 : 273	111 ¢
10	13/9	𝄳D	636 ¢	63 : 64	27 ¢
11	3/2	♮D	702 ¢	26 : 27	65 ¢
12	128/81	♭E	792 ¢	243 : 256	90
13	13/8	𝄳E	840 ¢	1024 : 1053	48
14	27/16	♮E	906 ¢	26 : 27	65 ¢
15	16/9	♮F	996 ¢	243 : 256	90
16	91/48	𝄳𝄾G	1107	256 : 273	111 ¢
17	52/27	𝄳G	1134 ¢	63 : 64	27 ¢
18	2/1	♮G	1200 ¢	26 : 27	65 ¢

Table 2.11. Ibn Sinā's 17-tone gamut.

2.5 Safiaddin Ormavi (1216-1294)

Born in Urmia, Ormavi was one of the most influential musicians and theoreticians of music in Iran and the Arab world, with his book on music theory, The *Ketāb al-Advār* (The Book of Circles), undoubtedly the most crucial milestone in Irano-Arab music history. Written in the 13th century, it is a completely preserved work on scientific music theory, furthering the earlier works of Fārābi and Ibn Sinā. Ormavi's theories on intervals and tuning systems still serve as the basis for traditional Turkish and Arabic music today, and his division of the octave into 17 tones was the first step towards the Systematist school of music in West Asia, making him the "Zarlino of the Orient", as Raphael Kiesewetter famously called him (Kiesewetter, 1842, p. 13). Qutb al-Din al-Shirāzi, a 13th-century Iranian polymath and poet, also referred to him as *Afdal-i Irān*, which translates as 'the sage of Iran' (Neubauer, 2012). While there is no proof of his ethnic origin, evidence according to the Encyclopedia of Islam suggests he was of Persian descent. Moving to Baghdad at a young age, where he also died, Ormavi had the opportunity to study the Arabic language, literature, history, and the art of calligraphy. He also studied fiqh (Islamic jurisprudence) at the Al-Mustansiriyah Madrasah, a scholarly complex in Baghdad for higher education focusing on Islamic law and religious studies, as well as medicine, mathematics, philosophy, literature, and grammar.

Ormavi wrote in his diary that he received more fame and praise in his youth as a calligrapher, with his penmanship so admired that he was given the opportunity to work at the court of Al-Musta'sim[28] as a copyist for the new caliphal libraries (van Gelder, 2012).

It was by chance that Ormavi's musical talent was discovered by Caliph Al-Musta'sim. During one of the gatherings at the royal court, Lihaz, considered the Caliph's favourite songstress and a student of Ormavi, performed an unusual song that he had never heard before. When asked about the origin of the song, she replied that Safiaddin Ormavi, the calligrapher, had composed the tune. Immediately ordering Ormavi's presence in his court to play oud, the Caliph was so surprised and impressed by his talent that he assigned him as a member of his private circle of companions, providing a very high and generous salary. To Ormavi's incredible good fortune, and thanks to his extensive training in fiqh and comparative law, Al-Musta'sim also assigned him as a head of his juridical administration at court (Neubauer, 2012).

During the years he spent at Al-Musta'sim's court, Ormavi wrote his masterpiece, *Ketāb al-Advār*. Although the exact date is unknown, it is believed to have been written c.1235 CE and is considered the first book of

[28] Al-Musta'sim was the last Caliph of the Abbasid dynasty, who was overthrown and executed at the Mongol Sack of Baghdad in 1258 by the Hulagu Khan.

the 13th century focused in such detail on music and music theory, and the first attempt at discovering a temperament that could cover Arabic, Iranian and Turkish music.

During the Mongol invasion at the Sack of Baghdad in 1258 by Hulagu Khan, it was Ormavi's musical talent that helped him and his family survive, while the Caliph Al-Musta'sim and thousands more were executed. In this battle, the Grand Library of Baghdad, known as "The House of Wisdom" (*Bayt al-Ḥikmah*), containing historical documents and books on subjects ranging from medicine to astronomy, was destroyed. Fortunately, Hulagu Khan admired Ormavi's oud playing and gave orders to exclude him from the executions of the former ruler's court members. Consequently, Ormavi not only managed to save his book from destruction but also had his salary doubled compared to Al-Musta'sim's generosity.

After the events of the Sack of Baghdad, Ormavi was appointed as a teacher for the youngest members of the Juvayni family, a Persian family known to foster many scholars and poets over generations. Men from the Juvayni family held high positions in the government apparatus during the reigns of many different dynasties from the 9th century onwards, starting with the Abbasid Caliph Harun al-Rashid (763 -809) until the time of the Ilkhanate[29] in the 13th century (Rajabzadeh, 2009). Ormavi's relations with the Juvayni family helped him maintain a very successful position in Baghdad; appointed as head of supervision for the foundations *Naẓariyyat al-Waqf*[30] and head of the *Diwan-i-Insha*[31], where he was in charge of the royal correspondence.

Around 1267, Ormavi wrote his second important book, *Resāle al-Sharafiyye* (The Sharafiya Treatise), and dedicated it to his student Sharaf al-Din Harun Juvayni (d. 1286), who was also his patron and loyal supporter. In his new study, written more than thirty years after *Ketāb al-Advār*, Ormavi analyzed in depth all the existing and documented musical theories that had preceded him. He referred to ancient Greek music theories; the works of Irano-Arab musicologists, such as Al-Kindi, Fārābi, and Ibn Sinā; and even challenged his own ideas and theories from his first work. This book's systematic and methodical details make it an indispensable source for all present-day academic discourse in Irano-Arab musicology.

In 1284, Arghun Khan, the fourth ruler of the Ilkhanate of the Mongol Empire, came to power in Baghdad. Contrary to the policy of previous rulers, Arghun Khan was against the enrichment of art and knowledge, resulting in all members of the Juvayni family being removed from power or executed. This event caused

[29] Ilkhanate was part of the Mongol Empire in the 12th and 13th centuries. Their territories mostly covered today's Iran, parts of Turkmenistan, Turkey, Iraq, Armenia, Afghanistan, and Pakistan.
[30] En. Transl.: the supervision of the foundations and charities.
[31] En. Transl.: department of royal correspondence.

Ormavi to lose his patrons and support, leaving him to spend his final years in poverty and misery. He was eventually imprisoned for his debts and died in Baghdad on 28 January 1294 (Neubauer, 2012).

Ormavi's treatise consists of fifteen chapters on various topics about music. It begins with a description of the sources of sound, the division of the frets on the oud, and analyses the ratios of the intervals. In addition, the book contains a broad chapter about the effect of music on the human body and focuses on how the performer interprets the music.

In *Ketāb al-Advār*, Ormavi developed and proposed a theoretical system of a 17-tone gamut to describe Persian and Arabic music, in which the tones are not evenly distributed[32]. It is also important to note that this gamut has never functioned as a scale or mode but as a set of uniquely ordered pitches that were used as a source for constructing independent scales to create music.

Ormavi's access to the Caliph's library during the reign of Al-Musta'sim, and the possibility to study the books of his ancestors and the ancient Greek treatises on music theory, helped him to construct this very detailed and unique gamut. Like many treatises before him, Ormavi described pitches and intervals based on the position of the fingers on the oud's fingerboard and used the *Abjad* system to document them (Rustami, 2001).

In search of a complete system that would allow him to transpose scales unlimitedly, Ormavi formed his *Advār*[33] system based on the Pythagorean limmas and commas, built with the chain of perfect fifths. The structure of the gamut starts with $[3^{-12}]$ and goes up to the $[3^{4}]$ (FamourZadeh, 2005).

$$\frac{1048576}{531441}, \frac{262144}{177147}, \frac{65536}{59049}, \frac{32768}{19683}, \frac{8192}{6561}, \frac{4096}{2187}, \frac{1024}{729}, \frac{256}{243}, \frac{128}{81}, \frac{32}{27}, \frac{16}{9}, \frac{4}{3}, \frac{1}{1}, \frac{3}{2}, \frac{9}{8}, \frac{27}{16}, \frac{81}{64}$$

Fundamentally, his system contains a 12-tone Pythagorean scale that many before him described during the early Arabic tuning systems. However, his gamut contains five additional pitches that allow him to divide a tone into more details.

[32] It should not be confused with the 17-TET scale, where each step of the scale represents a frequency ratio of $17\sqrt{2}$, or 70.6 cents.

[33] Ormavi used the word *Advār*; it is equivalent to the term *Maqām*, *Par'deh*, and *Lahn*.

In his system, the inner structure of a tone (9/8) consists not of a diatonic semitone (90¢), a chromatic semitone, or Pythagorean apotome (114¢), but of two Pythagorean-limmas (256/243 or 90¢) and one Pythagorean-comma (531441/524288 or 23.5¢). In this way, the gamut is constructed according to the following steps: *Limma+Limma+Comma*.

256/243 + 256/243 + 531441/524288 = 9/8

Based on this structure, Ormavi writes that a tetrachord in his system builds up as follows:

LLC, LLC, L[34]

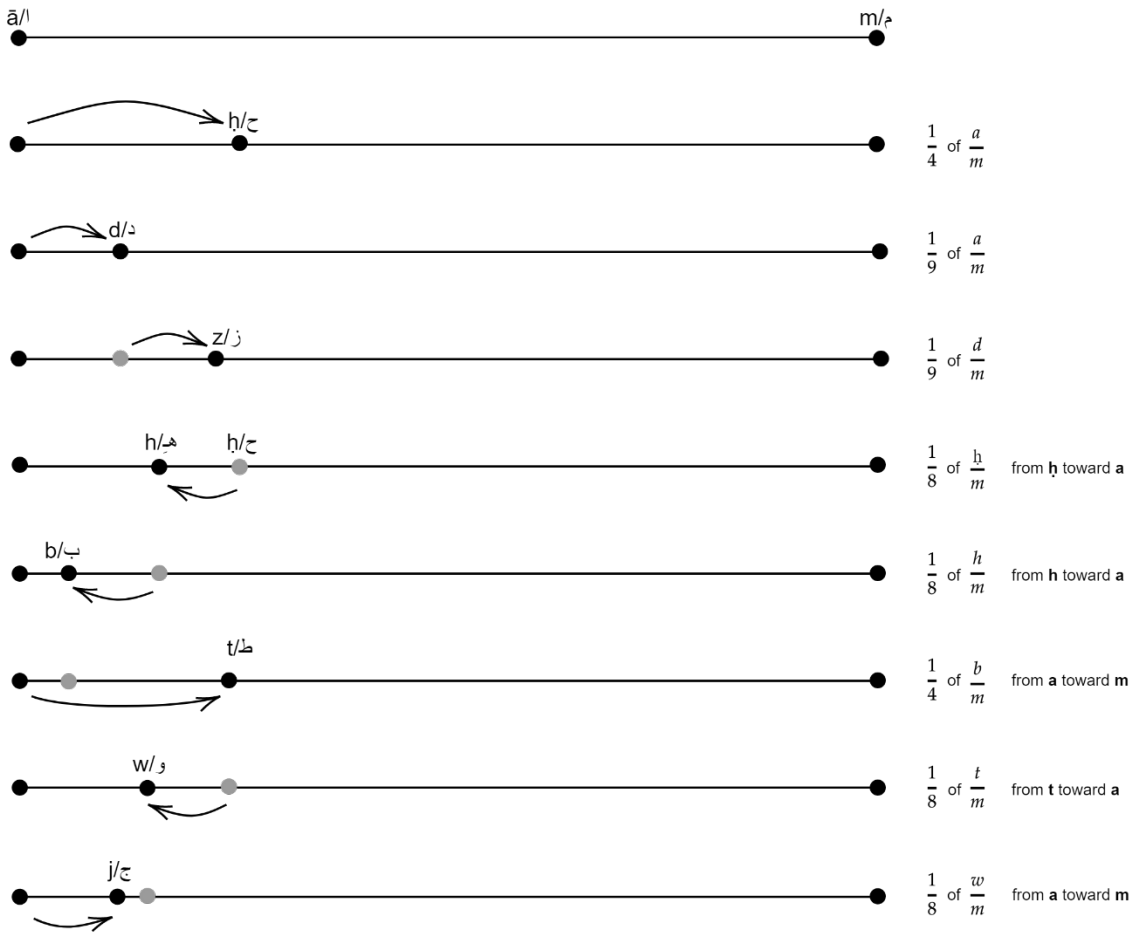

Figure 2.12. Ormavi's finger positions within the tetrachord movements.

[34] **L** stands for Pythagorean limma, and **C** stands for Pythagorean comma.

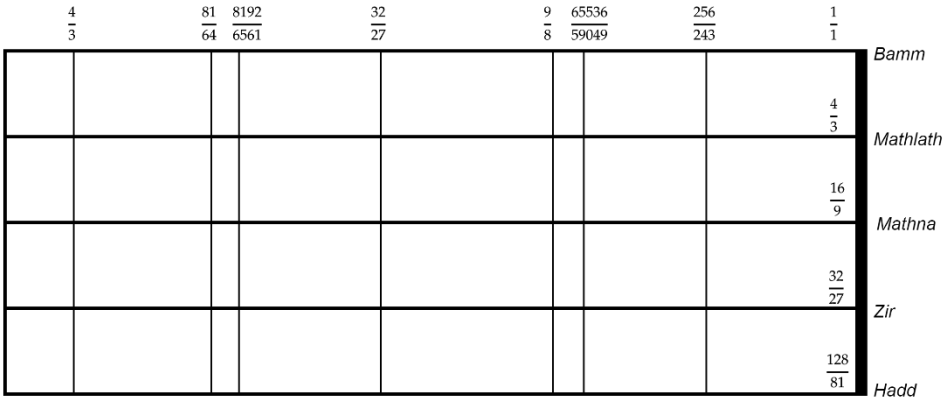

Figure 2.13. Ormavi's gamut represented as finger positions on oud.

Furthermore, one octave in this system consists of two tetrachords followed by a whole tone.

LLC, LLC, L + LLC, LLC, L + LLC

No.	*Abjad* System	HEJI	Ratios	Cents
1	ا - a	𝄮G	1/1	0 ¢
2	ب - b	♭A	256/243	90 ¢
3	ج - j	𝄫B	65536/59049	180 ¢
4	د - d	𝄮A	9/8	204 ¢
5	ه - h	♭B	32/27	294 ¢
6	و - v	♭C	8192/6561	384 ¢
7	ز - z	𝄮B	81/64	408 ¢
8	ح- ḥ	𝄮C	4/3	498 ¢
9	ط - ṭ	♭D	1024/729	588 ¢
10	ى - y	𝄫E	262144/177147	678 ¢
11	یا - yā	𝄮D	3/2	702 ¢
12	یب - yeb	♭E	128/81	792 ¢
13	یج - yej	♭F	32768/19683	882 ¢
14	ید - yed	𝄮E	27/16	906 ¢
15	یه - yeh	𝄮F	16/9	996 ¢
16	یو - yu	♭G	4096/2187	1086 ¢
17	یز - yez	𝄫A	1048576/531441	1177 ¢
18	یح - yeḥ	𝄮G	2/1	1200 ¢

Table 2.12. Ormavi's gamut in cents, ratios, HEJI and *Abjad* representation.

Ormavi goes on to say that each mode, or as he calls them, *Do'r*[35] (a circle), is made up of the combination of two *Ajnās*, and that there are two types of *Jins*:

- *Zu'l al-Arba* – a tetrachord
- *Zu'l al-Khams* – a pentachord

It is fascinating that the tetrachord is based on the lower tetrachord of the 17-tone gamut (between 1/1 and 4/3), and the pentachords are created based on the upper part of the gamut (between 3/2 and 2/1).[36]

He devoted an entire chapter of his work to the description of the intervals (*Abād*) and explained how to create and combine tetrachord and pentachord collections to achieve a closed cycle (*Do'r*). In order to do that, Ormavi also categorised intervals as consonant or dissonant and made a list of the most important consonant intervals used to form *Ajnās* as the following six *Abād,* and then used them in the creation of the tetrachords and pentachords of his system (Binesh, 1998):

No.	Name as Mentioned by Ormavi	Modern Name	Ratio	Size
1	Zu'l al-Kol	octave	1/2	1200 ¢
2	Zu'l al-Khams	perfect fifth	3/2	701.96 ¢
3	Zu'l al-Arba	perfect forth	4/3	498.04 ¢
4	Tanini	major second	9/8	203.91 ¢
5	Mujannab	neutral second	65536/59049	180.45 ¢
6	Baghiyeh	minor second	256/243	90.22 ¢

Table 2.13. Ormavi's list of the most important consonant intervals.

Ormavi explains that there are seven types of tetrachords and twelve types of pentachords consisting of the seventeen pitches of the gamut. In further calculation, eighty-four different *Advār* are created by combining tetrachords and pentachords[37]. He continues by stating that of these eighty-four *Advār*, only twelve are recognised as consonant and the rest are considered dissonant modes. These 12 acceptable modes are the same as the main 12 *Maqām* discussed in the previous chapter (Vojdani, 2018).

[35] The singular form of *Advār*.

[36] It is important to note that the tetrachord or the pentachords in his system is not about the number of pitches but only refers to the exterior interval of the pitch collection, which is why some of his tetrachords consist of five pitches and some pentachords consist of six pitches.

[37] By combining every single tetrachord with all the pentachords (7*12=84).

No.	Name of the Jins	Intervals[38]	Phonetic Transcription of *Abjad*	HEJI
1	Ushshāq	T T B	a d z ḥ - ا د ز ح	♮G ♮A ♮B ♮C
2	Navā	T B T	a d h ḥ - ا د ه ح	♮G ♮A ♭B ♮C
3	Bousalik	B T T	a b h ḥ - ا ب ه ح	♮G ♭A ♭B ♮C
4	Rāst	T M M	a d v ḥ - ا د و ح	♮G ♮A ♭C ♮C
5	No`ruz	M M T	a j h ḥ - ا ج ه ح	♮G 𝄫B ♭B ♮C
6	Arāq	M T M	a j v ḥ - ا ج و ح	♮G 𝄫B ♭C ♮C
7	Esfahān	M M M B	a j h z ḥ - ا ج ه ز ح	♮G 𝄫B ♭B B ♮C

Table 2.14. List of *Ajnās* according to Ormavi's *Ketāb al-Advār*: *Ajnās Zu'l al-Arba*.

No.	Name of the Jins	Intervals:	Phonetic Transcription of *Abjad*	HEJI
1	Ushshāq	T T B T	– ح یا ید یه یح ḥ yā yed yeh yeḥ	♮C ♮D ♮E ♮F ♮G
2	Navā	T B T T	– ح یا یب یه یح ḥ yā yeb yeh yeḥ	♮C ♮D ♭E ♮F ♮G
3	Bousalik	B T T T	– ح ط یب یه یح ḥ ṭ yeb yeh yeḥ	♮C ♭D ♭E ♮F ♮G
4	Rāst	T M M T	– ح یا یج یه یح ḥ yā yej yeh yeḥ	♮C ♮D ♭F ♮F ♮G
5	Hussayni	M M T T	– ح ی یب یه یح ḥ y yeb yeh yeḥ	♮C 𝄫E ♭E ♮F ♮G
6	Hejāzi	M T M T	– ح ی یج یه یح ḥ y yej yeh yeḥ	♮C 𝄫E ♭F ♮F ♮G
7	Homayoun	M M M B T	– ح ی یب ید یه یح ḥ y yeb yed yeh yeḥ	♮C 𝄫E ♭E ♮E ♮F ♮G
8	Esfahān	T M M M B	– ح یا یج یه یز یح ḥ yā yej yeh yez yeḥ	♮C ♮D ♭F ♮F 𝄫A ♮G
9	Arāq	M T M M B	– ح ی یج یه یز یح ḥ y yej yeh yez yeḥ	♮C 𝄫E ♭F ♮F 𝄫A ♮G
10	Buzurg	M B T M M	– ح ی یا ید یو یح ḥ y yā yed yu yeḥ	♮C 𝄫E ♮D ♮E ♭G ♮G
11	Zir'Afkand	M M B T M	– ح ی یب یج یو یح ḥ y yeb yej yu yeḥ	♮C 𝄫E ♭E ♭F ♭G ♮G
12	Neyriz-e Saqir	T M T M	– ح یا یج یو یح ḥ yā yej yu yeḥ	♮C ♮D ♭F ♭G ♮G

Table 2.15. List of *Ajnās* according to Ormavi's *Ketāb al-Advār*: *Ajnās Zu'l al-Khams*.

[38] **T** stands for *Tanini* (9/8) **M** for *Mujannab* (65536/59049), and **B** for *Baghiyeh* (256/243).

According to Ormavi's systems, the twelve *Advār,* which are still the basis of Persian classical music, are (Asadi, Safvat, & Tawoosi, 2007):

Cycle No.[39]	Name	HEJI	Structure[40]
40	Ushshāq	♮G ♮A ♮B ♮C ♮D ♮E ♮F ♮G	1 + 1
41	Bousalik	♮G ♭A ♭B ♮C ♭D ♭E ♮F ♮G	3 + 3
42	Navā	♮G ♭A ♭B ♮C ♮D ♭E ♮F ♮G	2 + 2
43	Rāst	♮G ♮A ♭C ♮C ♮D ♭F ♮F ♮G	4 + 4
45	Arāq	♮G 𝄫B ♭C ♮C 𝄫E ♭F ♮F 𝄫A ♮G	6 + 9
66	Esfahān	♮G ♮A ♭C ♮C ♮D ♭F ♮F 𝄫A ♮G	4 + 8
32	Rāhavi	♮G 𝄫B ♭C ♮C 𝄫E ♭E ♮F ♮G	6 + 5
46	Hejāzi	♮G 𝄫B ♭B ♮C 𝄫E ♭F ♮F ♮G	5 + 6
48	Hussayni	♮G 𝄫B ♭B ♮C 𝄫E ♭E ♮F ♮G	5 + 5
54	Buzurg	♮G 𝄫B ♭C ♮C 𝄫E ♮D ♮E ♭G ♮G	6 + 10
57	Zanguleh	♮G ♮A ♭C ♮C 𝄫E ♭F ♮F ♮G	4 + 6
58	Zir'Afkand	♮G 𝄫B ♭B ♮C 𝄫E ♭E ♭F ♭G ♮G	5 + 11

Table 2.16. The chart of twelve consonant *Advār* by Ormavi.

[39] The cycle numbers correspond to the numeration of the eighty-four cycle list, given by Ormavi himself.

[40] A tetrachord followed by a pentachords.

Chapter 3

Application of Medieval Tunings in My Compositions

A Critical Reflection

3.1 Finding the Holographic Composition Technique

In November 2020, I found myself almost halfway through my artistic research. It was quite frightening to look back at the starting point, seeing what you had done so far and what you had not. I remember when I started in September 2019, the future was so bright and promising and I had lots of ideas and energy to put into my work. I was hopeful for a promising future, but at that point in November 2020, I was tired and overwhelmed, and up to my ears in many cancelled or unfinished projects.

During the early stages of my research I was able to ponder my thoughts about the artistic project and gain a clear idea of its concept, process, and presentation, or to put it in just one word, I was looking for its essence.

I was fascinated by several concepts when I wrote my project proposal, some of which have lost importance in the course of my theoretical research, while others have played a more important role. Essentially though, my entire concept revolved around the following themes:

- microtonal tuning systems, especially those of my home country Iran (*Maqām, Advār, Radif*)

- psychoacoustics and the phenomenon of the perception of sound

- spectral techniques of instrumental synthesis based on mathematical equations

The focus of my project description was on the psychoacoustic phenomena of combination tones. Combination tones are the ghost sounds that occur in the inner ear when two different tones are played simultaneously. They can be divided into summation tones and difference tones, which as their names indicate, are the sum or difference of the frequencies of the higher-order pitches:
$f1+f2$= summation tone
$f1-f2$= difference tone

I imagined, by using the mathematical equation of the combination tones (f1±f2) and basing them on the microtonal interval(s) of both regional and classical Iranian music, that I would be able to produce a series of chords or sets of pitches (depending which angle one looks at the results) with different qualities. I could then expand the results and use them as raw material for instrumental synthesis in my compositions as chords, or by changing the Cartesian coordinate system (to change the x-axis to y and vice versa) to convert the chords into horizontal lines and create complex polyphonic melodies.

While I have worked all three angles of my project in detail, I have in some respects encountered limitations to the artistic exploration, while in others I have found the potential for further in-depth investigation. For instance, in my original consideration of traditional Iranian tuning systems in this artistic research project,

I had in mind to extract and translate what the Iranian polymaths and musicians suggested for tuning the oud by converting the findings into conventional microtonal notation systems such as quarter tone, third tone, or sixth tone. Based on the results of this translation and the systematic approach, I could create X-TET scales of the tuning charts where the X could be any number, for example 17-TET, 19-TET or 22-TET.

However, after a more thorough investigation, I discovered an intense interest in the old tuning systems. In particular, I found a lot of interesting theoretical material that I wanted to study and write about, but which either did not exist in English, or those with translations had some critical errors or misunderstandings. I have therefore devoted a large part of my research to the translation and comparison of different treatises and have dedicated the most extensive chapter of my research findings to this topic. Moreover, during my research, I have found a fascinating bridge between the tuning systems and intonation of the ancient, medieval, and modern music of Iran.

An important issue that always bothers me is the lack of broad knowledge in the West about historical events in my country, or in some cases, the fact that all history is pressed into the category of the "Muslim world", which is usually confused with the "Arab world". Unfortunately, we are witnessing the fact that in the Western education system, the scientific achievements of the people of my world are being systematically ignored, while the history of tuning systems is made the subject of study. Moreover, what is called the "Islamic Golden Age" does not refer to one country but to the history and heritage of several cultures, of which Iran and, of course, the knowledge of ancient Persia, is one of the most influential.

It is important to remember that Iran has a long and complicated history in which there have been multiple invasions and destructions, including several changes in religion and official language. The loss of thousands of books and treatises equals a loss of knowledge, and is therefore one of the most regrettable effects resulting from such a volatile and unpredictable history.

Another fundamental change I experienced early in the research phase was my passion for the rational intonation system. This was strengthened with the help and support of composer Marc Sabat. Since music in the Antiquity period was considered part of the quadrivium and Iranian philosophers and polymaths were not exempt from this rule, they wrote the tuning system using mathematical ratios. In order to properly understand the slightest difference between intervals, I had to delve into the techniques of Just Intonation Composition in addition to the research on Iranian music. I found that it was possible to build a bridge between the medieval tuning systems of Iran and the compositional techniques of Just Intonation.

Thus, I was finally able to create the following image as a visualisation of the meta-concept for my artistic research:

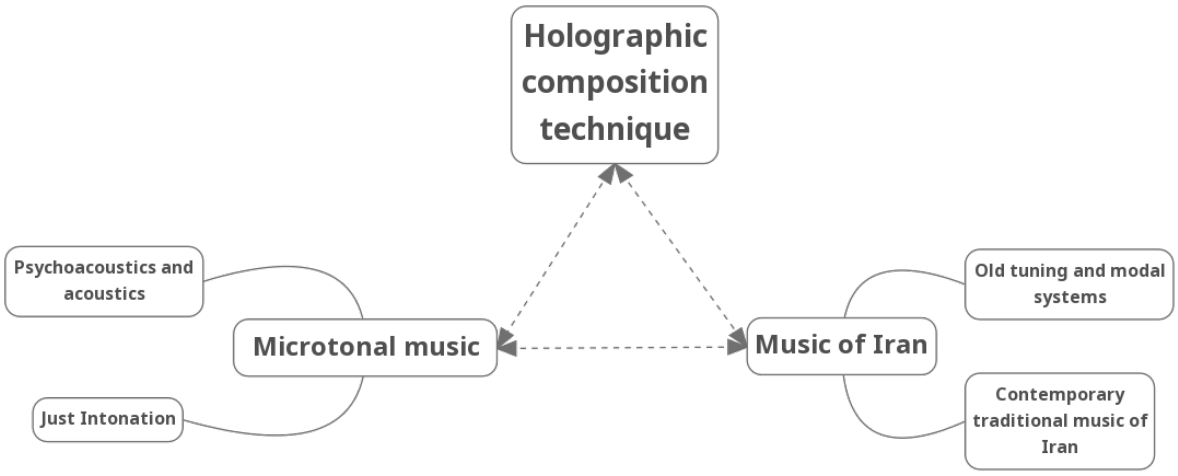

Figure 3.1. A meta-concept sketch of the research project.

Returning to the original concept of the Holographic Composition Technique, and the usage of the combination tones as the primary source for generating the pitch sets, I had to step back and reconsider the idea as I found some technical and aesthetic problems, especially with the results I was aiming for.

In a Just Intonation approach to the combination tones, one can find them in the Harmonic Space and examine their relation to the higher-order intervals as an overtone series, even with very complex intervals in mind. For example, if we put the number of the harmonic series into the most straightforward format of the combination tone equation (f1± f2), the result would be the fundamental as the difference tone, and the sum of these numbers (overtones) as the sum tone (Nicholson & Sabat, 2018):

$3° * 5° = 15°$[41] $(\frac{3}{1} * \frac{5}{1} = \frac{3*5}{1*1} = \frac{15}{1})$

Or in HEJI, if the reference tone is 𝄮G2 (98.00 Hz), then:

𝄮D (294.0 Hz) + 𝄮B (489.99 Hz) = 𝄯F (1469.98 Hz)

Alternatively, the sum of the third and fifth harmonics would be the 15th harmonic, and the difference would be the fundamental of both ratios.

[41] In the language of the ratios to combine two pitches, their ratios must be multiplied (Nicholson & Sabat, 2018).

The same results in the language of ratios if you normalise the ratios of the harmonic series within one octave:

$\frac{5}{4} * \frac{3}{2} = \frac{5*3}{2*4} = \frac{15}{8}$

If $\frac{1}{1}$ is 𝄮G4 (392.00 Hz) then,
$\frac{5}{4}$ is 𝄮B (489.99 Hz) + $\frac{3}{2}$ is 𝄮D (587.99 Hz) = and the $\frac{15}{8}$ is 𝄯F (734.99 Hz)

However, within equally divided temperaments, such as those found in European classical music, these combination tones are extremely dissonant due to the inharmonic relation between the parent intervals. Moreover, the result will be based solely on the sum of the frequencies of the parent intervals and not on the internal relationships of their harmonic series. For example, if we were to put the pitch frequencies into an equal tempered format, we would obtain a different result than if we used the ratio language:

𝄮B (493.8833) + 𝄮D (587.3295) + = 𝄯$C^{+44¢}$ (1081.2128)

Despite my excitement for the infinite number of possibilities and sonic results that can be achieved, I have chosen to stay with the combination tones, as I consider them in my later works from the point of view of Just Intonation.

I intend to focus not only on the search for the precise and correct intervals of classical Iranian music but also on the creative use of these intervals, tetrachords, and modes, that I have gained from studying ancient Iranian treatises on music as part of my research. To move in this direction, one of the first steps was to select a pitch system from the various tuning systems explained in the previous chapter. Naturally, each of my compositions has its own sonic world, and this choice was made on the basis of the original idea or the desired form I wanted to compose in.

Since Ormavi's book, the *Ketāb al-Advār*, was my first entrance into the world of old Iranian treatises on music, it became the primary source of inspiration for the rest of my research and the pivot for shifting to the music existing before and after it. I used intervals, tetrachords and even the tuning system proposed in this book in several of my compositions.

As mentioned in the previous chapter, Ormavi was looking for some kind of temperament to create a system for the music theory of his time, encompassing Persian, Arabic and Turkish music. While working on the compositions *Ketāb al-Advār* for retuned piano (2020), *Crystallum* for string quartet and tape (2021), and *Abjad Dream* for piano and tape (2022), I realised that the best and simplest way to use his modes is to map

them in the harmonic series of a vibrating string. The first and most important reason is that most of the ratios suggested by Ormavi are highly impractical in real-life situations. For example, the ear cannot tune a ratio like 1048576/531441. However, I have found that from a rational intonation perspective, it is easily possible to tune almost the same pitch with a slight difference, either as a natural harmonic or as a pitch, seen in the following example:

if 1/1 is ♮E, then 1048576/531441 is ♭F, while it is possible to use 𝄲E with the ratio of 160/81, and the difference between ♭F and 𝄲E is 2.0¢[42]

In the same case, 𝄲E with the ratio of 160/81, resulting from the ♮E as the reference tone, is equal to the 5/4, resulting from the ♮C as the reference tone or simply the fifth harmonic of the ♮C, which can easily be found in the harmonic series of most orchestral instruments (e.g., on the ♮C string of the strings section or the fifth harmonic of the brass section). In this case, it is simple enough to think of the ♮C as the reference tone for this single pitch and use the 𝄲E instead of the ♭F with the ratio of 1048576/531441.

This hypothesis led me to the conclusion that it is possible to look at Ormavi's list of ratios from the perspective of rational intonation and, with only a 2.0¢ difference, find them all in the lower harmonic series range of the orchestral instruments:

No.	*Abjad* System	HEJI	Cents	Ratios Proposed in *Ketāb al-Advār*	HEJI	The Alternate Ratio	Difference
1	ا - a	♮G	0.00	1/1			
2	ب - b	♭A	90.23	256/243			
3	ج - j	𝄫B	180.45	65536/59049	𝄲A	10/9	2.0¢
4	د - d	♮A	203.91	9/8			
5	ه - h	♭B	294.13	32/27			
6	و - v	♭C	384.36	8192/6561	𝄲B	5/4	2.0¢
7	ز - z	♮B	407.82	81/64			
8	ح- ḥ	♮C	498.04	4/3			
9	ط - ṭ	♭D	588.27	1024/729			
10	ى - y	𝄫E	678.49	262144/177147	𝄲D	40/27	2.0¢
11	يا - yā	♮D	701.96	3/2			

[42] The difference between the Pythagorean comma and the syntonic comma or a Schisma (32805/32768).

12	يب - yeb	♭E	792.18	128/81			
13	يج - yej	♭F	882.40	32768/19683	𝄲E	5/3	2.0¢
14	يد - yed	𝄮E	905.87	27/16			
15	يه - yeh	𝄮F	996.09	16/9			
16	يو - yu	♭G	1086.31	4096/2187	♯F	15/8	2.0¢
17	يز - yez	𝄫A	1176.54	1048576/531441	𝄲G	160/81	2.0¢
18	يح - yeḥ	𝄮G	1200.00	2/1			

Table 3.1. Ormavi's gamut compared with the rational intonation ratios.

It is easy to notice that with a slight change in their internal structure, the tetrachords become more accessible and playable for any instrument that can produce the lower harmonic series. Based on this table, I have adjusted the inner structure of the *Ajnās* proposed by Ormavi as follows, and used them in many of my compositions:

No.	Name of the Jins	Original Ratios	HEJI	Alternate Ratios	HEJI
1	**Ushshāq**	1/1 – 9/8 – 81/64 – 4/3	𝄮G 𝄮A 𝄮B 𝄮C	-	-
2	**Navā**	1/1 – 9/8 – 32/27 – 4/3	𝄮G 𝄮A ♭B 𝄮C	-	-
3	**Bousalik**	1/1 – 256/243 – 32/27 – 4/3	𝄮G ♭A ♭B 𝄮C	-	-
4	**Rāst**	1/1 – 9/8 – 8192/6561 – 4/3	𝄮G 𝄮A ♭C 𝄮C	1/1 – 9/8 – **5/4** – 4/3	𝄮G 𝄮A 𝄲B 𝄮C
5	**No`ruz**	1/1 – 65536/59049 – 32/27 – 4/3	𝄮G 𝄫B ♭B 𝄮C	1/1 – **10/9** – 32/27 – 4/3	𝄮G 𝄲A ♭B 𝄮C
6	**Arāq**	1/1 – 65536/59049 – 8192/6561 – 4/3	𝄮G 𝄫B ♭C 𝄮C	1/1 – **10/9 – 5/4** – 4/3	𝄮G 𝄲A 𝄲B 𝄮C
7	**Esfahān**	1/1 – 65536/59049 – 81/64 – 4/3	𝄮G 𝄫B ♭B 𝄮B 𝄮C	1/1 – **10/9** – 81/64 – 4/3	𝄮G 𝄲A 𝄮B 𝄮C

Table 3.2. List of *Ajnās* according to Ormavi's *Ketāb al-Advār*: *Ajnās Zu'l al-Arba*.

3.2 Retuning the Ideas: on *Ketāb al-Advār*

When I moved to Oslo in September 2019 to start my artistic research project, I was faced with the unknown and a new beginning, not only for my artistic career but for life in general. At that point, full of energy and hope, I quickly tried to understand the tasks and duties required of my role as a research fellow at the Norwegian Academy of Music in Oslo. To my great surprise, I was immediately approached by a fellow

colleague who shared a common passion for, and interest in, microtonality; Sanae Yoshida. Thanks to this encounter I received my first commission, which became the prelude to my artistic research endeavours. ***Ketāb al-Advār*** for microtonally retuned piano was a commission for a new work by Yoshida.

The main source of inspiration for this piece was the book of the same title by Ormavi. During my three years of research, this piece was the first work I composed, but as it turned out, not the first I had the pleasure of hearing live. When Yoshida commissioned me to write the piece, her only recommendation was to change the tuning of the piano. I received no further advice and faced the task armed only with my own imagination and expectations.

With the idea of reproducing the sound of a santur, an Iranian instrument, and exploring the spectral timbres that I thought might emerge from iterations of microtonal clusters, I changed the middle section of the piano to the Ormavi tuning system. In this way, I created a 17-tone octave in the middle section of the piano that could play the role of the santur in my music.

The problem of notating the newly tuned 17-note gamut within the original piano tuning was an additional challenge in this work. I could not leave the performer without the correct information about the sonic character of the retuned notes, especially since only the selected number was altered and not the entire keyboard. I was also not in favour of the idea of notating the retuned keys differently in the score, as this would make reading the music quite difficult. Each time the retuned key appears, the additional upper staff is made visible in the score. It refers to the sound equivalent in the HEJI system with the deviation from the 12-TET in cents. The iterated chords imitating the sound quality of the Iranian santur, are notated thus:

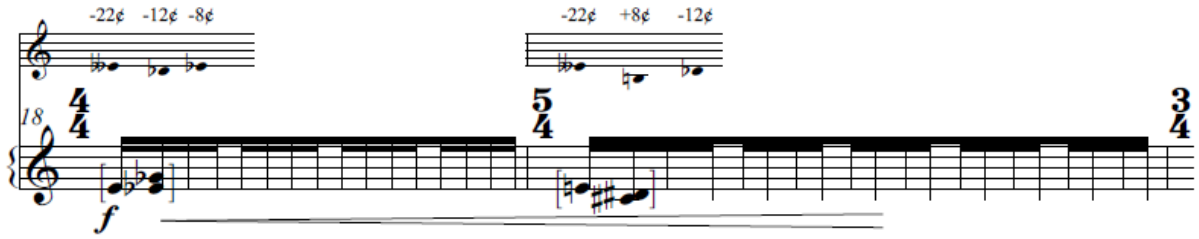

Figure 3.2. Measure 18 and 19 of *Ketāb al-Advār* demonstrating iterations of microtonal clusters.

No.	Notation	HEJI	12-TET	Deviation	Frequency	Ratio
0	G𝄮3	G𝄮	G𝄮	0.00	196.000 Hz	1/1
1	A𝄭3	A𝄭	G♯/A𝄭	-10	206.486 Hz	256/243
2	A𝄮3	B𝄫	A𝄮	-20	217.532 Hz	65536/59049
3	B𝄭3	A𝄮	A𝄮	+4	220.500 Hz	9/8
4	B𝄮3	B𝄭	A♯/B𝄭	-6	232.296 Hz	32/27
5	C𝄮4	C𝄭	B𝄮	-16	244.724 Hz	8192/6561
6	D𝄭4	B𝄮	B𝄮	+8	248.063 Hz	81/64
7	D𝄮4	C𝄮	C𝄮	-2	261.333 Hz	4/3
8	E𝄭4	D𝄭	C♯/D𝄭	-12	275.314 Hz	1024/729
9	E𝄮4	E𝄫	D𝄮	-22	290.043 Hz	262144/177147
10	F𝄮4	D𝄮	D𝄮	+2	294.000 Hz	3/2
11	G𝄭4	E𝄭	D♯/E𝄭	-8	309.728 Hz	128/81
12	G𝄮4	F𝄭	E𝄮	-18	326.298 Hz	32768/19683
13	A𝄭4	E𝄮	E𝄮	+6	330.750 Hz	27/16
14	A𝄮4	F𝄮	F𝄮	-4	348.444 Hz	16/9
15	B𝄭4	G𝄮	F♯/G𝄭	-14	367.086 Hz	4096/2187
16	B𝄮4	A𝄫	G𝄮	-24	386.724 Hz	1048576/531441
17	C𝄮5	G𝄮	G𝄮	0.00	392.000 Hz	2/1

Table 3.3. Table of the frequencies to be re-tuned on the Piano (from G3 to C5). 0 is equal to the G3 (Helmholtz G=195.998 Hz - The concert pitch note A4 = 440 Hz).

Ormavi's tuning also helped me to create a saturated illusion between the chords I used in the final sections of the piece, combining the chords in the keys of the retuned and non-retuned sections.

In the example below, the bottom staff refers to the retuned middle section of the piano, while the surrounding staves use various non-retuned octaves of the piano. As always, the upper staff provides sound information in the HEJI system with the deviation from the 12-TET in cents.

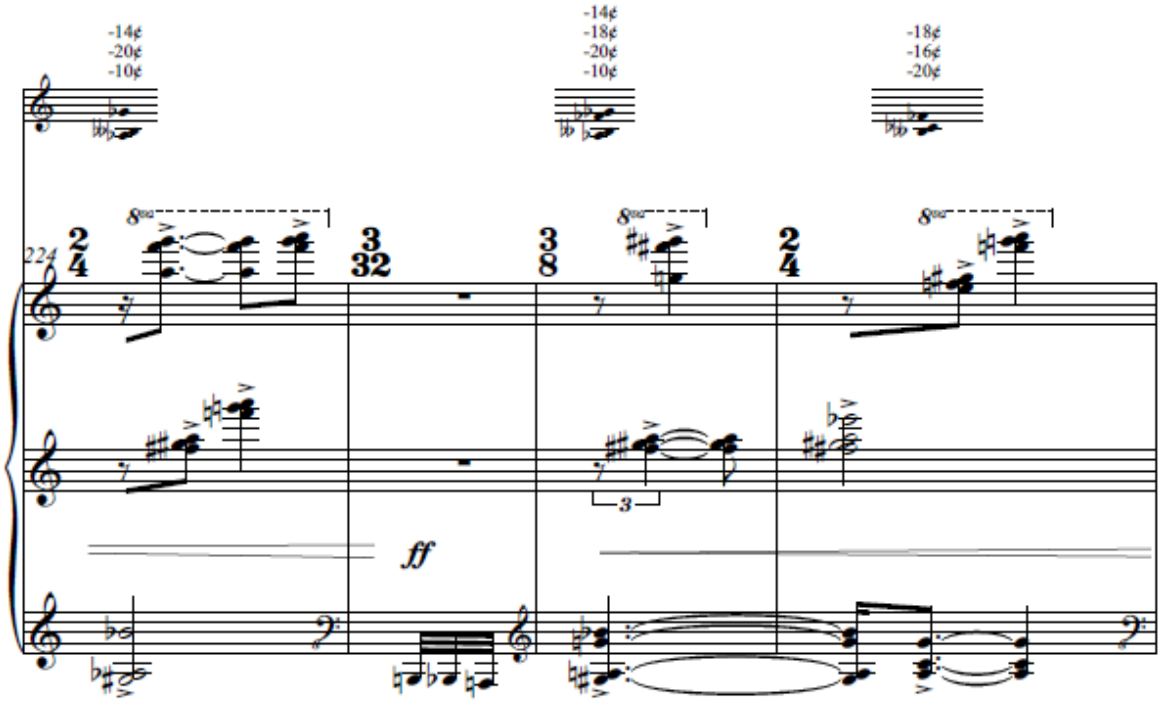

Figure 3.3. Measures 224 - 227 of *Ketāb al-Advār* demonstrating a three-layered microtonal narration.

I also used natural harmonics on the piano strings in the creation of this piece. The reason for this was to expand my palette of microtones on the piano to include the quarter and sixth tones and to confront some of the intervals I found in the works of Fārābi and Ibn Sinā, which use the prime numbers 11 and 13.

In the piano preparation of *Ketāb al-Advār*, I asked the pianist to prepare the lowest register of the piano (from A0 to E1) on the 7th, 10th, 11th and 13th harmonic nodes to form an 18-tone microtonal scale whose tonal result would be between the G3 to C5 registers of the piano, corresponding to the set or register of the piano's retuned keys.

It is worth noting that the selection process of finding these pitches in the harmonic series for this piece was based on experimentation and was an approach of auditory trial and error. In making the selection, I tried to use the seventh partials with a deviation of -31 cents for the sixth tones, the 11th and 13th harmonics for obtaining the quarter-tone notes, and the 10th(5th) harmonic in order to create beatings with the tones tuned close to it.

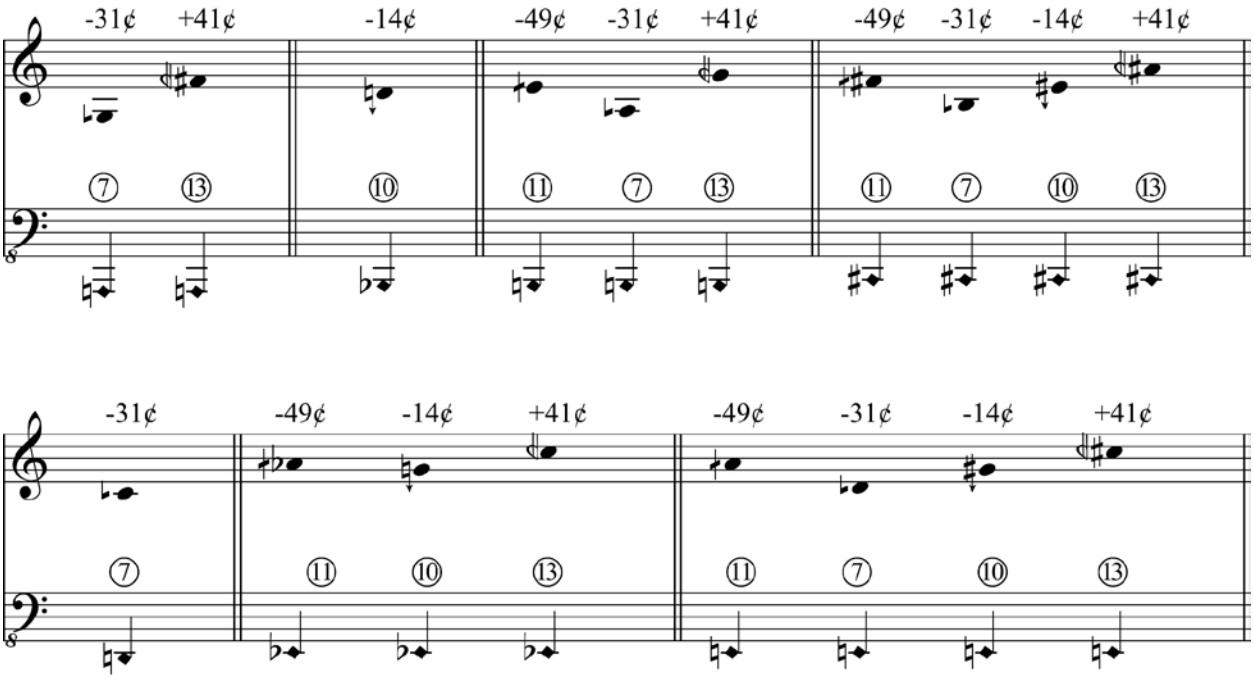

Figure 3.4. Harmonic nodes preparation chart for *Ketāb al-Advār*.

Figure 3.5. Marking of the harmonic positions on the piano string. From low to high, respectively: 11th harmonic (yellow), 7th harmonic (white), 10th harmonic (green), and 13th harmonic (red).

Unfortunately, the completion of this piece coincided with the start of the 2019 global pandemic of the coronavirus disease (COVID -19) and a very long lockdown in Norway. My relationship with Yoshida was limited to meetings in the virtual world and endless emails for the next 16 months. During all this time, neither she nor I had any possibility of accessing the piano to be used for retuning, so we could only talk theoretically about the piece and try to imagine its sound. After several months of silence and one period of thaw under the strict Covid-19 lockdown regulations (September-October 2020), Yoshida managed to prepare a mockup recording of the piece, this time with the properly retuned studio piano at the Norwegian Academy of Music.

Not long after, the lockdowns took over our lives again, and we continued our conversations about the music back in the virtual world. I continued to listen to the rehearsal recording and analyse my score, and more and more doubts overcame my thoughts about *Ketāb al-Advār*. During this time I became obsessed with recomposing the piece. I rewrote it many times, to the point where I even decided to write the piece from the beginning with a different form of retuning the piano. This decision was probably due to the fact I was concentrating too much on learning and applying the Just Intonation methods to my compositional attempts, which was met with Yoshida's objection for various reasons, so I returned to the first idea and moved on.

The final and long-awaited premiere of the composition took place at the recital given by Sanae Yoshida at the Norwegian Academy of Music on 15 May 2022. By this time, I had already started composing my final project, with the overwhelming feeling that this artistic research was slowly coming to an end. My encounter with *Ketāb al-Advār*, which finally sounded live after such a long wait, was a nostalgic journey back in time to my beginnings as a research fellow at the Norwegian Academy of Music and to the starting point of my research.

3.3 The Ethics ...*of struggle and hope*?

At the beginning of spring 2020, I had to participate in a seminar on ethics during the most severe situation of staying at home due to the lockdown. One of the assignments for participating in this seminar was to write a text about ethics in artistic research. I wrote my text as an open letter about the events that had affected me mentally and emotionally over the previous few months and sent it to the organisers. Here is the text:

Idin Samimi Mofakham
Norges musikkhøgskole/Fagseksjon for musikkteori, komposisjon og musikkteknologi
Starting year 2019
Holographic Composition Technique
Music Theory and Composition

As a human being and an artist, the biggest ethical and moral question I am asking myself is, what is the impact or result of my work to the society? To the national level (to both countries which I came from and the country I live in now) and international level?

During last several months my home country faced several tragic accidents, whose shadows are still covering the life of any Iranian in the world: the mass killing of the protestors to the economic crisis in November and December 2019, where the government killed more than 1,500 citizens, including children, and tortured arrested protesters followed by the attack of the American air forces assassinated the highest Iranian general in Iraq in in January 2020, which led the country to the war state. We were still in the shock of this event, when the accident of flight PS752 happened, caused by a human error. An Iranian soldier, due to the stress of war state between Iran and USA, confused the civil airplane with a rocket and shot down the Ukrainian airplane shortly after its take off from Tehran Imam Khomeini International Airport. All 176 passengers were killed. Now when you imagine that it was the same airway and international route that me and my wife took several times to travel to or from Iran, your skin is covered in goosebumps. These events led the whole country to a mass depression, especially Iranian artists, this mass depression caused several cancelations of national or international events.

These accidents happened before the coronavirus COVID-19 pandemic, which caused the cancelation or postponement of all the prepared plans to an unknown future. As a composer, my hardest task fort the last two months was to reshape all my plans for actualizing my artistic research, trying to find a solution for the performance of my music, which stays still in a limbo with no concrete answer from any concert organizer and performers.

As a human being and then as an artist, the biggest ethical and moral question I am asking to myself is, what is the impact or result of my work to the society? Should I write laments or should I make very strong political manifestation in my works? Should I avoid the facts and news around me and just do my work as nothing has happened? Or, like many other colleagues, should I make a very personal interpretation of Adorno’s "There can be no poetry after Auschwitz."? And simply stop working?

After the seminar, although I felt extremely hopeless due to circumstances surrounding both Iran and the pandemic, I began to write a sketch for four double basses. It came out of nowhere; no commission, no particular performers in mind, just an obsession with the sound of the double bass. Its deep growl, the loud hiss of the bow under pressure, and its raw, untamed energy, matched my mental state from those last dark

months, as described in the letter above. Initially my idea was to create a sketch to steer the musical form the way I normally would, but this idea gradually developed into something more with the sound guidance of my wife Martyna Kosecka.

...of struggle and hope for double bass quartet and electronics became my sonic reflection on the impact of socio-political events in the world we live in.

I do not remember how the first sketches for this composition came about, however I do remember that when the lockdown in Norway began on 17 March 2020, shortly after my 39th birthday, I started reading book after book and came across many valuable sources on the Just Intonation approach, microtonal music practices, and spectral analysis. The books that influenced me the most were undoubtedly *The Genesis of Music* by Harry Partch, *Tuning, Timbre, Spectrum, Scale* by William A. Sethares, and *The Just Intonation Primer* by David B. Doty.

To find the best solution for what I was looking to achieve in *...of struggle and hope*, I had to rewrite the work several times. I had the idea of composing a piece in which I controlled the general form and structure of what was happening, but which could surprise me on the micro-levels of the performers' interpretation in each new performance. In the process, I realised that I could not use standard notation. My solution was simple: instead of the conventional division of the piece with bar lines, I divided the timeline into blocks of ten seconds each and described the sound material in each box in extreme detail in terms of tuning, desired colour, preferred natural harmonic position, and dynamic indications. In many of the blocks I described different patterns of repetition with a variable number of repeated notes per block and specific instructions for openness of interpretation. However, the speed and intensity of these repetitions was left entirely to the creativity of the musicians. A collage of different harmonic solutions, both randomly created chords and randomly occurring melodies, as in Witold Lutosławski's controlled aleatoric technique, corresponded to my idea of being "positively surprised" by my own musical material. I will present these specific solutions and their results later in the chapter, as they are closely linked to my composition, *Abjad Dream*.

As a new idea related to the Holographic Composition Technique, I decided that the performers and loudspeakers should surround the audience during the live performance. By doing this, I wanted them to be immersed in a sea of sounds, as if they were invited into my inner sound world and listening to my inner music with their own ears.

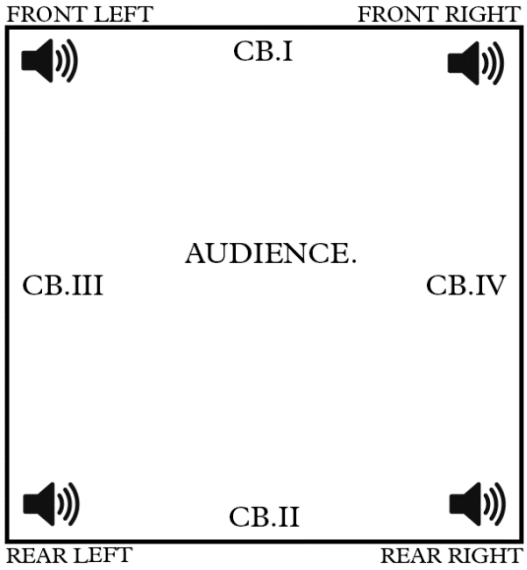

Figure 3.6. Disposition of sound sources in …*of struggle and hope*.

With this allegorical description, I have added a new layer to the definition of the title of my project. Furthermore, the mixture of the arrangement of the acoustic sound sources with the electronic design surrounding the audience, supports the spontaneous emergence of various psychoacoustic phenomena in the concert situation. The emergence of random beatings, due to the existence of nodes and anti-nodes in the reverberant performance space and the occurrence of naturally arising combination tones within the sound sources, supported the holographic idea of my research subject. Holography, as a three-dimensional idea adopted from the world of photography, began to realise itself in the acoustic space. I also began to understand that the superimposition of the sound layers of these carefully designed sound materials could be a crucial tool for the meaning of the Holographic Composition Technique.

I like to share the concepts behind the sound material of my composition. I like to experience the continuum of the intermingling boundaries of sound and noise as my sonic material, and the borders of smoothness and roughness as the two extreme points in the texture of my music. The general form of the piece, and in particular the harmonic structure of the opening section (ca. five minutes), was created by calculating all the possible combination tones that four double basses could produce when playing the given pitches, and was then synthesised in the studio as an integral part of the piece in a fixed media material.

…*of struggle and hope* starts at the top-right of this two-dimensional axis with a representation of ‘sound smoothness’ where all four double basses and the tape material are in unison using the most consonant ratio in the world of the harmonic series. Next, the structure gradually evolves towards the bottom-left of the

axis with complex spectra created by the combination tones. Lastly, each layer of the score (both the performers and the tape material) moves separately around the axis to create the obscure soundscapes. At the end, it moves back to the upper right corner of the axis, arriving at a unison of a clear and simple interval, a single component, where it then remains for a while to pause and prepare the audience for another departure and journey into my Harmonic Space.

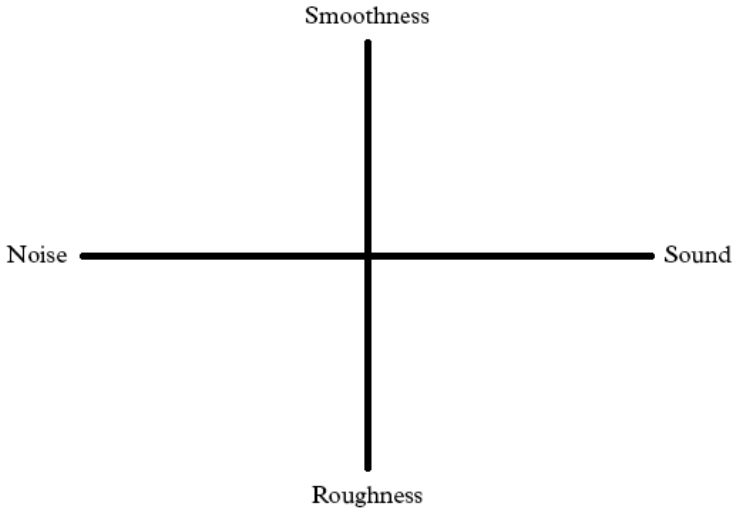

Figure 3.7. The axis of textural continuum concept for my compositions.

The piece contains the timbral fluctuations of acoustic instruments, with the added transformation of their sound and sonorities through digital audio processing, while I experiment with the idea of manipulating the Harmonic Space and timbres in the fixed media part of the piece. For the first time, I have tried to combine two different tuning systems. In the first part of the composition, based on the idea of continuous glissandi in order to achieve a fluidity of sound development, I have set the beginning and end point of each glissando based on one of the notes of the Ormavi gamut. It served as a compass when composing the piece and allowed me to manoeuvre and work on the harmonic identity of the composition.

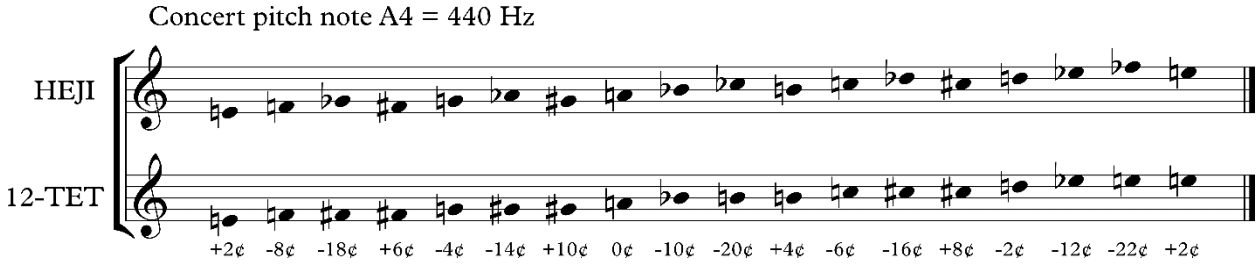

Figure 3.8. The components of Ormavi's gamut used in creating the Harmonic Space of …*of struggle and hope*.

Of course, due to the continuous movement of the glissandi, the difference of a few cents of a pitch is relatively unrecognisable and also impossible for musicians to execute, especially in the chaotic sound world that was designed. In order to grasp the concept of the Ormavi scale, I wrote the exact tuning of each note in the score. Many may say that this information was superfluous from the performer's point of view and only served as a theoretical tool within the score, but I dare to disagree. It is my belief that the precise notation of tuning deviations and indications provides clarity about the interpretation of the tuning of my music in a broader sense. It embodies the necessity of the research I have been working on for several years, namely the precise indication of the old Iranian tuning, and how it can be implemented in the composition. Perhaps through this approach, a legacy of the old treatises on music is being brought back to life through sound. Could this be the turning point in my research? Was this the right direction for me to take?

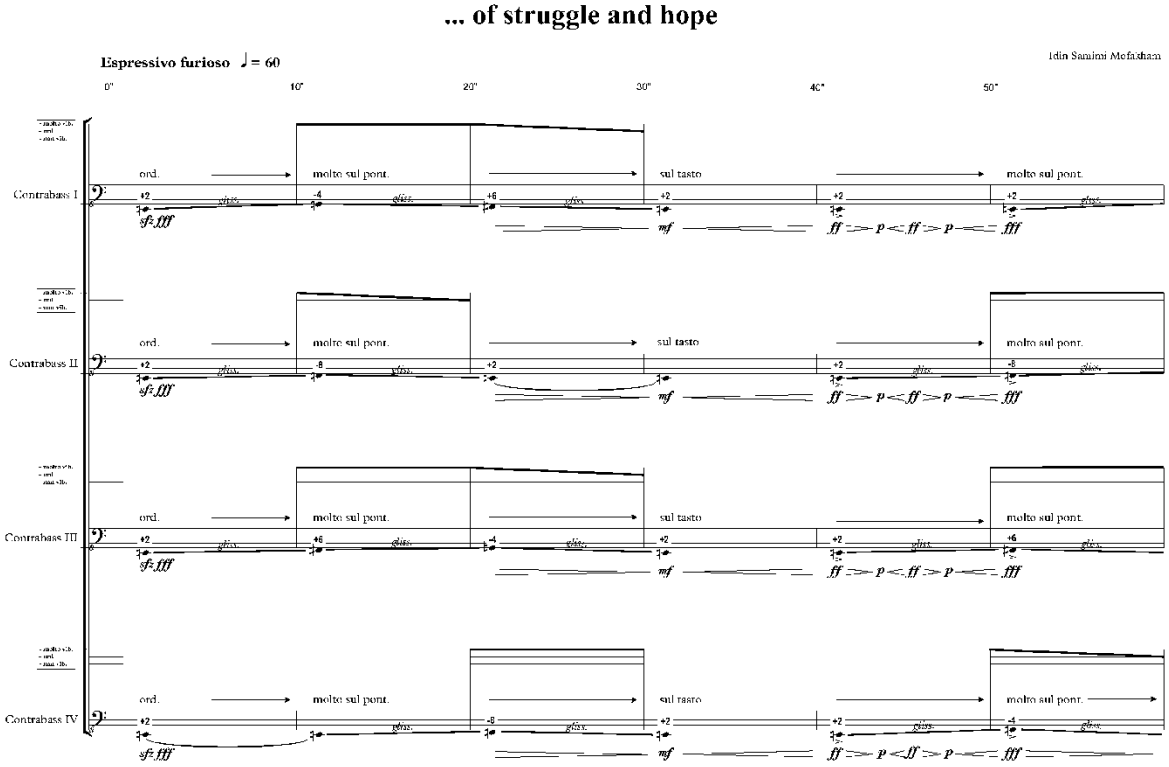

Figure 3.9. The opening page of …*of struggle and hope*.

As with *Ketāb al-Advār*, it also took a lot of time and effort to bring this piece to life in the form of a live performance, and to hear the sound manipulations which I had worked on mainly in theory. I composed most of the music in 2020 without having access to the instrument and with no particular performers in mind. It is important to mention that I was simultaneously working on a side-project researching the topic

of "Playable natural harmonic nodes on the string instruments". This research was conducted from April to September 2020 under the supervision of Marc Sabat and became a crucial part of this composition.

During a friendly conversation over coffee with percussionist Jennifer Torrence, on one of those days in the summer of 2020 when the COVID-19 restrictions seemed to be erroneously coming to an end, I mentioned working on a double bass quartet. I had no vision for a possible performance until she suddenly had the idea to contact the Oslo-based double bass Quartet, Abyss, with the plan to collaborate with them on this project. This information prompted me to put things into action.

After a lengthy email exchange with the string department at the Norwegian Academy of Music, I managed to get permission to experiment with the double bass myself. I got my hands on the instrument on 30 October 2020 and, together with my wife, reviewed some parts of the composition I had written, and tested the playable natural harmonic nodes on the double bass as part of my research project with Marc Sabat. I also managed to reach an agreement with the Abyss Quartet and set a date for a recording of the piece, which took place at the Norwegian Academy of Music in February 2021.

In the second and more complex part of the work, based on natural harmonic nodes, I referred indirectly to the tetrachords of Ibn Sinā and Fārābi. In their works, as explained in the previous chapter, one can arrive at intervals or notes whose mathematical ratio uses the highest prime numbers of the harmonic series, especially the 11th, 13th, 17th and 19th harmonics. The compositional method of these fragments largely refers to the repetition box method described a few paragraphs earlier. The composed blocks contained different repetition patterns with a variable number of repeated notes per block and specific instructions for openness of interpretation. I left the speed and number of repetitions in each block to the performers' preference. During the rehearsal period with the quartet, I noticed with great surprise that certain primes of the harmonic series derived from the tetrachords of Ibn Sinā and Fārābi began to resemble the fragmentary melodies (*Gushe-ha*) of traditional Iranian music. In this particular example of *...of struggle and hope*'s sonic material, they have mainly created the holographic impression of the *Shūr* scale, one of the most important modal scales of my native Iran.

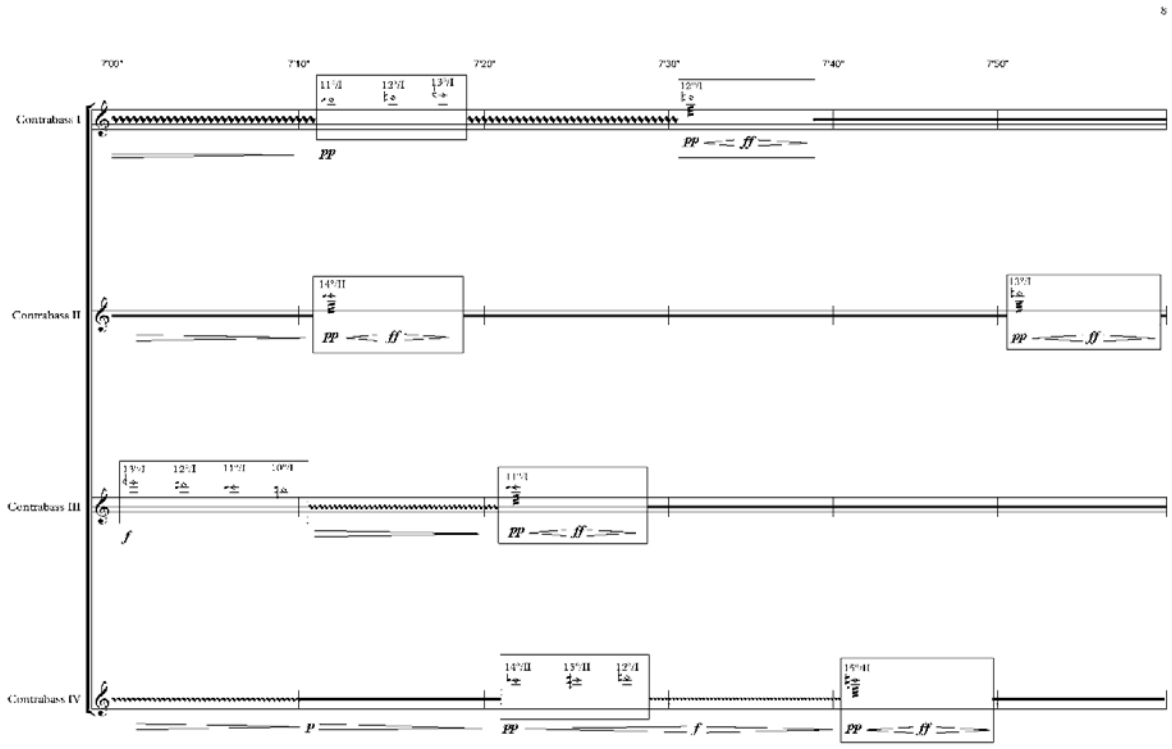

Figure 3.10. The usage of harmonic series components in …*of struggle and hope* as an accidental holographic recreation of traditional Iranian music.

Although rehearsing and recording the piece in February 2021 helped me understand many of the artistic choices I made in the process, I have still not heard the exact design of my music from the acoustically correct level. I am referring here to the concert situation and the placement of the musicians, speakers, and audience, as shown in the graphic opening the artistic process description for this piece. A stereo mixdown of the composition during the recording session reduced the acoustic phenomena that occurred in the physical space. I had to wait a few more months, until October 2021, to hear ...*of struggle and hope* in live concert performance. This wait was worth it for me because I now understand that all the descriptions and reflections I have just written about for this phase of my artistic project have somehow led me to new ideas and concepts for this research.

3.4 *Shivan*: a Harmonic Outcry

Many artists have suffered the consequences of the COVID-19 pandemic, especially during the darkest year of 2020. Unfortunately, I have also been affected by this situation, which has taken my activities related to artistic research into uncharted waters. I have come to terms with the fact that there is no choice when it comes to fighting the virus. Instead of arranging concerts, listening to the premiere of *Ketāb al-Advār* as planned in November 2020 and struggling to find new commissions for my project, influenced by so many non-musical factors, I decided to compose the double bass quartet with no plans for the future, and to immerse myself in studying the old Iranian treatises and the supporting subject literature. I accepted what fate might bring and tried to use the time of lockdown to learn as much as I could from the works of Fārābi, Ibn Sinā, Ormavi and the other polymaths whose writings have reached our time.

The piece I will now briefly describe is the result of a close collaboration with flautist, music educator and researcher Mehrdad Gholami during the summer and autumn of 2020. Mehrdad and I have known each other for a long time, although we have not had the opportunity to meet in person. During the 2020 lockdown, the relationship between us began to grow. We started having more regular and longer internet discussions about life, art, culture, sociology and politics. We both had very dark moments for several months. We both lost loved ones during the pandemic and neither of us had the opportunity to fly home to Iran to say a proper goodbye. Grief was our companion, stubbornly lodged in our hearts, and it would not go away.

I wrote ***Shivan*** as an etude based on exploring the possibilities of using the harmonic series of the flute. This was the main source of inspiration for creating a new piece using the intervals and tetrachords of traditional Iranian music from the harmonic series playable on flute.

The whole structure of the piece explores the detailed timbral fluctuations and experiments with different techniques on the instrument. The extremely high register of the flute pushes the listener's comfort zone to its limits. It is an uncomfortable piece to perform or listen to, as the soundscape derives from its name - *Shivan* - meaning "outcry" in Persian.

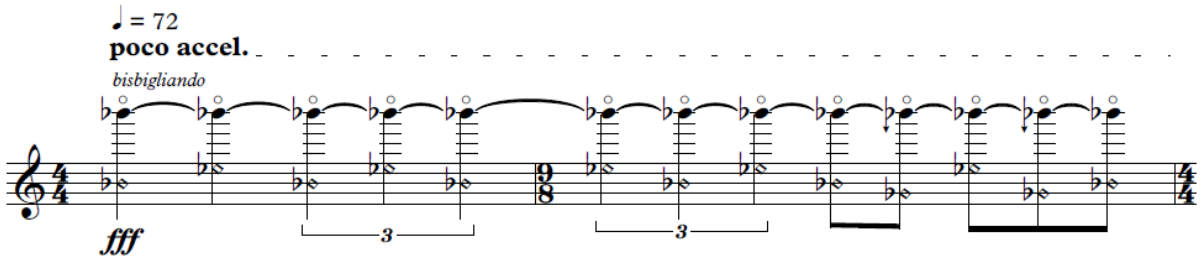

Figure 3.11. A passage of *Shivan* demonstrating the harmonic series' melodic narration.

This composition is like an inner monologue for me, full of stuttering, confusion, and delusion. It is like looking for puzzle pieces in a formless space. The space is a musical mode, and the pieces I am looking for are the pitches of this mode. *Chahārgāh*, one of the most characteristic modes of Iranian classical music, was the basis for this piece and has a special attraction for me because this scale is used in Iranian traditional and folk music for both festive and mourning purposes. The mode is a versatile tool for expressing both negative and positive emotional states, which had even more meaning for me when composing this piece.

After completing the recording session of *Shivan* for his upcoming CD featuring Iranian music written for flute, Mehrdad shared a commentary on the piece that he posted on his social media:

> "Idin's Piece came in the same week that my dad passed, and at the same time, I was going through the darkest days of 2020.
> Shivan, literally meaning outcry, immediately became a piece I went to for calming myself down, while playing the extremely rigorous fourth-octave notes that go for 9 pages. The composer is exploring the slight differences of the Iranian "mode" *Chahārgāh*, reflected on the various high microtone B-flats."

In the musical structure of *Shivan*, as the performer has correctly described, I am looking for the right B flat for the mode structure. For this purpose, I have used B flat as harmonics from several different fundamental tones, thereby using the tuning structure to musically express my confusion. I have analysed and rehearsed the possible approaches to developing this piece with Mehrdad several times over our endless exchange of voice messages, via the social media communicator, Telegram. With a seven-hour time difference between Austin, Texas, where Mehrdad was living at the time, and my home in Oslo, we worked on the tuning possibilities for the flute, the methods for creating and performing Iranian scales on the instrument, and the psychoacoustic phenomena that occurs when performing *Shivan*'s intense material.

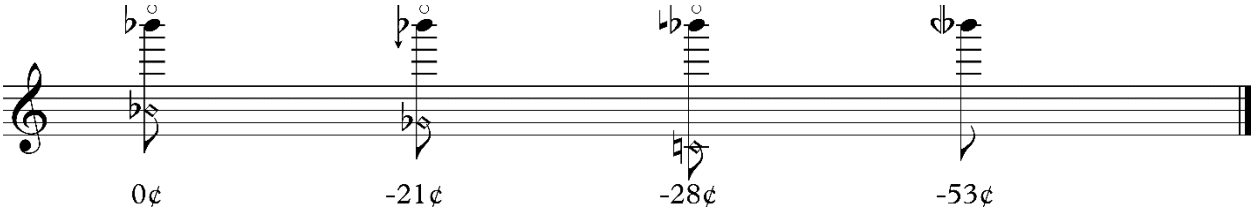

Figure 3.12. The representation of B flat as harmonics resulting from different fundamental tones.

At this point, I consider *Ketāb al-Advār, ...of struggle and hope* and *Shivan* as the first stage of my artistic research process; full of sonic curiosity, hesitation, and timid trial and error, in implementing the theories and tuning systems of Iranian medieval polymaths and thinkers. I find that the three compositions I have written about so far share many common points of development, both in terms of the expressivity of the musical material used and the nature of the narrative and formal structure. They may even clearly correspond to the compositions I wrote before I started this research, especially regarding the aesthetic approach to working with tensions, the dynamic distribution of forces, or the concept of melody, to name but a few. At each step of my research, I questioned my artistic actions with growing criticism. The more I read about the old Iranian tuning systems, the more I realised how many possibilities existed that could take a lifetime to explore scientifically and artistically.

3.5 *Crystallum*: The World of Natural Harmonics

While the excitement with which I started my artistic research at the Norwegian Academy of Music had turned into despair over the COVID -19 struggles of 2020, the beginning of 2021 slowly brought a softening of the restrictions related to the pandemic and opened a new chapter of post-pandemic reality. This marked the beginning of a new phase of my research – a phase of overcoming fears about whether my investigation was going in the right direction. More than that, what was the purpose of this research and would it be relevant to the academic and artistic community? The thoughts from the ethics seminar in spring 2020 were the only ones that did not abandon me, and continued to haunt me during the post-pandemic rush and excitement over the world opening up in its slow return to live, in-person, accessible art.

At the end of 2020, I became one of the participating composers in the Modern Multicultural Quartet project. Its idea was to design and present modern and innovative facets of string quartet setting. The project was based on the premise that the starting point of classical acoustic instruments is shifting through a musical evolution and progressing towards electronic media. With the resulting unlimited sound possibilities, it is a postulate worthy of artistic exploration by contemporary composers. All these

transmutations were to be presented from Persian, Central European, and Nordic perspectives by commissioning six composers: from Iran, Mohammad H. Javaheri and myself; from Norway, Agnes Ida Pettersen and Tze Yeung Ho; and from Poland, Martyna Kosecka and Anna Sowa. The initiator of this project, Polish string quartet NeoQuartet, planned to premiere the concept on 29 October 2021 as part of the 10th anniversary "NeoArte Synthesizer of Arts Festival" in Gdańsk, Poland, a festival that the quartet has so far successfully organised for many years.

Crystallum for amplified string quartet and electronics, is a piece I composed as a contribution to this project. It is a journey into the depths of sounds, exploring the inner and invisible relationships of their internal components and the complex network of their nature. The piece is structured on the relationship and mapping of all possible natural harmonic nodes, independently produced on the strings of each instrument of a string quartet. This construction is based on the highly complex interconnection of the overtones and subtones of a single pitch, ♮D, which for me plays the role of a tonal centre in relation to the open string spectrum of a string quartet i.e., ♮C ♮G ♮D ♮A ♮E. This piece is a compositional kaleidoscope of networks, organised with sounds in multiple layers and categories to be perceived from different angles.

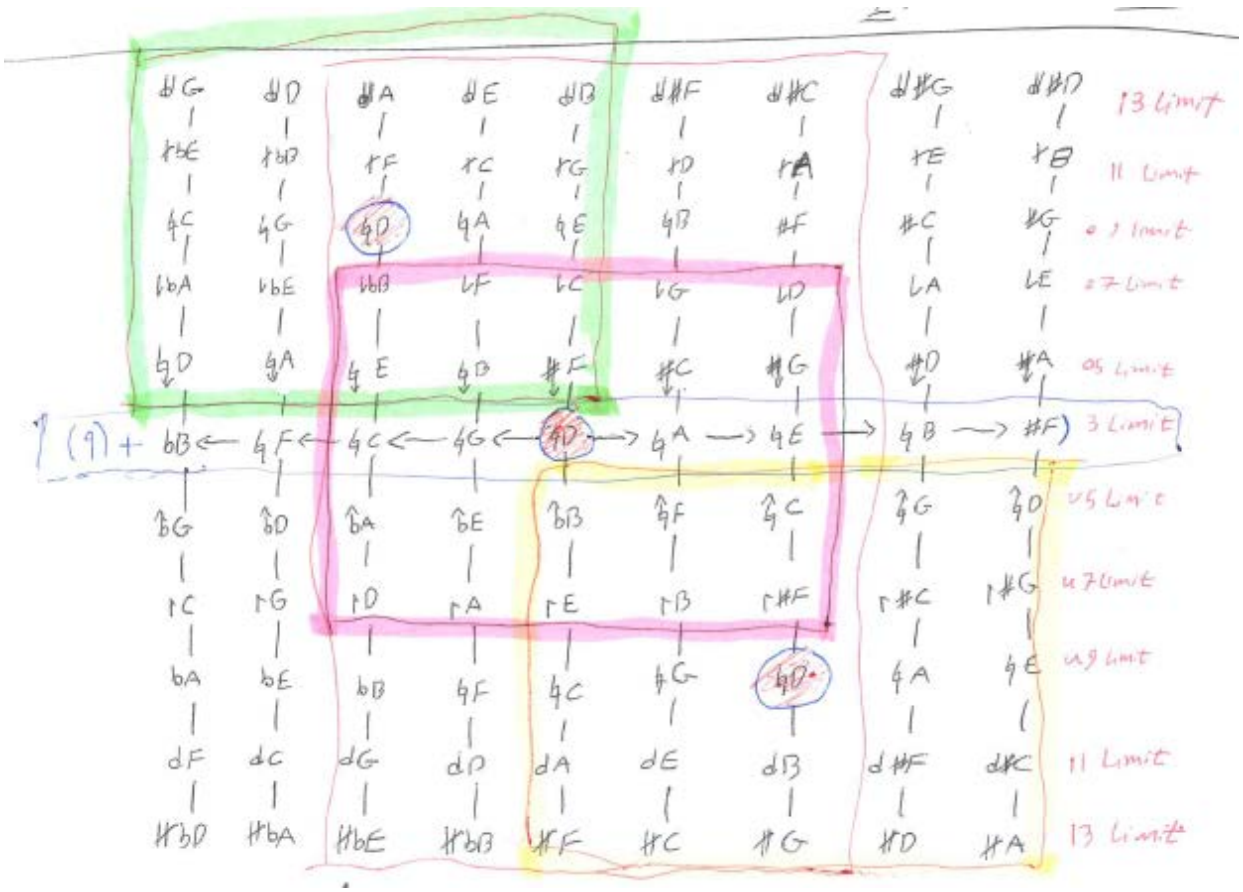

Figure 3.13. Sketch of the Harmonic Space for *Crystallum*.

In this piece I invite the audience to hear and feel the complex transformation of pitch organisation in the context of a very slow but precise reshaping of musical events. By amplifying and spatialising the live instruments, I frequently switch the audience's auditory focus between the acoustic sounds, the amplified and reshaped versions of them, and finally the synthetic sounds. These three levels of sound projection allow me to disrupt the perception of temporality in my music and make the listener feel "lost in time". Moreover, they are so interdependent that one element could not exist without the other, otherwise the sonic balance would be disturbed and the acoustic phenomena between the layers would not take place in the way I want them to.

Crystallum, as the name suggests, is based on the natural growth and expansion of micropolyphonic, non-rhythmic structures that are intertwined. From a macroscopic point of view, they create a woven heterophonic texture that changes throughout the piece. I have once again taken the idea of using the natural harmonic series, but this time applied it differently – by expanding their coloristic texture. I begin the piece by introducing the tonal centre of the entire work and then explore the harmonic space towards various, often distant harmonic dimensions, always remaining within the tonal base of my primary sound network.

The radicalisation of the string quartet material used in *Crystallum* relates to the non-melodic approach in operating with sound sources and the exaggeration of the unstable components of the string sound, for example a hissing of the strings and the instability of the higher rank natural harmonics while playing long note repetitions throughout the piece.

At first, this idea was met with shock by the ensemble members, as the composition did not resemble any canonical way of operating within the historically well-established tradition of the string quartet form. However, the musicians found it intriguing and challenging to maintain the stability of the note over long periods of time. I strongly encouraged them to pay close attention to all the minimal changes and the microscopic deviations in tone, to make them appear as a natural flow resulting from the different, unknown style of melodic ornamentation. This idea, which relates to my research into compositional methods, allowing me to compose many musical elements rigorously and yet remain surprised by the materials that are controlled by the performers, goes even further beyond this calculus. Neither myself nor the performers were able to consciously control the noise and distortion that came out of their bowing procession.

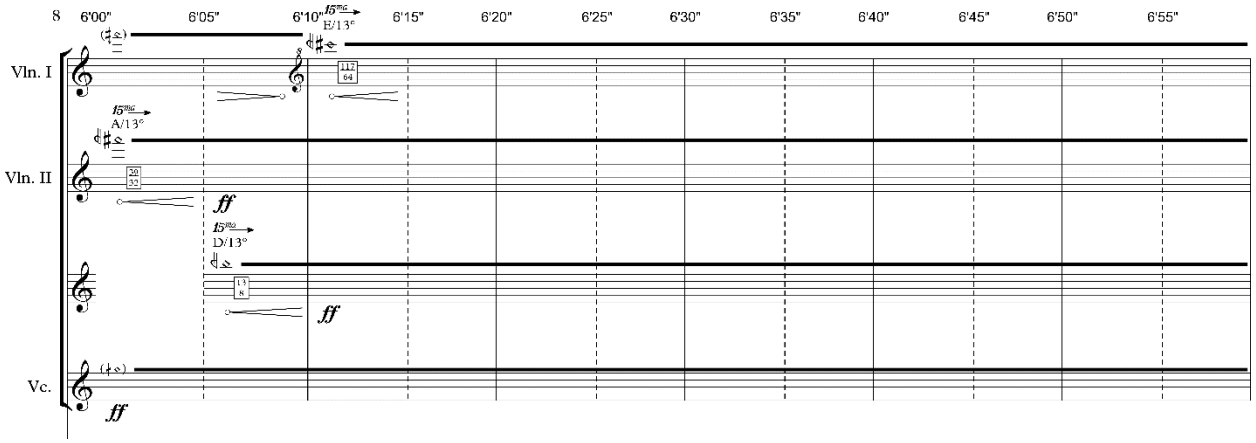

Figure 3.14. This example shows the long-held natural harmonic passages in *Crystallum* which produce the random noise and distortion in the music.

In this work, I have used the tetrachords of Ormavi (rationalised ratios, as explained earlier) and Ibn Sinā, as well as the tetrachords from contemporary Iranian classical music (*Radif*) in the form of chords to naturally capture the psychoacoustic phenomenon of certain selected frequencies and their relations in acoustic space. To support this process, I used the frequencies of the combination tones in the electronic part of my piece so that they would be perceived and somehow amplified throughout the work. I also created the beatings that I wanted to be involved using continuous glissandi and different commas, with special emphasis on the syntonic comma (81:80 or 21.5¢). The main electronic material consists of manipulation between several layers of oscillators as sine waves; the type of waves that I think gives the best acoustic results in terms of blending with the live instruments. It also enhances the roughness of the musical passages and leads to very dramatic, dynamic shifts in the perception of the dominant tones that recur in the mass of sounds.

As an example of this compositional method, I will show a fragment of the score from *Crystallum* and attempt to explain the development of the tuning variations between the layers, as well as the origin of the tuning and its correspondence to that used by Ibn Sinā or the contemporary *Radif*. In the example below, with the tetrachord *Rāst* [♮D ♮E ♯F ♮G] in the strings using the natural harmonics, confronted with the tetrachord *No'ruz* [♮A 𝄭B ♮C ♮D] in the electronics, I led the modulation with glissandi to the tetrachord *Arāq* [♮A 𝄭B ♯C ♮D]. The 13th harmonic in the viola moves into the tetrachords of Ibn Sinā and emphasises the harmonics between 12 and 16, which could refer to the contemporary tetrachord *Shūr* in traditional Iranian music in both sound and tuning patterns, with only slight deviations from each other.

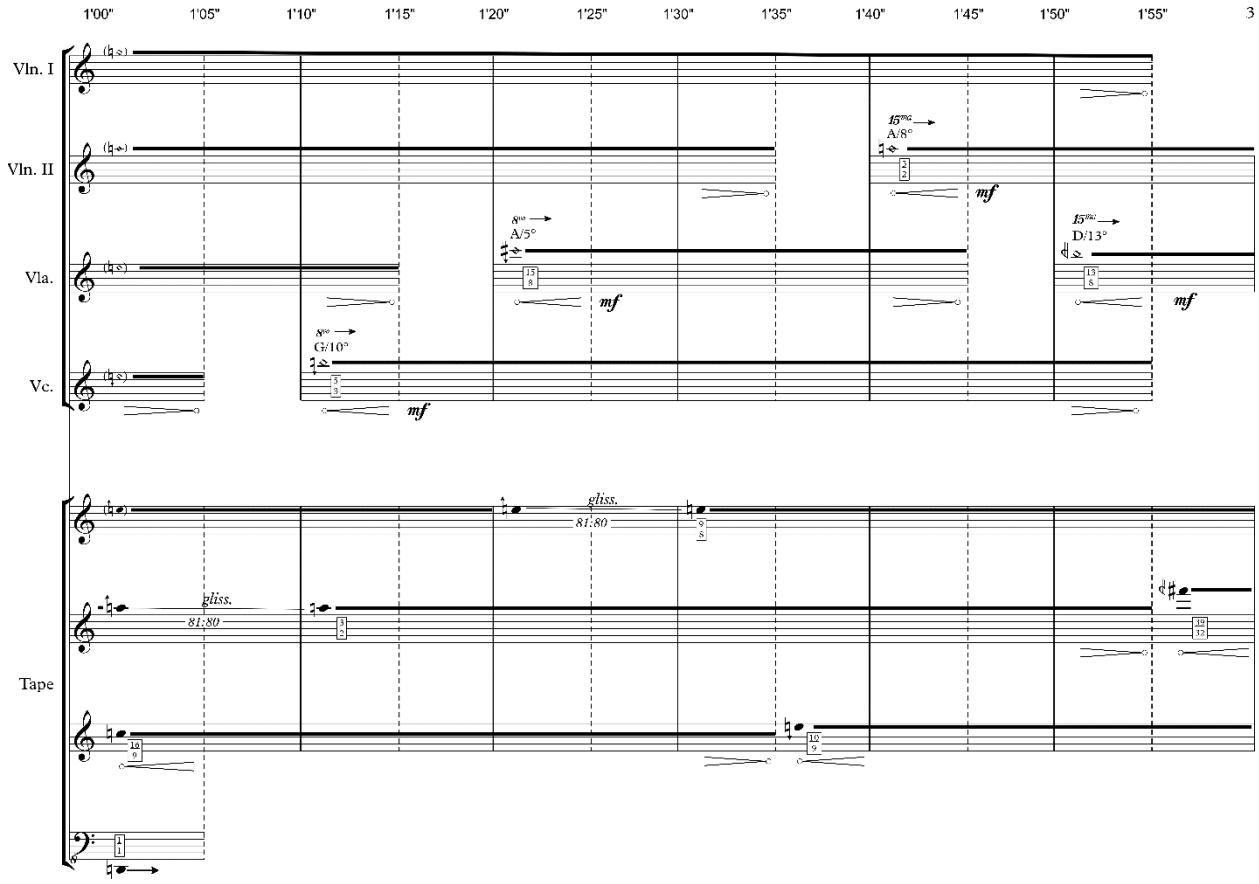

Figure 3.15. An excerpt from *Crystallum* between the string quartet and electronic material, demonstrating the clashes and resolutions from combining the tetrachords of Ibn Sinā and classical *Radif*.

The premiere of *Crystallum* was one of the most exciting concerts I have attended in the post-pandemic reality. The audience of the NeoArte Festival gathered in the concert hall of the Gdańsk Old City Hall, and waited eagerly for the sounds of the Modern Multicultural Quartet project. *Crystallum* sounded strong within the walls of this listed building, built at the end of the 16th century. After the concert, various people approached me to share their reactions to the music. Apart from general enthusiasm, the comments were mostly about things I had not expected to hear, ranging from shortness of breath to an excited heartbeat, or from increased anxiety to the reactivation of a toothache! All this was due to the intensity of the frequencies and their pressure on each other while played at a generally high volume within the acoustic space. I had no intention of reactivating anyone's pain through my music, but this incident reminded me how important it is to think about the side effects of electroacoustic sound manipulation. It is not for nothing that music is said to have different functions depending on how it is used; it can heal but it can also kill, it can cheer you up but it can also make you sad. I could not help but think of the sine waves I so often use in my works, of their spatialisation, of the interference with the amplified sound of the instruments, all of which adopt the tuning of the old Iranian systems. The medieval polymaths, while explaining the calculations of the existing

tunings, also placed great emphasis on the functions of music and the mood-setting aspects of it. Almost all the sources I have examined contain such a reference to a greater or lesser extent. Although this particular aspect was not the element of my research in this specific project, I could return to it in order to develop and analyse the connections between the old tunings and their emotional functions, and how they translate into the world of sounds we can create today.

3.6 Elusiveness of Sound: Notes on *Nežm*

Shortly after composing *Crystallum* in the autumn of 2021, I thought of writing another etude to serve as a study for certain sound procedures I could trial in connection with my project. Fortunately the opportunity arose, thanks to an invitation to the project "The Art of the String Multiphonic". This symposium and artistic project, developed at the Hochschule für Musik FHNW in Basel, Switzerland, led me to explore other ways of sound development in the context of studying old Iranian tuning systems. Thanks to the invitation of cellist Ellen Fallowfield, I was able to compose a new work for her and pianist Sanae Yoshida, who was simultaneously preparing herself for the (delayed) premiere of *Ketāb al-Advār* in the coming months.

Nežm for cello and piano is a short etude for studying the multiphonics of a vibrating string. The idea for this composition came to me after reading an article of the same name by the Basel-based composer Caspar Johannes Walter (b. 1964) (Walter, 2020).

Nežm means "the morning mist of winter" in the Parthian[43] language. The non-solid shape of the multiphonic sound with its evanescent components have an unstable and fragile character which somehow reminds me of the structure of a fog. It contains fixed components (overtones of a fundamental tone) that simultaneously float in the air (duration of the multiphonic sound). It is reliable and yet elusive; impossible to grasp. Its form can morph steadily and with ease but the changes themselves can occur in an instant.

The composition focuses on the morphology of the multiphonic components and the transformation between noises and sounds through the manipulation of multiphonic structures in different temporal and spatial layers. On the other hand, it is also an attempt to find Persian intonation and intervals within the multiphonics of vibrating strings by focusing on the tetrachords described by the polymath Ibn Sinā. All the sound material in this piece is based on the various permutations or transpositions of the following pitches obtained from these four tetrachords:

[43] See glossary.

Original Tetrachords Harmonic Steps	Harmonics Reduced to Lowest Terms	HEJI
16:14:13:12	1:7:13:3	𝄮G - 𝄭F – 𝄲E - 𝄮D
20:18:16:15	5:9:1:15	𝄯B - 𝄮A - 𝄮G - 𝄯F
16:15:14:12	1:15:7:3	𝄮G - 𝄯F - 𝄭F - 𝄮D
28:24:22:21	7:3:11:21	𝄭F – 𝄮D - 𝄳C - 𝄭C

Table 3.4. Ibn Sinā's tetrachords used in *Nežm*.

Apart from the aforementioned tetrachords of Ibn Sinā which make up the bulk of this composition, I have also tried to construct an illusion and instability using microinterval manipulations. The illustration below shows the distribution of the final pitches of the piece with a detailed analysis of the intervallic structure between them. The microintervals are also shown in tabular form, with the exact name, size, and prime factorization for each of them. With this compositional approach, and the very technical attempt to distribute the distances between the sounds, I supported the idea of creating a formal representation that relates to the concept of *Radif*. The general form of *Nežm* was inspired by the concept of *Sayr* in the performance of classical Iranian music, where the end point is built up gradually by going through the different degrees of the scale in the form of tetrachords or pentachords.

In this case I began with a low 𝄮C in the opening, and using the same concept, ended the composition with a C sharp two octaves plus a major limma (𝄯C 135/128 or 92¢) higher. One does not notice the shift of the tonal centre during the performance of the composition, however some notion of the raising and sharpening of the tones is clearly heard in the music.

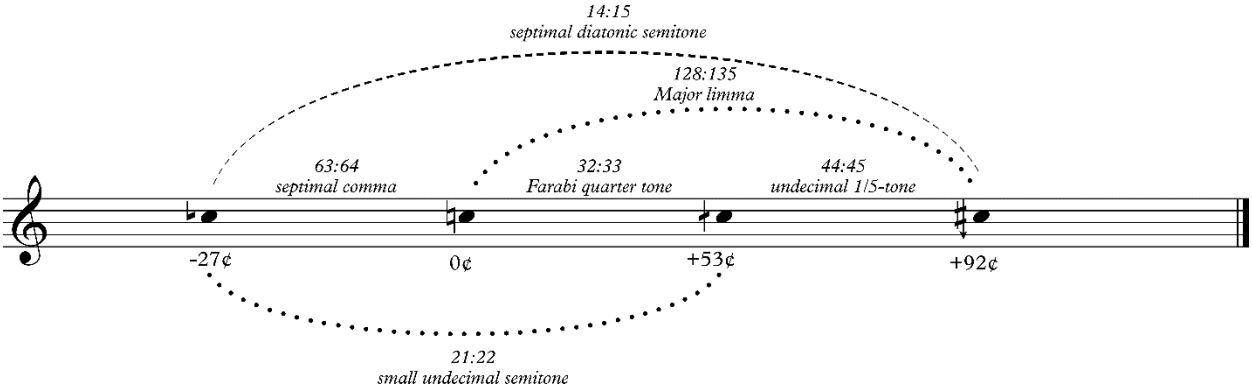

Figure 3.16. The microinterval harmonic shift of the tonal centre throughout the composition.

Name	Interval	Size	Prime Factorization
Septimal comma	64/63	27¢	$2^6/3^2*7^1$
Undecimal 1/5-tone	45/44	39¢	$3^2*5^1/2^2*11^1$
Fārābi quarter tone	33/32	53¢	$3^1*11^1/2^5$
Small undecimal semitone	22/21	80.5¢	$2^1*11^1/3^1*7^1$
Major limma	135/128	92¢	$3^3*5^1/2^7$
Septimal diatonic semitone	15/14	119.5¢	$3^1*5^1/2^1*7^1$

Table 3.5. The interval analysis of the microinterval harmonic shift of the tonal centre in *Nežm*.

Nežm was an interesting formal study that gave me several ideas on how to distribute the musical narration and incorporate micro-interval illusions into compositions of longer duration, especially in relation to my upcoming final project presentation. My compositional process also became more flexible through learning how to adapt the tetrachords from medieval musical theories and the old Iranian tunings in my own works. At least that was what I hoped. I finished composing the piece in December 2021 but I recognised once again that overwhelming sensation of nearing the end of my artistic research, and it was approaching more strongly than ever.

3.7 The Power of Numbers

I mentioned earlier in my reflections that I was having coffee with Jennifer Torrence during the summer of 2020 and discussing the possibility of performers for ...of struggle and hope. In the exact same moment I learned of the Abyss Quartet, she asked me if I would like to compose a piece especially for her, for solo percussion. I happily agreed, even though there was no opportunity to discuss deadlines or concert dates in the middle of the pandemic. The promise itself however, the verbal agreement on the new piece for percussion that could somehow relate to my artistic research project, probably became one of the most difficult tasks I had faced.

The process of composing the piece took almost a year and a half, and by that I mean finding the concept, the musical material, its relevance, the sonoristic values and the connections to my research. Typing the score onto a piece of paper took two days.

4C2 (4 choose 2) is, as the title suggests, an investigation into how many combinations you can get if you have four elements but choose only two at a time. The form and structure of the piece were developed based

on this simple idea and was followed consistently throughout the composition. By imposing such a formal constraint, I wanted to explore the possibilities of creating form based on permutation, combination, and derangement with a single equation: *4C2*. The pulsating content of the piece derives from the mathematical ratios that describe the microintervals in Persian classical music, focusing on the following tetrachord:

16:14:13:12

This particular tetrachord was introduced by Ibn Sinā more than 1000 years ago, and despite a slight difference in the size of the intervals, it still exists in classical Iranian music and is known as part of the *Dastgāh-e Shūr*. The piece is therefore inspired by the microtonal tuning system of Persian classical music, even though there are no pitches in the work that would relate to Ibn Sinā's tetrachordal tonal structure. I decided to use the smallest possible instrumental setup for the work in the most compact form, but the main focus was to find different kinds of timbres and spectra that could unfold in the monotonously repeated patterns of the music. To achieve this I used two bongos, two crotales, two woodblocks and two cowbells in unison, octave or fifth tunings. The performative categories of how to get the sound of these instruments were also limited to a few techniques: touching or rubbing with the fingers, or the fingers carrying a thimble.

I assigned one of the numbers of the chosen tetrachord to each percussion instrument as a phrase with static rhythmic pulsations as follows:

A. Bongo 12 (7*2)
B. Crotales 13
C. Woodblock 14 (7*2)
D. Cowbell 16 (8*2)

Based on this labelling, the different permutations of *4C2* would be:

AB/BA
CD/DC
AC/CA
BD/DB
AD/DA
BC/CB

Each section ends when the cycle between the length of the different rhythmic phrases reaches its starting point, for instance:

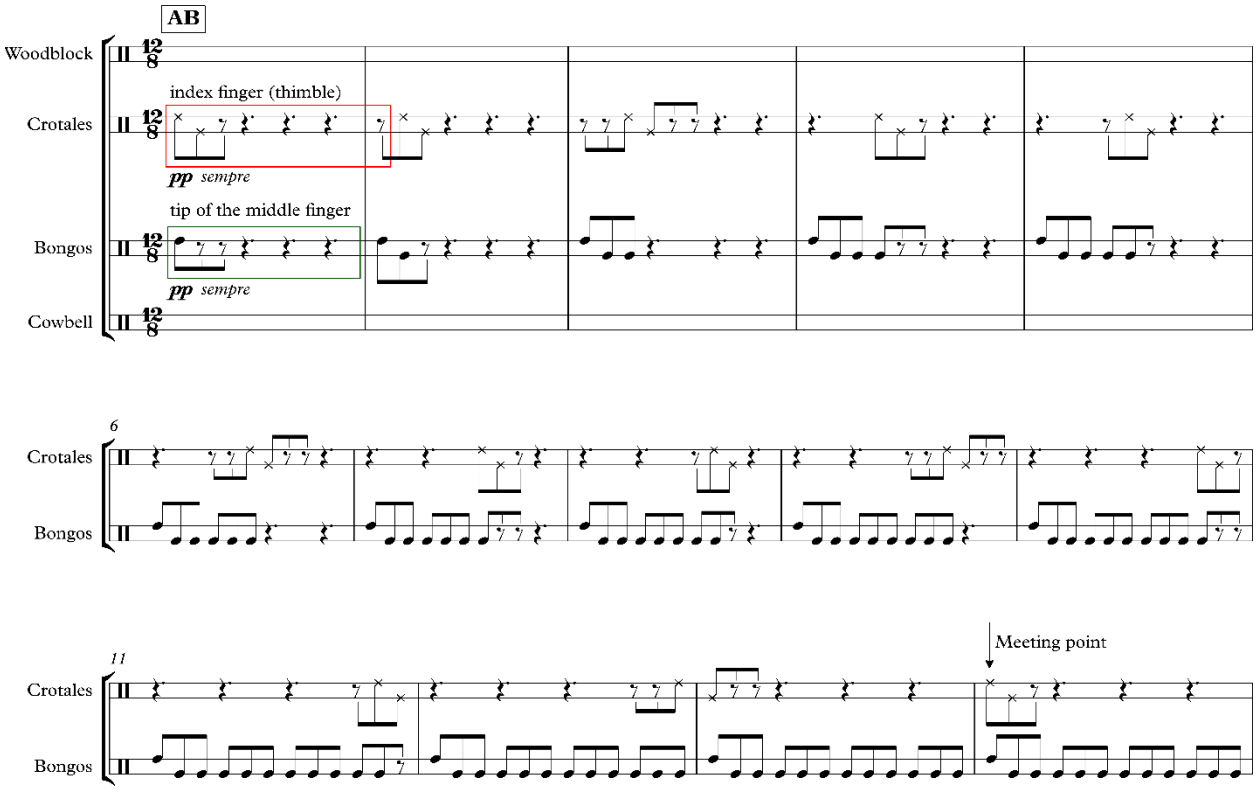

Figure 3.17. An opening section of *4C2* with marked interval relation of 13 (red) to 12 (green).

I have also been thinking about the dynamic levels of this work, which are somehow the opposite of what I usually aim for. Instead of a loud mass of sounds, the dynamic structure of *4C2* oscillates between different pianissimo levels, pushed even to the threshold of what I am able to hear as a 40-year-old composer wearing hearing aids. This limitation has a direct impact on the act of listening with concentration and on the expectation of changes in the repetitive passages with rhythmic fluctuations. Since Ibn Sinā's tetrachord of 16:14:13:12 is only heard in the composition as a numerical representation, even the slightest change in performance technique or repetition of a pattern reverberates like a sudden thunder during a summer storm. The general idea of the piece is extremely simple and I enjoyed its simplicity despite a complex result when the piece was premiered.

The day after the world premiere, Torrence wrote to me:

> "Still thinking about your piece. So scary and difficult in its simplicity! But also something very interesting about how naked it is, naked in so many different ways. I am happy I memorized it, I think it only heightens this. I find it interesting how it dances around this line between rigidity

and spirituality. Sometimes when I practised, I felt I could do both at the same time (only from my perspective). Something interesting about the purity of the octaves, the purity of the math, against my human error. I start to like the mistakes in the context, but at the same time, I love it when it is really close to the score. In performance, also the world premiere, it was like being in a storm, and I started to wonder if I am strong enough to be in that discomfort, even if I say it is interesting from a research perspective..."

3.8 On Processing Art

While writing this text, I have been wondering all along whether it deserves the title of ‘my critical reflection’ on the artistic research process. What is critical reflection in this case? Is it not thinking about or questioning our artistic and practical life choices in general? And how can it be interpreted by the assessment committee at the doctoral defence? Is it artistic enough to be admitted as a valuable artistic research paper? There is no recipe for writing this kind of text, no specific guidelines, rather a void of constant reflection on the events of the last three years and four months of the research period. What structure should I apply to this task? Should it sound like a novel, a diary? It should definitely not sound like a heartless report. For the person who works with sounds to communicate something significant to others, writing becomes a burden, a process that is painful, difficult to realise, and full of doubts about its validity. At this point, I still believe that the compositions I have written over the last few years form the core of critical reflection for the Holographic Composition Technique research project. They represent the application of the transcription of the old Iranian tuning systems to their existence in contemporary composition. No words can disguise this fact, not even my own in this literary work.

As a special feature of my engagement as a research fellow at the Norwegian Academy of Music, I was offered two options: to deliver my critical reflection one month before presenting my final assessment (a term I feel could be altered in the future of artistic research endeavours), or to deliver the critical reflection exactly two months after my final concert. For my case, I found that neither of these options were ideal for the needs of talking about art. I declined the first option to deliver this text prior to the concert with my final artistic contribution, given on 19 October 2022, knowing I would be unable to reflect on something that was not yet complete. Art needs time to be processed; thoughts need time to mature and develop into a valuable written statement of the artist's actions. Since there was no possibility to extend my period of engagement as a research fellow, I had to take upon myself the heavy task of writing the majority of this text in two months. I could have easily used another six months to document the intricate findings of this project.

The idea of including a scholarly section for this work, seen in chapters one and two, provoked a serious and interesting discussion among the heads of my artistic research department at the Norwegian Academy of Music. I stand by my statement however that artistic research cannot take place without justifying and contextualising the research methods. At least for the purposes of this particular project, I found it to be a vital necessity, and in doing so I emphasise the need to discuss the historical tunings and achievements of the medieval polymaths scattered across the vast territories of the Middle East. I believe that collecting and translating data relating to the tuning systems of Fārābi, Ibn Sinā, Ormavi, and other scholars of the period, was not superfluous but rather an obligatory documentation of my research subject, giving it context and a proper introduction to the artistic process. Without this foundation, I could not have built my Holographic Composition Technique at all.

It was precisely at this moment that I realised *Crystallum*, *Nežm* and *4C2* somehow established a second phase of my artistic research contributions. All three compositions explored certain processes of working with the old Iranian tunings and tetrachords that oscillate between medieval and present-day Iranian music. These processes led to a radicalisation of the musical material by way of a detachment from the melodic component, especially in *Crystallum* and *Nežm*. I also focused on the inclusion of noise as a factor of the "unexpected" in musical performance by inviting the occurrence of string fluctuations in multiphonic or long-held natural harmonic positions of high order. The same idea can be discovered through the colouristic variation of performance techniques on the limited number of instruments used in *4C2*.

3.9 A Dream of *Abjad*

At the end of 2021, I noticed my mind was heavily occupied with two upcoming artistic projects. One I considered a new composition in the portfolio for this research, while the other represented the summation of all my efforts as a research fellow. Only now, as I reflected on the last year of my artistic activity, did I realise that these two projects represented the final contribution to my artistic research journey.

The original idea for ***Abjad Dream,*** for piano and electronics, came to me in the winter of 2021 when I was investigating the difference between the *Abjad* system in the works of the polymaths and medieval musical treatises. As I explained in the first chapter, this system was common to all Arabic and Iranian writers between the 7th and 15th centuries, where each author implemented a specific form of *Abjad* writing.

Initially I thought of this piece as a multi-channel sound installation, but I soon realised that I needed to add an acoustic instrument. I created this piece based on Ormavi's 17-tone scale, but this time I did not compose

in the same way as with *Ketāb al-Advār*. In order to make the sound of the piano as close as possible to the tunings Ormavi presented in his music, I changed the 12 notes of the octave on the entire piano from tempered to Pythagorean tuning.

The most important aspect of creating this piece was to use the musical material derived from Ormavi's 17-tone scale in dialogue with the Iranian *Radif* of classical music, but on one condition: that the final sound result be not at all reminiscent of Iranian or any "oriental" notions of music.

No.	Pitch	Tuning Meter Read-out/¢ Deviation	Ratios proposed in *Ketāb al-Advār*	Cents
1	♮A	♮A 0 cents	1/1	0.00
2	♭B	♭B -10 cents	256/243	90.23
3	♮B	♮B +4 cents	9/8	203.91
4	♮C	♮C -6 cents	32/27	294.13
5	♯C	♯C +8 cents	81/64	407.82
6	♮D	♮D -2 cents	4/3	498.04
7	♭E	♭E -12 cents	1024/729	588.27
8	♮E	♮E +2 cents	3/2	701.96
9	♮F	♮F -8 cents	128/81	792.18
10	♯F	♯F +6 cents	27/16	905.87
11	♮G	♮G -4 cents	16/9	996.09
12	♭A	♭A -14 cents	4096/2187	1086.31

Table 3.6. *Abjad Dream* piano tuning chart.

By using 12 chromatic pitches in the piano and the five non-conventional microtonal pitches (existing only in Ormavi's scale) in the electronic processes, I have mixed the scale exclusively through all possible sound sources. In the electronic component of *Abjad Dream* I have incorporated all the experience I gained in creating the fixed media material for ...*of struggle and hope* as well as for *Crystallum*. This means that I again tried to create a liquefied sound modulation with glissandi and a synthesis of all the combination tones. Again, these had to be created with a sine wave operation similar to an oniric procession of the *Abjad* material. The tetrachords of Ormavi inspire the pitches used in the chords for the piano, and the harmony created between the piano and the electronics is based on the modulation between the tetrachords and Ormavi's modes.

Abjad Dream was composed especially for Martyna Kosecka, with whom I have worked several times as an interpreter of my works. It was she who performed my Piano Concerto *Holography* during the first Tehran Contemporary Music Festival in 2016, which became one of the pieces that gently triggered the vision of the Holographic Composition Technique project. Kosecka agreed to participate in the realisation of this project, even when I told her that *Abjad Dream* would be a temporally and interpretatively intense compositional project.

As the next step in developing the idea of a composition with a relatively free form, where the musical content is given to the musician within the time frame I set, the performer has the right to choose the frequency and speed of the pitch repetitions. I have used this method several times in my earlier compositions, as already described, but now I had the idea of creating a work with an even freer form. The piece consists of 12 boxes, each containing one or more sound materials in the form of chords with different rhythmic patterns and tempi. Each new material is introduced after every 5 minutes and develops from the selected pitches that resonate with the tetrachord of Ormavi and the progression of the Iranian *Radif*.

This description is given in the instructions for performing the piece:

> The performance begins with the first block together with the tape material. Every five minutes the performer should add a new section/block to the interpretation. Repetition of the previous sections is essential.
> The number and order of repetitions depends on the interpretation and will be different in each performance. The material accumulates up to minute 45. The performer is encouraged to gradually increase the dynamics of the performance up to fortissimo, but only up to that moment. Otherwise, the dynamic level of the work should be in a dialogue relation with the electronic material and rooted in a subtle piano atmosphere. After minute 45, the repetitions of the previous material should be gradually reduced until only the last three blocks remain. In the last five minutes of the performance, only the last block should be repeated. The performer should stop at minute 60, but the performance is finished when the sounds fade away completely after several more minutes.

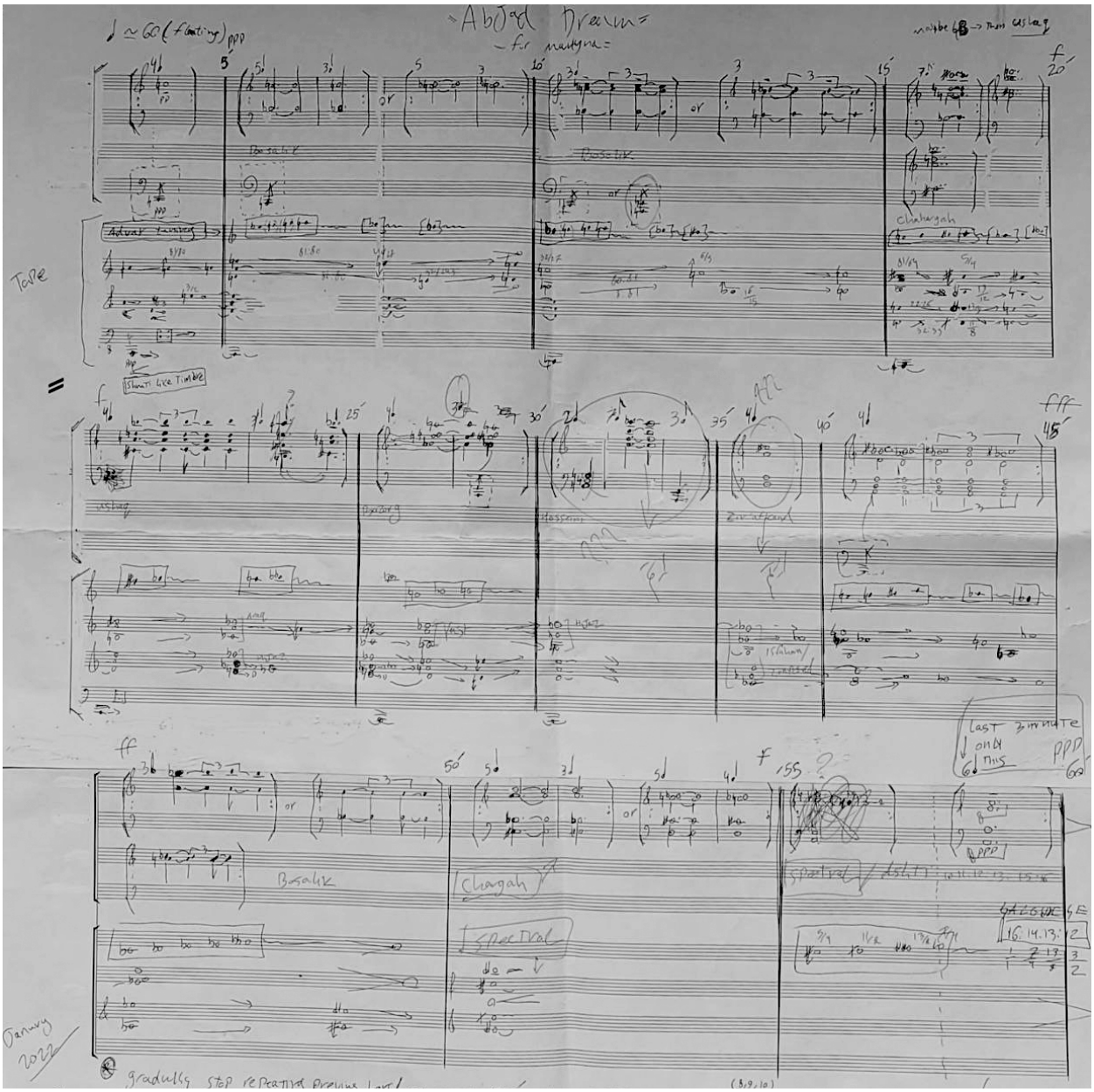

Figure 3.18. The first sketch of *Abjad Dream* showing the modulation procedures within *Radif* in the tape material, and the corresponding material for the piano part.

The confrontation of this modular system in writing for the instrument, combined with a fixed harmonic progression that occurs in the electronic material, enabled me to obtain completely new harmonies that appear randomly in the acoustic space at each performance. So far, the composition has been performed twice. Each time the structure of the work took different shapes, as Kosecka told me that the particular repetitions she wanted to play at the concert were often dictated by the sudden harmonic shift, combination

tone, or the beating phenomena she began to hear. She could somehow get stuck in the repetition pattern, but if she wanted to develop the piece further would eventually switch to another block or return to a previously used structure. I also realised the great responsibility that lay in the hands of the performer, because certain skills in live composition and interpretation that require energy, stamina, even resilience or intense concentration, are crucial to maintaining the constant tension in the music. This atmosphere must last the sixty minutes of *Abjad Dream* and bring about a hypnotic state that is out of this world, where the harmonies of the old and new Iranian tunings determine the laws of music.

3.10 Mantiq Al-Tayr: The Conference of the Birds

In the last months of my artistic research period, I was busy developing the final contribution to the Holographic Composition Technique project. I wanted to create a work inspired by the collision of the medieval Iranian tuning systems of Fārābi, Ibn Sinā, and Ormavi, with contemporary Iranian classical music (*Radif*), using contemporary compositional techniques as a method to combine all these elements. The coexistence of these materials in a musical composition would require me to personally establish the dialogue between centuries of research on the development of tuning in the Middle East between 9th and the 15th centuries, alongside the meaning of these tunings in contemporary *Radif* practice. Moreover, the composition was another attempt to implement the subject of my research into contemporary compositional work on an artistic level. To this end, I re-examined the medieval Iranian tunings I had been working with using the knowledge of Just Intonation. Working between the worlds of medieval Iranian modes, harmonic series, and Just Intonation techniques, became a method for me to achieve an endless network of shifting sounds. I can compare this process to the concept of the Moebius strip: a structure of an abstract topological space in which one cannot consistently distinguish between clockwise and counterclockwise. For me, this concept can easily be transferred to holography as a three-dimensional tool for creating sound illusions associated with the suspension of time and a certain purification through the sound ritual.

For the leading theme of my final artistic project, I decided to interpret one of the most meaningful literary works from my homeland into a multimedia composition. *Mantiq Al-Tayr: The Conference of the Birds* is a 4600-line mystical epic poem by the 12th-century Persian poet Farid al-Din "Attār" Nishāpuri (1145-1221) and is very dear to my heart. In his masterpiece, Attar tells the story of the birds of the world who embark on a journey and travel to the highest peak in the world to find and speak with their ideal king, the

Sīmorgh[44]. Led by a hoopoe, a group of birds set out on a journey and must cross seven valleys to reach the Sīmorgh's abode. Each valley is the symbol of a stage of spiritual awakening and has a metaphorical meaning. According to an exceptional translation of the book by Sholeh Wolpé, the seven valleys are as follows (Farīd Al-Dīn 'aṭṭār, 2018):

- *Valley of the Quest*, where travellers forget all dogma, belief and disbelief
- *Valley of Love*, where reason is abandoned for the sake of love
- *Valley of Knowledge*, where practical knowledge no longer has any meaning
- *Valley of Detachment*, where one leaves aside all desires and attachments to the world and reality disappears
- *Valley of Unity*, where transformation and the feeling of connectedness unites the spirit
- *Valley of Wonderment*, where one finds the laws and thoughts beyond ordinary understanding
- *Valley of Poverty and Annihilation*, where the self disappears into the universe and time ceases to exist.

After passing through seven valleys and approaching the throne of the Sīmorgh, the birds, contemplating their reflection in the mirror of the Sīmorgh, realise that they and the Sīmorgh are one. They come to understand that they are all part of a whole.

In September 2021, I approached the Oslo Sinfonietta and Christian Eggen with the proposal to participate in the performance of my final artistic research project, ***Mantiq Al-Tayr: The Conference of the Birds***, written for santur, percussion, amplified ensemble, octophonic sound diffusion and video. It was a concert work that would summarise my knowledge and more than three years of research on old Iranian tunings. In this audio-visual interpretation of Sufi allegory by Attar, I wanted to explore the inner and invisible relationships of the sound components, and their path to musical metamorphosis and conscious rebirth. I did not want to use poetic words as sounds, but only their meaning on the symbolic, musical level, with the artistic abstract representation through video format. My artistic urge to hear and feel the complex transformation of pitch organisations within a very slow but precise reshaping of musical events was to recreate Attar's allegory of a journey into the depths of the soul and the search for the true self – a journey to purify and cleanse the emotions, a catharsis. I was fortunate that the musicians of the Oslo Sinfonietta, soloists Jennifer Torrence and Mirsaeed Hosseyni Panah, and Martyna Kosecka (this time was making her debut as an independent video artist), agreed to collaborate on this project.

[44] Benevolent mythical bird in Iranian mythology and literature, representing the highest spiritual unity. The literal translation of *Sīmorgh* in Persian is thirty (*sī*) birds (*morgh*).

Figure 3.19. Illustration of *Mantiq al-Tayr* by Habiballah of Sava (ca. 1590–1610). Open access at The Metropolitan Museum of Art, New York, Folio 11r f.

The beginnings, however, were not easy. For several months I had an artistic block and could not come up with an idea for the musical realisation of the piece. I had too many materials at hand and could not decide how to combine them into a coherent and logical narrative. I studied Attar's text in both the original Farsi and English translation. Finally, in the summer of 2022, I began composing.

The musical structure of the work is similar to that described in Attar's masterpiece. I divided the music into seven parts using the same titles as the valleys described in the story, and similarly begin and end the work with the prologue and epilogue. *Mantiq Al-Tayr: The Conference of the Birds* consists of three separate but interwoven layers of sound: the two soloists to whom the work is dedicated, the ensemble, and the electronics. The musical idea of the piece was to juxtapose the old and new tuning systems of Iran. Unfortunately, there are no authentic Middle Eastern instruments that could naturally play in the ancient Iranian tunings of the polymaths I studied. So for the new tuning systems of Iran, and to use *Radif* as purely

as possible, I needed an instrument that would automatically have the tuning system I wanted without having to be retuned or redesigned. From among the many Iranian instruments, I chose the santur because it has a unique timbre and tone colour, a wide range compared to other Iranian instruments, and most importantly for me, because it has the unique ability to hold the notes. Since a significant part of *Radif* is based on improvisation, I needed to work with an instrumentalist who has a deep knowledge of Iranian classical music but also understands the nuances of contemporary music and was able to adapt their own musical preferences in accordance with my often unconventional way of notating music. I was fortunate to know Mirsaeed Hosseyni Panah, who is an excellent *Radif* improviser as well as a composer. Working with him helped me greatly in reducing many of the explanations for the unusual network of modulations in *Radif* that I used frequently in this work. Most of the time, the material for santur related to improvisation over different modes. I mainly gave the instructions for the modulations in the santur part without going into the details of the exact notation.

Having the santur sound against the rest of the ensemble, consisting of two violins, viola, cello, double bass, bass flute/piccolo and bass clarinet, I imagined an extremely opposing force in front of this instrument. My thoughts circled around the axis of energies I introduced when explaining the artistic process of working with ...*of struggle and hope*. This same axis of sound/noise | smoothness/roughness drove me to the non-melodic setup of percussion instruments that could complete the sound balance of santur with its relatively constant and gentle timbre.

Knowing Torrence and her ability to control the sounds, or as I call it, the way she paints the sound, I asked her to participate in this project. The percussion part contained many verbal explanations of the sounds and how they evolved over time.

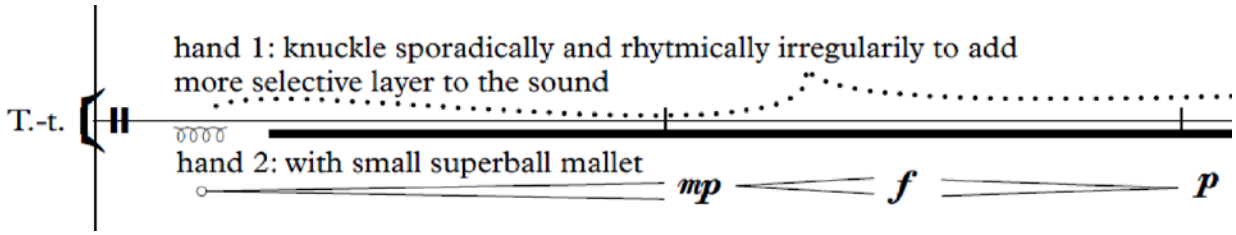

Figure 3.20. An example of timbral operations in the percussion score seen here for tam-tam.

The modal structure of the piece is based on the unusual modulations in *Radif* created by the harmonies extracted from the old tuning systems, and the use of tetrachords of older music, as chords to construct my Harmonic Space. Each valley has its characteristic *Dastgāh* used in santur, and the equivalent or closest tetrachord (*Jins*) from the old tuning systems used in the ensemble. Therefore, we had to use two different

santurs with two different tuning systems to realise this performance without additional retuning during the concert.

- Santur tuned in *Shūr* with tonal centre ♮A
- Santur tuned in *Māhūr* with tonal centre ♮D

Hosseyni Panah changed the instrument depending on the evolution of the Harmonic Space and the reference tones that circulated in the air between the ensemble and the electronic layer. The percussion sounds expanded this sonic landscape by creating non-harmonic timbral clusters, mainly on tam-tam or bass drum, but also with other instruments agitated by a superball mallet.

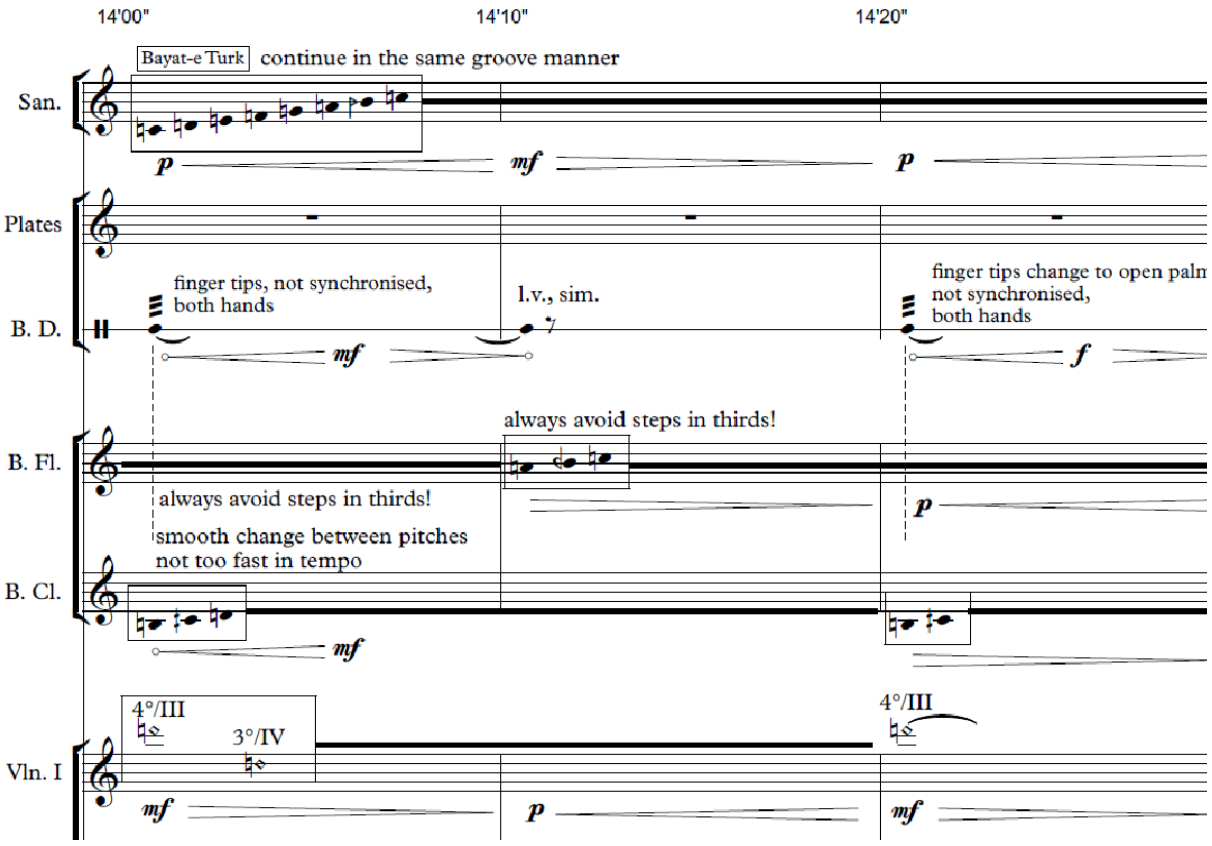

Figure 3.21. An example of implementing *Radif* throughout the musical passage of *Mantiq Al-Tayr: The Conference of the Birds.* Santur performs in *Āvāz-e Bayāt-e tork* on an instrument tuned in *Dastgāh-e Shūr* with tonal centre A. The other instruments follow with chosen notes from the scale.

The rhythmic patterns used in this work are all Persian meters, and the pulsation with which Torrence opens the work on the bass drum is the meter on which Attar wrote his book. This meter is represented as:

Fāʿelātun Fāʿelātun Fāʿelun
(فاعلاتن فاعلاتن فاعلن)
|- u - - | - u - - | - u - |

where - = a long syllable and u = a short syllable.

Rhythm is a common thread throughout the piece building to an intense culmination in the middle section, *The Valley of Unity*, acting as a certain reminder of the never-ending journey towards ultimate purification through sounds.

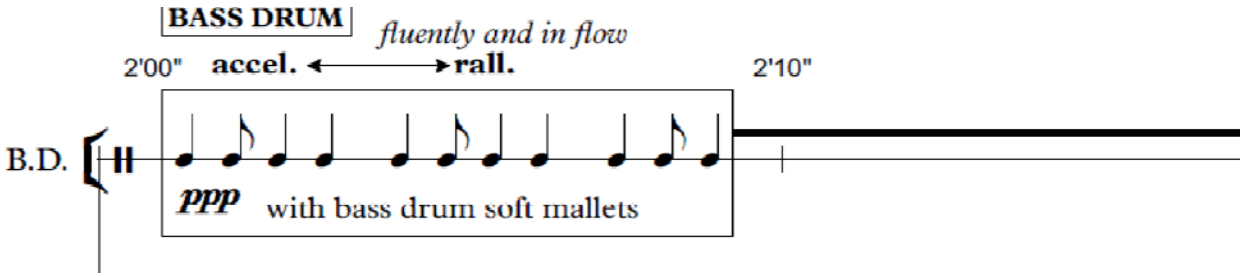

Figure 3.22. A rhythmic pattern of Fāʿelātun Fāʿelātun Fāʿelun for the bass drum.

In the electronic layer, I summarised all the details and nuances of the tuning systems and how to operate them with sine waves in such a way that they unite with the amplified ensemble and the soloists' sounds. The material brought into the electronics related to the manipulations between the *Maqām* and *Radif*, which corresponded neatly with other instruments. The sound diffusion of the live instruments and electronics was played back in an 8-channel system creating an intricate network of beats, spatial movements, and resonances.

The idea of eternally floating pure chords containing only octave and unison pitches for the beginning and end of the piece was like moving in and out of a trance, preparing me for an unusual journey and its unusual

end. It could be considered a sonic interpretation of what the poet and polymath Omar Khayyām (1048-1131) said, “that we came from nothing and became nothing.”[45]

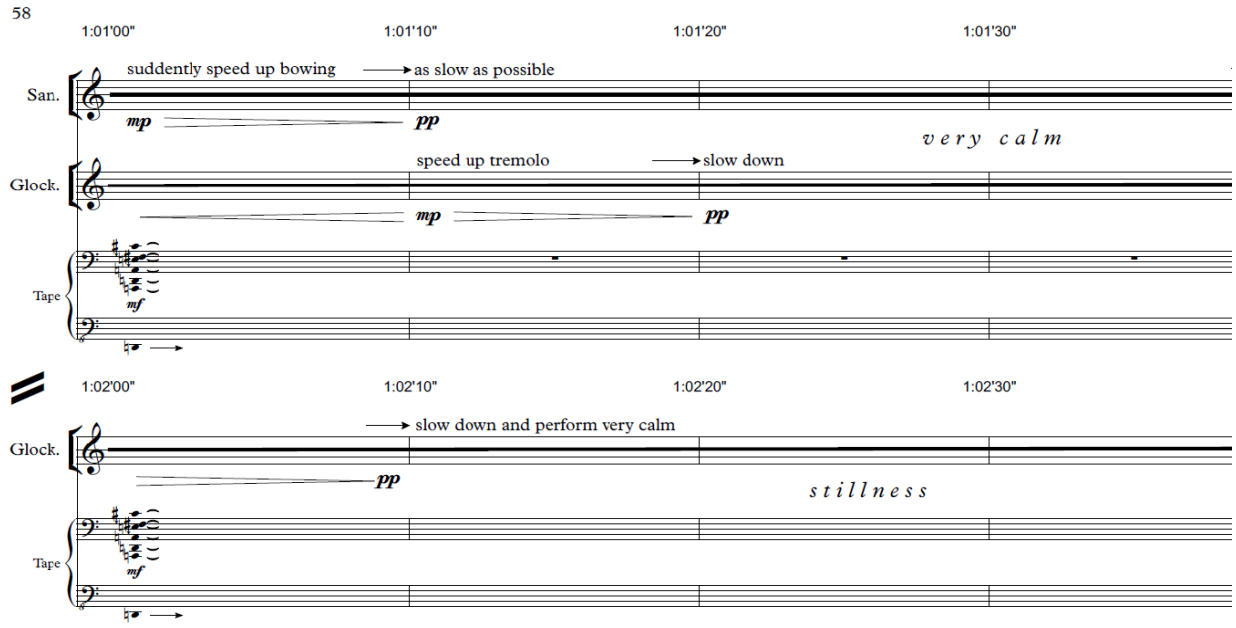

Figure 3.23. An example of final drone structures and suspended chords.

To create a journey that is not only a sonic experience, but also an auditory and visual one, a video was developed and created by Martyna Kosecka, in which a surreal atmosphere was created using the original words from the book "Mantiq Al-Tayr: The Conference of the Birds" in Farsi.

[45] A loose translation of the meaning of the Rubaʿi No.138 by Omar Khayyām. An English translation by Edward FitzGerald as follows:
Myself when young did eagerly frequent
Doctor and Saint, and heard great Argument
About it and about; but evermore
Came out by the same Door as in I went.

Figure 3.24. A still image from the live performance of *Mantiq Al-Tayr: The Conference of the Birds* on 19 October 2022. Moment refers to *Valley of the Quest* where the video displays visual illusions of the Persian word for hoopoe.

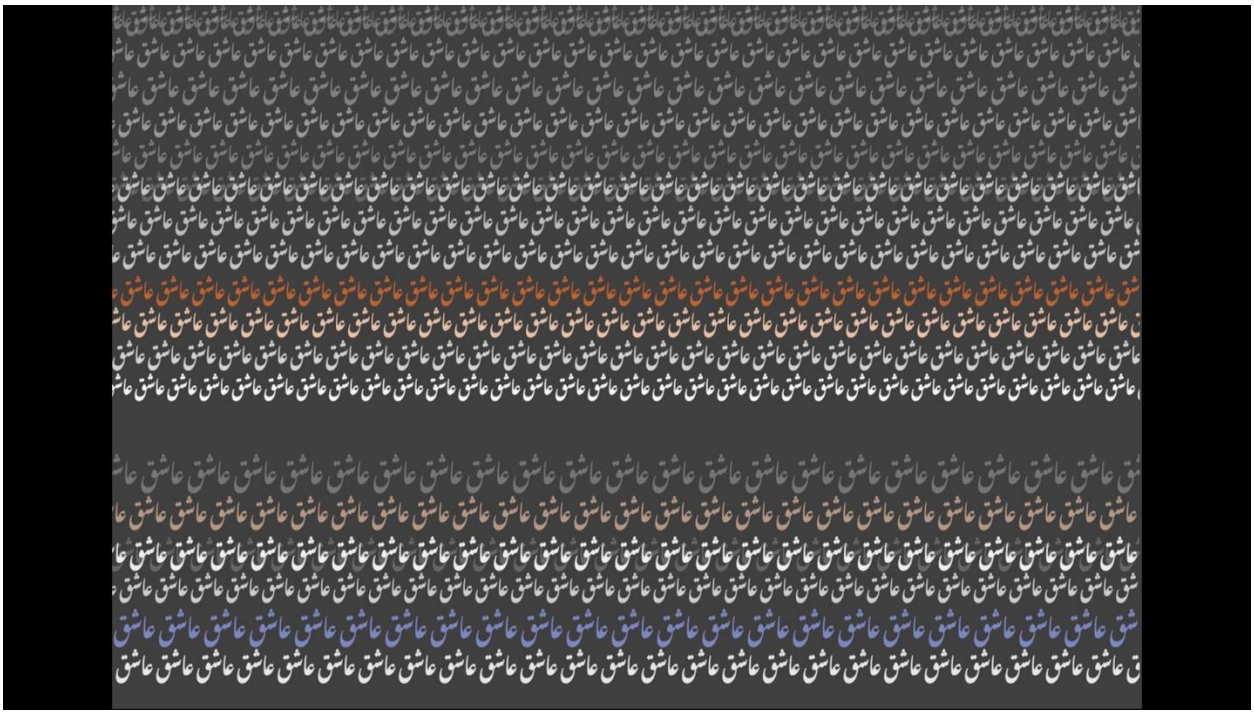

Figure 3.25. A screenshot of the video material for the composition from the section *Valley of Love*.

The transformation of these words was based on my conceptual translations of the opening description for each valley and were then reformulated into visual elements. I largely worked with Kosecka at the Norwegian Centre for Technology and Art (NOTAM) in Oslo from September 2022 until the day of the composition's premiere. The video was designed to support the sounds in every possible detail, to become a canvas for the passing visions like the valleys Attar's birds had to cross to find enlightenment. The narrative of the visual content developed as follows:

- *The Prologue*, in which everything is still shrouded in darkness

- *Valley of the Quest*, in which the selected words from Attar's verses fly across the screen like the birds in relative slow motion. There is a particular emphasis on manipulation with word illusions, especially with the word "هدهد" which means a hoopoe in Persian, the famous leader of the Mantiq Al-Tayr quest

- *Valley of Love*, where the emphasis is on the word "عاشق" meaning in this context devotion to the beloved (God) as a direct allusion to Sufi philosophy. The word takes up the entire screen in slow horizontal movements

- *Valley of Knowledge*, where the verse "صد هزار اسرار از زیر نقاب", meaning "One hundred thousand secrets from under the veil", creates an intricate network of words that float to the top of the screen

- *Valley of Detachment*, where the verse

هفت دریا یک شمر اینجا بود
هفت اخگر یک شرر اینجا بود

meaning "Here, the seven seas are but a puddle, the seven planets are just a spark", moves through the screen like a talisman, in a calm and monotonous passage, in anticipation of the next

- *Valley of Unity*, where the fragments of Attar's text are introduced in larger pieces and flashing in different rhythmic patterns to complement the unity of the instrumental ensemble's rhythm

- *Valley of Wonderment*, where "آه", an exclamation that translates as "ah!", trembles and reconfigures in the middle of the screen, followed by the continuation of the verse in the form of scattered words that float in the air for a while until they disappear from the screen

- *Valley of Poverty and Annihilation*, in which the words from Attar's verse are barely visible, creating a mist of overlapping greys and warm whites. The granulation of the canvas between the overlapping visual layers slowly leads to the final resolution of colour

- *The Epilogue*, in which all colours finally merge into white

Figure 3.26. A still image from the live performance of *Mantiq Al-Tayr: The Conference of the Birds* on 19 October 2022. Moment refers to the visual interpretation over the section *Valley of Detachment.*

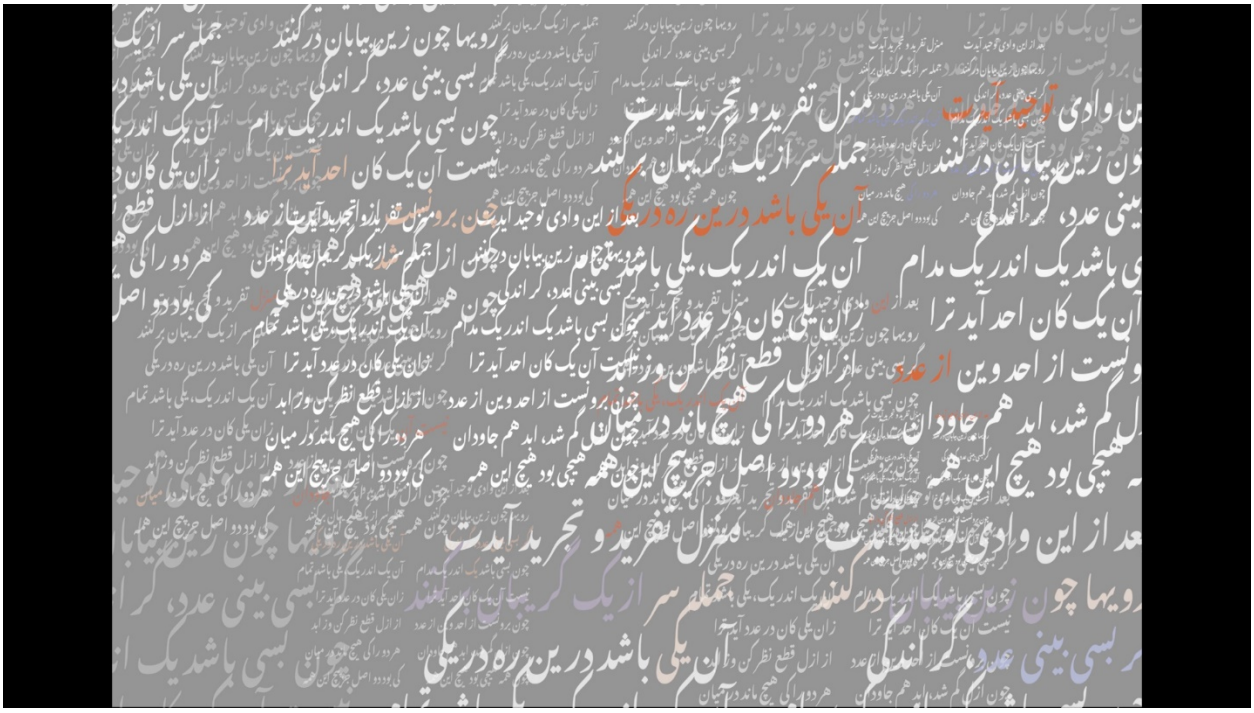

Figure 3.27. A screenshot of the video material for the composition from the section, *Valley of Unity*.

After the performance I felt happy but also empty. It was as if a weight had been lifted from my shoulders, relieving me of all emotions, both positive and negative. Was my journey complete? Did I succeed in

grasping the essence of my research? Was it all in vain and just an ordinary concert experience, or did it have some meaning for the purposes of artistic research?

From the perspective of the time that has passed since the concert until the dark time in December 2022 (as I type these words), I believe that the journey is not over and that this research has created something that will be the beginning of the road for many other scholars; a beginning for those who are interested in the old Iranian tuning systems, the relationships between *Radif* and *Maqām*, the importance of Just Intonation, and most importantly the application of these concepts in composition.

Final Word

Every immigrant leads two lives: one life connected to what is happening in the country of origin – following the news, keeping up with the situation of friends and family, trying to understand the political and social issues and hopefully do something for the country they come from; the other runs in parallel to this virtual life, and involves the daily struggle and existence associated with living in a new environment and a new country. In the last three years, this double life has become a tedious and damaging nightmare for all Iranians I know, affecting all aspects of our lives.

Iran's economic collapse in 2019, leading to the November 2019 protests, resulted in the death of at least 1,500 protesters across the country and the disaster of Ukraine International Airlines Flight 752 on 8 January 2020 that was shot down by the Islamic Revolutionary Guard Corps (IRGC) shortly after take-off. These tragedies, along with the extremely critical situation of COVID -19 cases in Iran during 2020 and 2021 due to government negligence, are just some of the heavy burdens that every Iranian has had to bear.

In this closing section I find myself contemplating the idea of conclusions in relation to artistic research and in particular the results of my own artistic process during this time. By definition, a conclusion marks the end of an event, process or text, and while I am only required to reflect, a term defined as the expression of serious thought, a conclusive nature still hovers over this closing chapter of my studies. While this leaves me feeling mildly conflicted and yet equally encouraged for what is to come, I take comfort in these meaningful words of Attar's masterpiece, and will consider that the results from this artistic research process fall outside of beginnings and ends.

> *The Beginning is lost; the End stretches into eternity.*
> *Don't bother with them, they're all irrelevant.*
> *And since all is really nothing,*
> *Then nothing is truly everything.*
> (Farīd Al-Dīn ʻaṭṭār, 2018, p.290).[46]

I am completing this artistic reflection while my country is in its darkest phase in recent decades. The death of Mahsa Amini (2000-2022) at the hands of the morality police occurred on 16 September 2022 in Tehran, the metropolis where I am originally from, and put the country in a state of revolution. In less than three months, 488 people were killed in demonstrations, 68 of them children. More than 18,000 people were

[46] Translation from the original text (Farid al-Din "Attar" Nishapuri (1145-1221), The Conference of the Birds)

arrested and many face immediate execution. I am writing these lines on 12 December 2022 while the regime has already executed two people and does not seem to stop its thirst for blood.

Throughout the thesis I have repeatedly mentioned the historical events of the Arab (6th century) and Mongol (15th century) invasions on the vast territories of Persia. It was fascinating to note that the authors of the treatises I worked on lived under constant shifts of power and the turmoil of war but never gave up their research, creating masterpieces that are still among the treasures of humanity. The idea of translating and documenting some of these works as a result of my artistic research, bringing their voices to the Eurocentric academic world, and presenting them to my colleagues, gave me the hope and energy to complete this text.

Another point that struck me is the way we as humans respond to the global and private issues that matter to our lives. My time as an artistic research fellow was riddled with obstacles almost from the beginning and I can safely say that most of the compositional contributions to this project came about precisely because I was unable to block my feelings or remain indifferent to what was happening around me. ...*of struggle and hope*, *Shivan*, even *Mantiq Al-Tayr: The Conference of the Birds*, to name a few, were my projections of empathy, and I think it was that very feeling that inspired me to create and compose. That same feeling of longing for the motherland and the inability to reach it in person since 2019 made me realise that thanks to that very research and immersion in the musical history of Iran and the Middle East region, I feel closer and less distant to what I miss with all my heart.

Ultimately, my goal was to tackle this research and focus on the old treatises on Iranian music in order to start a discourse and bring Iranian music closer to non-Iranian musicians and researchers. On several occasions I have lost my spirit and worked with the conviction that this research is pointless and useless, that it is rather a way we deceive or save ourselves in a world full of cruelty and injustice. The need to dull these feelings, to soothe them and pretend that nothing bad has happened, drove me to continue the research at any cost. I know that my art is undoubtedly useless in the current situation in Iran and does not help the fate of my homeland in any way, but despite my blurred expectations of a better future, I do sincerely hope that I have been successful in my wish for this to become a starting point for others to undertake further artistic and scientific research based on the historical tuning systems of Iran. I have also written this for fellow composers, who by delving into the themes presented, might find in them a source of inspiration and encouragement. My work is just a stepping-stone for others, and an example – hopefully one of many to follow – of how they can apply the tetrachords of Fārābi, Ibn Sinā, or Ormavi in their own music and artistic imagination. I have only paved the way in the humble anticipation that someone will follow.

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