

## Music: Early Modes, Neumes, and Vocal production

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The Alexandrian school and its influence on Irish and European, Greek, and Russian music. Comparison of modes using the Latin and Greek Resurrection Hymn. Tuning. Neumes. Bard schools: singing over rough seas. Ornaments. “Throat music.” Some training by rote.

Last year, I attempted to start at the beginning, and cover everything about early Medieval music and music reading in only two hours. At this point, I assume that everybody who is interested in knowing, already knows how to read music. There are many modern music theory books available that will, at least, show a modern staff and notes, define music terms, etc. Some piano lessons will explain these; and these days it is only necessary to own an electronic keyboard to be able to study as a beginner. But, since there is a great deal of confusion about Medieval modes, early neumes, etc., I have decided to concentrate on these.

When studying the modes, a careful description of their tuning has been kept by the Greeks. Since the time of Pythagoras (who taught in Italy in the Greek colony), through the Medieval period, to the present, these modes have been in use, and their tuning has been preserved. Although the hexachord scale of the eleventh century (Ut, Re, Mi, Fa, Sol, La), based on a popular hymn “Ut Queant Laxis” from the Nativity of St. John the Baptist (June 24<sup>th</sup>), is usually thought of as the “gamut” of all modes, the earlier modes were not derived in this way. The “Ut Re Mi” or later “Do Re Mi” system was a method of teaching music reading, and also where to place flats in ascending and descending scales for pleasing melodies. But the “Ut Re Mi” system does not supercede the earlier tuning methods; methods which continued to be used.

The Venerable Bede states that the English missions were desperate for music, and asked for a simplified musical form. Therefore, since Pope St. Gregory the Dialogist had sent the missions to England in the first place, the simplified music was named after him (although those simplified modes were developed much later). Some of those changed modes did not take their modern names or forms in western Europe until well into the seventeenth or eighteenth centuries; the Baroque era used “Mos-Arabic” or imitation Arabic sounds, trying to emulate other modes. Research into accurate musical forms of the past begins with books and oral tradition:

### Books, sheet music, music samples, recordings:

*The Ancient Music of Ireland, Arranged for Piano*, Edward Bunting Dover Publications, Inc. Edition published 2000, complete and unabridged republication. (original title: *The Ancient Music of Ireland arranged for the Piano Forte to which is prefixed a dissertation on the Irish Harp and Harpers including an account of the Old Melodies of Ireland*. Dublin: Hodges and Smith 1840. “Edward Bunting, 1773-1843, was the first systematic collector of Irish folksongs and a leading musician in Belfast. Of particular significance was the meeting of harpers in Belfast in July 1792 at which he acted as scribe, notating the performances of traditional players. He thus preserved this music from oblivion, becoming virtually the only source for the manners and customs of that ancient tradition.” Owing to the great book burnings and bans on music which the Irish suffered, this book must be used cautiously as a source of earlier Irish music. The earlier tunes are probably Medieval, because the traditional players passed along early tunes and style of playing. It also gives a careful system of Irish harp music theory, the same theory used in all Celtic music, which was not a new invention. )

There are several Greek music theory books. I use mainly:

Byzantine Music Theory and Practice by Prof. Savas I. Savas, 1975, Holy Cross Orthodox Press, 50 Goddard Ave., Brookline, MA 02146 ISBN 0-916586-24-3 In this book, the Greek musical system is laid out in terms of Byzantine notation. There are many terms and symbols that must be memorized in order to get to the next page, and is difficult for an advanced music student. (A few pages have been copied to show examples of Byzantine neumes.) This book was explained to my husband by Basil Kazan, who had been the chanter to the Patriarch of Antioch. Savas does have some modern notation in the back of the book, but the modern notation does not explain the tuning that he describes earlier, such as the 72 moria within the octave. The intervals that Savas uses have been explained in modern terms and also perfect ratios, together with a description of all Greek and European Medieval modes.

The best source on early Russian music is the City of Novgorod website, in the article on Znamenny chant. This includes history that is essential to understand the connection between the different kinds of music, and also a description of some of the notation and problems in deciphering it, including examples of early neumes.

wysiwyg://13/http://www.novgorod.ru/eng/cult/cd2/hist\_e2.htm

Each source for Znamenny chant has a little more information, so I will also include a site from Vienna:

wysiwyg://3/http://www.geocities.com/Vienna/4612/znamenny.htm

I was prepared to take a trip to a music conservatory, but the catalogues of most libraries in the area have no information at all on early Znamenny chant (in any spelling of Znameny, Znamenny, etc.). If you have a special interest in this form of music, it would be best to support the archiving of the crumbling music found in old church files by purchasing a newly published book on the subject. This is music research that is necessary for all Medieval study, but has been neglected, and is not being well funded. Very few libraries, even in music conservatories, have this book):

Monuments of Russian Sacred Music, One Thousand Years of Russian Church Music, Series I, Volume 1, Vladimir Morosan, Editor-in-Chief (etc.), 1991, Musica Russica, Washington, D.C. ISBN 0-9629460-0-1 It might be listed under the title, One thousand years of Russian church music 988-1988. (One nice feature of this book, is that you may order individual musical selections from it, without buying the whole book. Write to Musica Russica, 27 Willow Lane, Madison, CT 06443 USA, phone in USA: 1-800-326-3132, or fax and international: 1-203-421-3132. For example, there is a composition by Ivan the Terrible, and many of the pieces have very interesting melodic lines. Everything is in easy-to-read modern notation, and with both English and Russian script, and a translation after it, although the earlier Znamenny notation and history is explained. The book is heavy, but bound in such a way that it opens flat.) This book has only a few pieces of music in each period, but without further funding, it is not possible to publish the complete series. If interested, buy it! (If you are a college or music library, buy it! And... help them get more grants to complete this series... now before the music crumbles away.)

Another worthy book on early neumes is:

Ethiopian Christian Liturgical Chant, An Anthology, Edited by Kay Kaufman Shelemay and Peter Jeffery, 1994, by A-R Editions, Inc. (Volume One: General Introduction and Dictionaries of Notational Signs, Volume Two: Performance Practice and the Liturgical Portions, and Volume

Three, History of Ethiopian Chant), ISBN 0-89579-285-0 (v. 1) ISBN 0-89579-294-X (v. 2) Catalogue number M2160.5.E 93-6407 The authors have researched and recorded the meanings of about 600 neumes and tried several ways to notate them. They include words using English letters. If you are interested in musical notations, early church, Medieval, and modern Ethiopian singing styles, religious history, music history, etc., this is another “must have” book series. If you are a college or music library, it is a necessity. (Found this book at Oberlin Conservatory Library.)

Hymns and Hymnals:

Hymns of Praise (Troparia and Kontakia) by Rev. James C. Meena, Brooklyn, 1964, may be out of print: Byzantine hymns; also, various other Byzantine choir books from the Greek, Antiochian, and Russian churches.

If interested in the “Dies Irae,” look up the words to “Altus Prosator,” which is an “Abecedarian” poem of twenty four Latin verses by St. Columba of Iona, each verse beginning another letter of the Latin alphabet, and then ending with the subject verse. The “Dies Irae” does not begin on the interval note “1” or plagal tone “5,” and since the content of “Dies Irae” is plagiarized from verse “R” and later of “Altus Prosator,” it seems as if some of the music might have been lifted as well. A translation of words only for “Altus Prosator” may be found at CelticChristianity.org.

The website of the Greek Orthodox Patriarchate of Jerusalem calls a “bard” a person who practices magic using music. The website agrees with Hindu musicians such as Pandit Pran Nath that this may occur among the greatest of musicians, but the bards themselves were not known as magicians, but as musicians and poets. Many such as St. Fiacc, St. Columba of Iona, and St. Brigid were trained as bards but became church musicians. The term “bard” used in a derogatory way by the Greeks may come from a snit about the Irish bard known as “Caelius Sedulius” (“heavenly” Siadal) who taught in Latin, in Athens, and wrote the famous Carmen Paschale (Song of Easter) which may be found in the Migne Patrologia. The Carmen Paschale was the most popular read or sung poem throughout the Medieval era. Pieces lifted from this epic hymn include the “Salve Sancta Parens” to the Blessed Virgin Mary. Caelius Sedulius pre-dates St. Patrick; the Carmen Paschale was written in classical Latin, not the later Medieval Gaelic-style Latin. The Carmen Paschale does employ the complex rhythms, poetic structure, and double meanings of the most advanced Irish bards, which would have made the Greeks furious (even though they honored Caelius Sedulius as a great teacher in Athens). The only language which this great epic has not been completely and literally translated into is English, because the Normans were also infuriated by the Irish, although Milton plagiarized this epic extensively in Paradise Lost. Musicians are in ill-repute, yet, every religion employs them.

I am grateful for comments from Nancy Bick Clark, my sister, who is a harpist, pipe player, dulcimer player, and most knowledgeable in Celtic music theory. (She has produced several harp CD’s: write to her at lionsbrd@one.net Look her up; she runs a harp circle for many of her students at the annual Cincinnati Celtic Festival, and she did play with the Chieftans in July 2003. An award was named after her at the Ohio Scottish games at Oberlin. If you are interested in finding a harp teacher near you, go to <http://www.shsa.org/teachers.html> Nancy has some excellent suggestions on what to look and listen for before you purchase a harp. She has also given me a wonderful little plucked psaltery, not the same as the bowed.

Some music resources, either on the Internet with a sound system or on CDs:

Valaam, the island home of several monasteries, has produced several albums of early chant, some of which are available from sources in the United States, although more difficult to find. (At the moment, the monastery is not doing mail order.) Some examples of whole pieces may be found at: <http://www.valaam.karelia.ru/en/sound/>

There is some buzz on the internet site they use, but the quality of the singers, their intonation and musicality is wonderful. I especially liked these selections:

Chants of the Holy Transfiguration Monastery 1993, “Blissful Man,” 4.12 minutes Znamenny chant. The low contra-basso introduces this hymn. The scale has the slightly flat major third at the bottom of the scale, which is the tuning of the older “Ionian” mode in Greek and Russian tuning. (Modern wider major third tuning that we are used to hearing is closer to a bolder “enharmonic” mode called in Greek “Barys,” meaning lower, bass, or grave, and is the bold sound of a brass band.)

Northern Athos 1995, “Kontakion from the Great Canon of Saint Andrew of Crete, Tone 6,” 2.21 minutes, Byzantine chant. This chant sounds simple, but the mode, also called “hypolydian,” has some minor third jumps. This mode was not “Turkified,” because it is similar to the early Ethiopian music. The monks easily hold the drone steady when there are minor second intervals, and the sound is pleasing, because even these very small intervals are in tune with few if any “beats” in the near frequencies.

Hear Me Heaven 1998, “Kontakion from the Great Canon of Saint Andrew of Crete, Tone 6,” 2.43 minutes, Znamenny chant. This chant, the same words as the previous selection, has the interesting modal pitches ironed out of it, showing the difference between the Znamenny and Byzantine chant styles. It uses some ornaments similar to “Embracing Father,” a simple grace note, done in the back of the throat called a “glottal stop.” This same ornament is heard in Mongolian music, Irish music, Byzantine music, etc. (As in the Gregorian hymn of the Angels for Easter, this version of “Tone Six” has been simplified; same words as above.)

Secret Way 1997, “Glorious Sergius and German,” 0.42 minutes, Znamenny chant. This is part music, and the chords consist of thirds and seconds. In tune it is pleasing, although some notes are very close in pitch. The chords are a wall of sound held steady, and then notes drop out of the wall leaving more chords consisting of thirds. It is as if one were painting a picture the opposite way as usual: instead of adding sound to make a melody, a solid chord is sung and then sound is subtracted. (Beethoven heard Russian music when he stayed in Russia, and the same kind of phase-shifting chord experimentation is heard in such pieces as his Fifth Symphony. However, that is a much later piece, and this Russian example is very early Znamenny chant.)

“Jesus Prayer,” 0.58 minutes, Znamenny chant. Several notes are on one syllable, illustrating “melisma;” in English this prayer is only thirteen words long, so any melody would need to have several notes per syllable. Although this is a popular prayer, it is not often heard set to music; it is often a silent prayer repeated day and night.

“Embracing Father,” 3.44 minutes. There is much use of ornaments and vowels. The ornament used to repeat notes, a slight “glottal stop” in the throat scooping quickly back up to a note, is often used in eastern music, including Siberian, Indian, and also in Irish music. The word “Oche,” or “Father” is heard with various suffixes.

Blessed Saturday 1999, “Thrice Holy,” 1.23 minutes, Valaam chant, with bells. Again, notice the slightly flat sound in the minor thirds, which does make a pleasing harmony with the bells, although the tuning sounds mournful.

House of the Most Holy Mother of God, 1999, 1.17 minutes, “O come, let us bow down and worship,” Kartolino-Kahetinsky chant. Notice the Italian influence and the complex parts, a popular style in Russia for awhile. The parts have key changes in the piece, reminiscent of the Gabrielli family in Italy.

Tuva Voices from the Center of Asia Smithsonian Folkways Recordings, Washington, D.C. 1990. From the liner notes: Tuva was under the control of the Mongols and Manchurians at various times, and many were Tibetan Buddhists until 1920. One of the features of the music of this region is the use of high overtones in singing that are louder than a fundamental drone note [the low Russian basses have a quality in their voices close to this used in the Znamenny chant]. Siberian throat singing, (“khoomei,” “xoomij, xomei,” or “hoomi”), shows off the overtones that are present by changing the shape of the mouth. The singers control the pitches of these overtones. At one time, this was taboo among girls because it was said to cause infertility, but now women sing this as well. Kargiraa means to wheeze, and is produced with a hoarse sounding very low voice and open vowel sounds, usually found in songs that have words. Sigit means whistle, and unlike kargiraa has a higher pitched fundamental drone note. Although sung in the same register as khoomei, the khoomei style has less tension in the larynx and more nasal resonance than Sigit. Often, khoomei and sigit are joined in one composition. Ezenrileer (stirrup) and borbannadir (rolling) signify rhythm of horse-back riding, and can include fingers striking against lips, tea bowls, etc.

The resonance and overtone sounds are produced in the face, throat, mouth, soft palate, etc. It is possible to produce overtones in the voice by singing a kind of German or French umlaut, or “uer” sound, with strong resonance in the face. This technique was suggested by Lady Constance Fairfax as a probable Medieval vocal technique that would bring out some of the beauty of the early Medieval melodies of Western Europe. People who speak a similar language to Tibetan are able to produce sounds of the soft palate, due to the use of the “ng” sound (as in slang, sing, long, strung). This is another one of the areas of the mouth used in producing the overtones. The word “nga” means “I” in Tibetan. Although most English speaking people, except for those from Long Island, have no trouble with the “ng” sound at the end of a word, it is harder to produce at the beginning of a word. The “ng” is similar to a semi-soft “G” as in the Greek pronunciation of “angelos.” Some children take a long time to hear and reproduce the sound of “ng.”

Here are some pieces that I liked from this recording:

2. Sigit (Very high overtones) 0:33
3. Sigit “Alash” 1:38 (Overtones controlled with the same kind of ornament, a quick glottal stop with a quick scoop).
5. Khoomei 0:34 (Notice rhythm within the sound)
8. Kozhamik 2:00 medley with khoomei, sigit, and kargiraa (Mixing words and also khoomei)
12. Borbannadir 0:47 (Very fast note changes in the overtones, and very tense, imitates horse-back riding.)
- 14: Borbannadir 1:25 (Very fast trills in the overtones.)
15. Ezenrileer 1:22 (Trills in overtones. Also, finger snapping against tea bowl imitates boots)

clicking in stirrups.)

18. Kargiraa “Artii-Sayir” 1:04 (very low fundamental note)
19. Melody on the amirge (hunting horn) used to lure a stag. 0:48
27. Lullaby 0:55 (Example of the singing technique of a woman, with some ornaments showing her use of vowels.)
29. Lullaby with Khoomei 0:55 (Alto range voice, showing that vowels and overtones used in the treble range).
30. Long Song: “Don’t Frighten the Crane” 1:49 minutes (Slightly sharp major third, an enharmonic mode.)
31. Long Song: “When I Graze My Beautiful Sheep” 1:31 minutes. (Woman’s voice, showing overtones in vowels)
32. Kozhamikar (antiphonal quatrains) (Both men and women) 1:03
33. Ceremonial song: “Hymn to the Mountains” 1:01 (17:25)

To get an idea of a folk music form that uses ornaments in a very early style, I suggest the music of Azerbaijan, the art of Mugham. The artist Alim Qasimov is currently famous; I heard him perform live. The ornaments are similar to Indian vocal ornaments and Irish ornaments of the older recordings of Seanos singers.

Some more music on CD: Medieval music rarely fit into the “hexachord” system:

L’eau & Le Baptême (Water & Baptism) Venance Fortunat, 1996 Domaine de la Garde, France

2 Ex Olive Remensium 3’30 manuscript from Florence 13<sup>th</sup> century, Notre Dame de Paris.

Intervals of thirds and seconds play around each other in a descant.

3. Mizmor le David, Psalm 29 1’36 Similar to all other Greek chant; from Greek Sephardic Jews that had been driven out of Spain. The phrase “Voice of the Lord” appears seven times. Used to greet the Sabbath, “a queen whom one goes to meet at sunset every Friday evening” (liner notes).

6 To Alithinon Fos Epefani (Light of Epiphany) Byzantine chant. Not a very good rendition.

7 Alleluia! Inter Natos 13<sup>th</sup> century Florence manuscript. Same ornaments as Irish, Russian, Mongolians, etc. This is an example showing unity between the Europeans and everybody else.

9 Adjuvabit, neumes d’Einsiedeln. Also shows ornaments that correspond to many other places. Vowels have ‘repercussions,’ i.e., vowel repetitions and glottal stop ornaments.

11 Sicut Unius Dei Trinitas. Response from the service for the Transfiguration by Peter the Venerable 12<sup>th</sup> century. Shows very Irish style ornaments, unifying Europe with everybody else.

Six Gaelic Psalms from Lewis School of Scottish Studies: University of Edinburgh 1994, first issued 1975. These Psalms are sung very slow; it is hard to see how anybody could get through a Liturgy at this speed. On the other hand, the ornaments and intonation are exactly the same as found in many places, especially Greece, Siberia, etc. Although this music was a kind of “filk” or “fiction-folk,” from about 1643, in this case using folk rhythm and melodies and putting the Scriptural words to them, the melodies are traditional none-the-less. The liner notes also say that there are about seventeen to twenty tunes, adapted to Gaelic “modal patterns.” Robert Burns from ‘The Cottar’s Saturday Night,’ “Compared with these, Italian tunes are tame; The teclè’d ears no heart-felt raptures raise; Nae unison hae they, with our Creator’s praise.”

1 Martyrdom Psalm 84 vv 11 & 12 Murdina Mac Donald 4:40 Tuning and ornaments.

2 Coleshill Psalm 118 vv 15-23 Murdina and Effie MacDonald 14:55 Two voices.

- 3 Stroudwater Psalm 46 vv 1-2 Donald MacLeod & Congregation 3:26 Not as pleasing or as in-tune or as complex in ornament, but the congregation follows behind, not in unison.
- 4 Dundee Psalm 103 vv 1-2 Norman MacLeod & Group. 4:35 (As number 3)
- 5 London New Psalm 107 vv 1-4 Murdo MacLeod & Group 7:45 (As number 3)
- 6 Martyrs Psalm 79 vv 3-4 Alasdair Graham & Congregation 3:25 (As number 3)

Stor Amhran (a wealth of songs), Noirin ni Rian, Sounds True Audio, Colorado 1988  
 17 Seven sorrows of Mary Seacht Ndolas Na Maighdine Muire 4:32 (with chorus) Ornament from Seanos tradition, different ascending and descending scales, melody from oral tradition.  
 19 Ave Maria 2:46 Noirin Ni Rian Gregorian Chant with typical Seanos ornaments.

Hymnes De Noel Greek Byzantine Choir 1997 Jade Records, Colem, LLC, BMG Distribution. This is Greek intonation, ornaments, use of vibrato as an ornament only with no vibrato most of the time, the drone or “yson”, and many of the modes. Oldest composers: Romanos the Melodist (5<sup>th</sup> century), Balasios the Priest (second half of the 7<sup>th</sup> century) The rest of the pieces are recent compositions from Constantinople from the 18<sup>th</sup> and 19<sup>th</sup> century: a kind of “filk” (fiction-folk) using very old words with earlier Byzantine rules of composition (and earlier moria tunings).

- \* 1 Today the Virgin 1:26, (3<sup>rd</sup> Mode) Kontakion, Romanos the Melodist, (5<sup>th</sup> century).
- 2 Three Heirmoi (Odes 1, 5, 9) 4:32 Petros Bereketis of Constantinople (+1700)
- \* 3 Doxastikon for the Sunday preceding Christmas, 4<sup>th</sup> Plagal Mode, “Glory be to the Father” 6:39 Iacovos Protosaltis (+1800) (transcribed by Hourmouzios Hartofylax, +1840, one of the three founders of the newer neume system of notation of 1814 and who defined the half-step as 7 moria, not the 8 moria of later theorists of 1881, p39 of Savas’s *Byzantine Music Theory and Practice*). About half-way through, a soloist sings with tuning and ornaments.
- 4 Kathisma (4<sup>th</sup> Chromatic Mode) “Come, O Ye Faithful and Let Us Behold” 1:31 (composer?)
- 5 Heirmoi for the 1<sup>st</sup> Canon of Christmas 7:49 Petros Lambadarios (+1777) and Petros Byzantios (1<sup>st</sup> Mode, Odes of the Canticles 1, 3, 4, 5, 6, 7, 8, 9)
- 6 “Glory to God in the Highest” (2<sup>nd</sup> Plagal Mode) 1:55 Petros Lambadarios (+1777)
- 7 Verses from the Great Doxology (2<sup>nd</sup> Mode) “Today Christ is Born.” 4:02 (A soloist shows ornaments and tuning) Petros Lambadarios (+1777)
- \* 8 Chant for Communion (1<sup>st</sup> mode, with accidentals) “The Lord Hath Sent Deliverance Unto His People” 10:27 Protosaltis of the Great Church Danlil (+1789) A beautiful development of this melody, showing chromaticism and also careful scale development, emotion, etc..
- 9 Troparion (2<sup>nd</sup> Plagal Mode) “Thou Wast Born Secretly in the Cave” 2:22 Petros Lambadarios (+1777)
- 10 Exapostilarion (3<sup>rd</sup> Mode) “Our Savior Has Descended Unto Us From on High” 1:16 Petros Lambadarios (+1777)
- 11 Doxastikon (1<sup>st</sup> Plagal Mode) “Glory to the Father, to the Son and to the Holy Spirit, The Magi, Kings of Persia” 2:47 Petros Lambadarios (+1777)
- 12 Sticherion (2<sup>nd</sup> Plagal Mode) “All the Angels in Heaven” 1:52 Petros Lambadarios (+1777)
- 13 Apolytikion (4<sup>th</sup> Mode) “Thy Nativity, O Christ our God” 0:56 Petros Lambadarios (+1777)
- \* 14 Calophonic Heirmoi “A Star Has Already Risen” 4:38 Balasios the Priest (second half of the 7<sup>th</sup> century) A soloist shows the early ornaments, tuning, accidentals, of Medieval music.
- 15 Kratima (1<sup>st</sup> Mode) 4:26 Protosaltis (Ecumenical Patriarchate) Ionnis Trapezountios (+1700)

Alleluias & Offertories Des Gaules, Iegor Reznikoff, harmonia mundi, Mas de Vert, 1980, CD 1989. Iegor Reznikoff connected his knowledge of neumes, Greek music, etc. to find a better

approach to Gregorian music. [However, Greek and Irish singers are better trained in this technique.] "...the realization that the melodies are in 'justly' tuned modes (and not 'tempered' ones); that 'just' tuning allows each mode to be given its 'ethos,' its individual character and, perhaps, its anagogical [prophetic-spiritual] function; that the scale by itself is of less importance than the relationship of each scale to the tonic of the mode; that if intervals smaller than our semitone exist in these modes, neither is there an absence of chromaticism in the melodies; that vocal tone-quality and breath management are very different from those practised in modern western singing; that this music is neither 'plain' nor 'measured' and that the trajectory of the symbols is primordial in its interpretation and the expression of its dynamic movement." "Most of these pieces are among the earliest that have come down to us, having taken shape between the end of the 4<sup>th</sup> and the end of the 6<sup>th</sup> centuries in the Gallo-Roman-Christian world." Text of the Office of St. Martin are from Sulpicius Severus (360-420?) the writer of the life of St. Martin of Tours ( November 11<sup>th</sup> festival date; same as WW I Armistice and the end of influenza).

2 Alleluia Non vos relinquam 6:27 A mode and performance showing other influences; although Dorian (Tone 1), this one weaves slow but typical ornaments more typical of the Greek.

3 Offertoire: Scapulis suis 10:58 Weaves between what we would call "major" and "minor" in ornaments that are both at home in Europe and Greece. [Major and Minor as Resurrection hymn.]

5 Alleluia Martinus 4:48 Weaves different musical ideas.

8 Alleluia Candor. Alleluia Concussus est 4:19 Using a slow but distinctly oriental descending melody, this piece describes the descent of the Archangel Michael.

### Producing ornaments, Staying in Tune

Although everybody reads music, it is important to listen while singing or playing. If in tune, the sound will be clear, and there will be no dissonant "beats," or frequency cancellations between two notes. If there is a slight difference in pitch between two notes that are not tuned in perfect fractions of each other, the sound waves will reinforce each other, becoming loud, and then cancel each other, becoming silent. This will make a sound like "wawawawawawa," and it will hurt the ears to hear. Very soon, the sound will completely cancel itself out, and will not be heard over long distances. Sound that is in tune; musicians being in tune with each other and also their environment, will travel a great distance at almost the same volume, and will sound more pleasing. Less vibrato is used to stay on a pitch. Scales do not have pitches of an equal distance apart. In a "major" chord, there is a wider interval between the bottom third than the top third within the fifth. In perfect tuning, within the "major third," the bottom second is a wider interval than the upper second. When learning scales, listen for beats; do not try to make intervals equal.

Being in tune and singing with less vibrato also allows a performer to play around with sounds and pitches more easily. Every culture has different names for ornaments. (Singers in "Bardic schools" were trained, although the vocal part of the training is not described, except to say that some were loud enough to be heard a mile away over rough seas. Welsh often have an "operatic" style to their traditional singing, and the Welsh modes on their triple-strung harps allow for key changes. Other traditional singers tend to have less vibrato but greater control over pitch and ornaments.)

Glottal stops: These are done with the throat alone. If you sing "Ah" repeatedly on one note, stopping between each, and then starting the next one, the stop and start is an ornament. "Ah Ah Ah Ah." Some people put a little "h" on the beginning of the sounds, but that does not use the same place in the throat. Try not to make a "Ga" sound. Monteverdi loved to use this as an ornament.

“Throat singing” This is not done with the throat all the time! Using a French or German “uer” sound (er said with an O shape in the mouth), make different mouth shapes or vowels, and hear the “overtones” or secondary notes that are made. The muscles of the tongue and cheeks also participate in holding the shapes of the sounds. Second notes, or “overtones” will be heard.

Ornaments around one note: These are subtle changes in tuning on purpose that go above, below, and back to a note. They are produced with vowel changes, etc. Sometimes this involves subtle sliding, glottal stops usually to the note above and back down, etc. These emphasize or punctuate words or melodies. All early music uses these ornaments in performance. Notice this among Russians, Greeks, etc.

Sliding: When approaching a note in a traditional style it is always best to slightly slide into it. Modern European music claims that they do not do this, but listen to opera, which carries on older traditions! While choral music does not slide, solo music certainly does. To slide gracefully when going up, go above a note and slide down to it, not just one big slide. Sometimes land squarely on a note from a great distance, proving that it is not just a lazy inaccuracy of pitch, and then this is a very effective way to enhance melody.

Vibrato: A fast or slow trill between two or more notes. In Greek notation, vibrato is only done sometimes, and there is a notation for it. Sometimes it is used at the end of singing a note. In all cases, it is controlled, and used as an ornament, never on every note. Practice singing a rather harsh glottal stop on two notes a wide interval apart, such as a fourth or fifth, going back and forth between the two notes, then this ornament up and down the scale. Gradually speed up, maintaining the correct pitches of the notes. Then, try some pitches closer together in interval, and a trill will be produced very easily. (Once the muscles have been trained to do the harder trill, the easier trill will almost seem natural.) A more gentle sound can be achieved after the ability to trill has been discovered. If you already have a heavy vibrato, practice supporting the voice with the diaphragm and holding a note carefully so that it does not waver at all. It will help at first if using the “Ah” vowel sound with a fairly low note and an open throat.

Low and High notes: To sing very low, open the mouth as though yawning, and slide down gently with very low volume. Relax and do not try to sing loudly. To sing high, put the chin lower, support the breath with the diaphragm and the face with the cheek muscles. Think that you are not going “up” to a note, but coming down to it, and it will be there. Don’t strain; music is an offering, and should not be a contest. To sing a greater range, practice both lows and highs, which will gently work out the vocal chords. Be gentle as much as possible. Listen for and try to produce the sound through the bones of the chest and head, not straight out the throat. For some reason, unless practicing a short exercise, singing straight out from the throat tends to strain the voice.

### How to be in tune:

I mentioned the beats before. Set up a drone instrument, that is, something that plays a continuous sound, such as a bowed string. (In our modern lives, any humming fan or refrigerator will do nicely.) A bell that is rubbed rather than struck so that it makes a continuous sound is also useful. Try to sing the same note, not so that you are heard, but so that your sound “disappears” into the other sound. It will give the uncanny feeling of not knowing where you are in the room. This was called enlargement, or in Greek “ecstasis” (ecstasy). Then, very slowly,

one note at a time, sing a simple scale. Change the notes' tunings until they also seem to disappear into the drone note and "enlarge" in the room or space. It might be easier to start with singing the fifths, fourths, and thirds in tune before trying to sing a scale. Now that you have the method of singing in tune, you should experiment with how these notes in the scale were produced. Although all sounds should harmonize, here are some special cases:

Octave: It should sound exactly the same, just higher or lower.

Fifth: (For those without a music theory background, starting counting to five starting on the drone note.) It will also sound very unified with the drone. The pitch will be very slightly higher than the pitch of a fifth on a piano or "equal tempered" instrument, so adjust the sound until there are no beats.

Major Third: It should also be different than the modern major third. The perfect major third is very slightly flat compared to the major third on a piano. (Imagine a blues singer: they are actually singing the perfect pitches.) Within the major third, the seconds are not the same.

Major Seventh: Sing a perfect fifth. Now, sing a perfect major third above that. The major seventh that results will be slightly flat compared to the modern major seventh on a piano; BUT there will be no dissonance compared to the octave or unison note. The ear can hear these differences in sound, and they will be pleasing, sounding like ringing bells.

### Controversies in Tuning

By the time the Medieval period came into being, people were in the habit of singing in several different modes. Early Greeks sang in hundreds of modes, which were reduced in the Christian era to eight. These modes did not simply move around as described today "on the white keys of the piano," but they employed various combinations of notes and various ways of using ascending and descending scales. Within any mode, there were different accidentals used for slower and faster melodies.

Although Pythagoras's school was in Taranto Italy, it is said that the Christian modes came out of Alexandria. Greeks, Ethiopians, Russians, Irish who had been trained in southern France by people who had studied in Egypt, all claimed the Alexandrian school as their musical foundation.

The Greek system attempts to divide a scale into seventy-two equally distant intervals called "moria." (Dividing a perfect circle into 360 degrees, then they attempt to divide the circle into a five sided pentagon with 72 degrees per angle... not black magic, but a description in Savas's book.) While Pythagoras and the Greeks tried for this first form of equal temperament, they lacked the machines to force this tuning into existence. (Their purpose for the equal temperament was not to push the tuning into dissonance, but to more closely describe the actual pitches they used... more below.) Therefore, up until the 1920s, the Greeks described their scales in terms of the nearest pitches to rational in-tune ("just intonation") pitches. But, between an irrational description and a rational description, some little bits of fractions got lost (truncation error). It could be called, instead of the "lost chord," the "lost decimals." In approximating the perfectly tuned scale, the numbers should add to 72, but when finding pitches that were closest to the perfectly tuned pitches, the scale seemed to add (on paper at least) to only 70 intervals. Horrors! So, to make up for that, the modern authors tried to change two pitches of the scale to illustrate a

larger distance, and well, it got all fudged up. But that is modern history... I believe, because all the earlier books do not attempt to add the numbers to 72, that instead the musicians actually used rational pitches in their scales, but for the convenience of describing the closest thing to what they were doing, wrote the intervals in terms of these 72 divisions.

What is the actual interval of the drone note? That would be 1.

What is the actual interval of an octave? That would be 2. All other notes in a scale inside of an octave are between 1 and 2.

What is the actual interval of one “moria?” 1 moria (72<sup>nd</sup> root of 2) is:  
1.00967353322851086219252140111861 (decimals not repeating, irrational).

What is the actual interval of 6 moria (6 times the 72<sup>nd</sup> root of 2) or the modern 12<sup>th</sup> root of 2?  
1.05946309435929526456182529494634 (decimals not repeating, irrational).

What is the rational half-step (the step between the major seventh and the octave)?  
16/15, or 16/15 is 1.066666666... (decimals repeating, rational, wider than the piano’s steps).  
This interval is closer to 7 moria, which is: 1.06971184580696084631350706045429 (irrational)

Larger major second: 9/8 is 1.125. (rational) Which is different from:  
12 Moria is 1.12246204830937298143353304967918 (not repeating, irrational. This is also the modern major second, 2 times the 12<sup>th</sup> root of 2, or 12 times the 72<sup>nd</sup> root of 2.)

Smaller major second: 10/9 is 1.1111111 (decimals repeating, rational). Which is different from:  
10 Moria is: 1.10105679545314306934580208895145 (decimals not repeating irrational).

A Greek “Ionian” scale, which is similar to our modern “major” scale, has the moria intervals of:  
**12 + 10 + 7 + 12 + 12 + 10 + 7 = 72** (Actually 70 plus 2 for the decimal truncation errors.)  
As you can see, the “whole steps” or “major seconds” are not equal in this scale. These are not the piano “white keys,” even in the simplest “diatonic” scale. The rational whole steps are closest to 12 moria, or 10 moria. When the rational intervals are used instead of the moria, the scale looks like this:

$9/8 \times 10/9 \times 16/15 \times 9/8 \times 9/8 \times 10/9 \times 16/15 = 2$   
(Or, if finding the intervals from the starting note:  
9/8, 5/4, 4/3, 3/2, 27/16, 15/8, 2/1.

If you are interested in the mathematics in the rational numbers, they multiply, not add, to make other intervals. The irrational numbers are easier to see because they are added, but the irrational numbers do not sound correct when played, and cannot be used for any traditional modes. The rational fifth (3/2) times the rational fourth (4/3) equals the octave (2/1).  $3/2 \times 4/3 = 2$   
The major third (5/4) times the minor third (6/5) equal the fifth (3/2).  $5/4 \times 6/5 = 3/2$   
When “climbing a scale” (scale means “ladder”), each step is actually multiplied times the previous ones.

Climbing the scale: (1 at the bottom, 2 at the top)  
 $1 \times 9/8 = 9/8$   
 $9/8 \times 10/9 = 5/4$ .

$$5/4 \times 16/15 = 4/3.$$

$$4/3 \times 9/8 = 3/2.$$

$$3/2 \times 9/8 = 27/16$$

$$27/16 \times 10/9 = 15/8$$

$$15/8 \times 16/15 = 2/1$$

This is all very interesting, but how do you hear this scale?

The actual “overtones” heard in a horn played without valves are the correct pitches. Listen for the major third that is slightly flat compared to modern pitches. Knowing that the major third is a little flatter than the third in the piano, the intervals can be derived by practicing against a drone, listening to recording of older or more traditional music, or, in some cases, it is possible to plug these actual intervals into a computer program to hear the scale. (Takes a little computer savvy to download and learn the program; but it is totally free of charge:)

<http://www.xs4all.nl/~huygensf/scala>

Traditionally, a computer was not used, so singers learned scales by mood. The usual major scale today, or “Ionian” scale, was thought of as sad, one of the funeral scales, wistful, nostalgic. If you learn a melody that is in that mood, it will have the tuning. (Paul McCartney sings the major third a bit flat in his song “Christmastime,” and hearing this song constantly on the radio at work, I realized that he is actually singing the older Ionian scale. The mood is nostalgic. Some traditional folk singers will tend to sing these slightly flat major third intervals; they are actually in tune more than the modern European classical musicians.) Did Medieval musicians know the rational mathematics behind music? At some point before the Medieval era they certainly did, and the Greeks recorded the moria system which approximates it. The main point is that they used this system in the way they performed their music, whether or not they did all the arithmetic. I will provide all the correct scales and all the irrational moria and rational intervals after the discussion on neumes.. (Savas uses a great deal of Greek music theory vocabulary; I have tried to simplify the vocabulary while retaining the meaning.)

## What’s in a Neume? History and Practice of Neumes:

So, if the intervals are not equal in distance from each other, what kind of musical notation was used? They used a kind of short-hand, sometimes called “neumes.”

Although both the Greeks and Russians claim that the earlier musical neume notation was lost, in a recent exhibition of the Dead Sea Scrolls (Akron, John S. Knight Center, March and April 2004) which included Bibles through the centuries, there was an example of a Greek manuscript from the tenth or eleventh century. Above each word was a musical neume, that I could read, because it was exactly the same as described in Sava’s book. The only trouble with that neume system is that on the first word there must be a notation telling what note on the scale is being started on. If you do not know what mode a piece is in, and what note it starts on, it would be impossible to tell what the melody is actually doing. In this case, it is necessary to have a more recent example of the same melody so that the music can be checked.

In the Russian and Ethiopian systems, one neume stands for several notes, a phrase in music. When translating Greek into another language, such as Latin, Slavonic (used by the Russians), or any other language, the first problem is that the same ideas will be expressed with a different number of syllables and a different syntax, sometimes extremely different. Therefore, one might

run into “melisma,” where several notes were sung on one syllable, or at the opposite end, repeating many word syllables on one note. I was surprised that the tenth or eleventh century Greek manuscript that I saw repeated many syllables on one note, as if something had been translated into Greek from another language... perhaps an Irish Abecedarian hymn in the Latin language becoming a Greek Kontakion? (The Abecedarian hymns were fifth to tenth century mostly, usually contemporary with the Kontakion.)

When visiting the Pierpont Morgan Library in New York City (a museum of original manuscripts), notice that the Drummond Missal, an Irish Missal, has strange marks over the words. Some reconstruction has been proposed: see the website [http://www3.oup.co.uk/earlyj/hdb/Volume\\_28/Issue\\_02/280205.sgm.abs.html](http://www3.oup.co.uk/earlyj/hdb/Volume_28/Issue_02/280205.sgm.abs.html) These are the older style of musical notation, called “neumes.” This writing was present among Byzantines (Greeks), Russians, Ethiopians, and Irish until the later Medieval period, after the great schism between the eastern and western churches. (Another document, the Drummond Antiphoner, is different from the Drummond Missal, and uses four staff lines. The Drummond Missal is not Liturgically different from early Roman Rite Missals, but the early music is very important.

The Irish Liturgical usage of the Stowe-Lorrha Missal is similar to the Ambrosian, Lyonaise Rites, Bobbio Missal, and other works from Luxeuil, St. Gall and Wurzburg, but there is no music notation on these works.) Some groups, such as the Ethiopians, Byzantines, and Russians, claim that originally there were certain set modes, and compositions within those modes, for the various liturgical hymns. Savas says that Byzantine music came from Alexandria and Sicily, on page 41 of his book, Alexandria having a school, and Sicily being the home of the “magna-Grecia” musicians that included Pythagoras. The Irish also claim Alexandrian heritage. St. Mark (the “Evangelist”) founded a school in Alexandria, and many others were trained there, such as St. John Cassian who later founded a school in Marseilles, France, and St. John Chrysostom who was a Patriarch of Constantinople. St. Basil “the Great,” who re-compiled the Byzantine Liturgy (trying to improve upon Liturgics that had been changed before him) also had spent time in Alexandria. The school of St. John Cassian in Marseilles influenced many in Europe, including St. Patrick who studied near there, and then the Irish continued this tradition, at least until they were not allowed to study after 1172. The closest musical tradition to the oldest Alexandrian neumes is thought to be the Ethiopian music. Although they had a theological split with other churches, their musical traditions continued the earliest of the musical traditions.

Each neume was a notation of one of three things:

- 1.) Often a neume indicated a group of notes (in modern jazz, a “riff”) that was a standard phrase found in many melodies. A group of notes within the neume might be a short phrase from a melody, but hundreds of phrases would need to be memorized in order to read this music. Sometimes another mark would indicate what note this neume symbol started on. In Byzantine neume notation, the first seven letters of the Greek alphabet were used to show the pitch that the neume note group started: Alpha, Beta, Gamma, Delta, Epsilon, Zeta, Eta. So that the names began with consonants, the names became: Pa, Vou, Ga, The, Ke, Zo, Nee. (Phonetically, B is pronounced “V.” D is pronounced as a voiced “TH” as in “this.”) The western European note “A” is an interval of a fourth lower than the Greek “Alpha” or “Pa.” The Greek letter “Alpha” or “Pa” is the western European note “D,” probably because the scale, without any re-tuning, that

starts on “A” is similar to the scale that starts on “D.” In music, the pairs of similar scales are called “plagal” (imitation, as in “plagiarize”), or sometimes “hypo” meaning under, because the “plagal” or “hypo” modes are usually an interval of a fourth under the paired mode. This scale starting on “Pa” or Western D is the Byzantine “Tone One,” the “Dorian” mode. Next to the title of a hymn, often the name of the scale or “Tone” would be indicated. In this way, the distance between notes and the tuning could be indicated, however, later on in Russia, the “Tone” had little to do with a mode.

2.) A neume could also indicate a single note: whether the note was the same as the previous note, up a note, down a note, up two, down two, etc. (See examples from Savas.) These single notes could also be marked to indicate the texture of the voice, either smooth or adding vibrato. Modern Byzantine notation prefers to use simple symbols for pitch on each note, but the earlier Russian used more of the symbols indicating groups of notes.

3.) Neumes were also used to indicate rhythm marks. (In Greek these are called “gorgon.” No doubt in “magna Grecia,” in Sicily and southern Italy where the school of Pythagoras was, and where the “gorgon” appeared at the pinnacle of every gable on the roofs, they were killing the time.) It is easy to see why the four line scale (“scala” meaning ladder) became popular: in reading neumes it is very difficult to see what note you are on in the music or how long to hold a note.

In the Ethiopian system, the neumes also represent groups of notes, and without a live interpreter who knows what they mean, there is no way to know what these sound like. Sometimes two different musicians trained in different regions will interpret the neumes differently. There are hundreds of neumes in their system. Musicologists have attempted to interpret such neumes with the help of live Ethiopian musicians. Older Russian neumes are used today among a group who are called the “Old Believers,” who kept older forms of music and also the notation, although their music is probably also not the oldest form of neumes. (Often, modern Russian “Tones” indicate the words, not a mode.)

Some Greeks claim that they originally did not need any notation; they only needed to look at the letters and accent marks to know whether or not to go up or down in pitch in a composition. (I am not certain as to the accuracy of this oral information.) It is true that the sound of a vowel changes the “harmonics,” or secondary pitches of a sound, and it would be possible for a musical composition to complement the vowels in words used. Or, possibly, some of the compositions made musical references about the alphabet names of the Greek scale that only a musician would hear. Some musical jokes are found in a few of the Western European “hexachord” songs, and the Western Europeans shared a love for hymns where each verse would start the next letter of the alphabet. In Irish hymns these are called “Abecedarian.” The Russians and Greeks called these hymns “Kontakion,” which later became reduced in length. The European “Ut queant laxis” which yielded the “Ut, Re, Mi, Fa, Sol, La” scale (the “hexachord” scale), was sung on the Nativity of St. John the Baptist, June 24<sup>th</sup>, the day opposite to Christmas on the calendar. Every village celebrated this day with great bonfires (for the solstice), and therefore, the favorite hymns of that day were quite well known, and therefore the “Ut queant laxis” was used as a teaching tool in southern Europe following the time of the “great schism” between the Eastern and Western churches. But... does that hymn really reflect the music that was still in use in much of Ireland, England, northern Italy in Milan, and many other parts of Europe?

The Irish did not use the Liturgy of St. Basil, but an older Liturgy similar to the Ambrosian or Lyonaise Liturgy, and although some Byzantine hymns seem to appear in the end of the Antiphony of Bangor, and some Irish hymns seem to appear in the Bridegroom service of Holy Week among the Byzantines, and also the Angelic Hymn of the Resurrection among the Byzantines, in other ways it would be difficult to match compositions at all. One interesting analysis would be to match the Byzantine composition for the angelic hymn of the Resurrection in Hypolydian or Tone Six with the similar Gregorian and Irish version, and see what changes occur, especially in the simplified mode of the Gregorian. The Russians also changed “Tone Six” to simplify it.

The music which we call “Gregorian Chant” was not invented by Pope St. Gregory “The Dialogist” (who is also called “St. Gregory the Great” in Europe... a much earlier St. Gregory was called “the Great” in the east: St. Gregory the Wonderworker, or Thaumaturgis, of Cappadocia, who “moved mountains”). However, St. Gregory the Dialogist was an ardent supporter of missions, and when some of the missions asked for music, and then claimed that they could not learn the complex music, he allowed them to simplify the music. Some of the simplified music produced centuries after Pope St. Gregory was still attributed to him. (See the Venerable Bede, in *The Ecclesiastical History of the English People*.) The late Medieval hymnal, *Liber Usualis*, rarely if ever attributed sources of compositions, but if these had been simplified from earlier compositions, and not just written new, the connection between the Byzantine and European music can be seen. (The Rhythm was also not flat, but the “Solemnes” school finally ironed out any interesting rhythms in Gregorian chant in the 1920s. Luckily, people like Noah Greenburg of the New York Pro Musica figured out some of the interesting rhythms and put them back. I also feel that it is possible sometimes, if not always, to figure out the real modes of the earlier music and put them back too.)

The early Russian and Byzantine compositions were notated, but the modern neume notation of Byzantine music is not the same as the early Medieval Byzantine notation, and often the musical notation is undecipherable if the music has not been continuously used since that time. The city of Novgorod’s website remarks that there is ongoing research into deciphering some of the early Znamenny and Kondakarion neumes and their placement on the scale.

Early Medieval music notation was too complex to assume that alphabet clues would indicate notes, and many pieces used “melisma,” or several notes on one syllable. There were hundreds of hymns, many composers, and the compositions were ornamented. When bringing a composition to another land, it would be translated into the local church language: Greek, Latin, Slavonic, Syriac. If the original composition had been in Greek, when it would be brought to Russia it would be translated into “Church Slavonic,” which was close to the old Bulgarian language. Suddenly, there might be greater or fewer syllables, and unless notes would be repeated, the tradition of using “neighbor notes” up or down a scale might be lost. Vowels would not match notes, and the rhythm would also be lost. New compositions were invented to fit the notes in. There are eight Byzantine “Tones” or modes, but in Russian usage often these indicate words to a hymn, not a mode or composition. The Byzantine “Eight Tones” or modes came from the hymns of the Resurrection in the eight days following Easter, which originally had a different mode on each day, although the Angelic Hymn that introduces the Vigil of the Resurrection is in “Tone Six.”

Although the earliest Russian music used “melisma,” a highly ornamented style, today, recordings of “Znamenny Chant,” the oldest form of Russian chant, often portrays only the simplest of these compositions, or the neumes for the ornaments have not been deciphered. Composers often preferred to be thought of as “anonymous,” saying that the music and words were sent by angels, so it is often difficult to trace origins of the music, but sometimes there is a relationship between the musical forms of one place and another in the same period. For example, the Russians took some of the tuning of the modes out of the Byzantine chant, often simplifying it, much the way Gregorian chant was simplified. When part singing became popular in Europe, it also became more popular in Russia, and new compositions were made. Much later than the Middle Ages, in the 19<sup>th</sup> century, a form of “fiction-folk” (in the Society of Creative Anachronism called “filk”) emerged in Russia: compositions imitating a much earlier style. True compositions of the sixteenth and seventeenth centuries in Russia sound similar to compositions of the same era in Europe, but the latest compositions up to the beginning of the 20<sup>th</sup> century tried to use harmonies with wider intervals and a plain style that they thought of as “traditional.” These compositions often repeat the same note or just a few notes endlessly, and sound very mournful, in contrast to the highly ornamented early Medieval Russian music.

## An Introduction to the Greek and European Modes, with a comparison of the Resurrection Hymns:

### “Diatonic” mode family:

#### **Dorian Mode, Western European and Byzantine, “Tone 1”**

Savas says, page 56, that the sixth is not stationary. This means that sometimes “Dorian” mode becomes “Aeolian” mode (plagal to the Dorian). Savas says, on page 56, that the Dorian mode is named after the Dorians, and is “axiomatic, magnificent, happy and earthly” in character. Today, such a minor key might not be thought of as “happy,” but singing Psalm 1 in Tone 1 gives the perspective of the beginning of a grand journey. The image of walking and avoiding pitfalls comes to mind. This is used at Byzantine Vespers, which is in the evening. (This is one of the evening ragas in Indian music, and one composition is simply the Dorian scale, repeating each note once up to the fifth: D, D, E, E, F, F, G, G, A., G, A, B, C, D, C, B, A, G, F, F, E, E, E, A, G, A, G, F, E, D. It grows on you.)

**Dorian mode:** (If C is 256, then the D is 288.)

(lower tetrachord) (link) (upper tetrachord)

D E(1/2) F G A B(1/2) C D D C(1/2) B A G F(1/2) E D  
**10/9 X 16/15 X 9/8 X 9/8 X 10/9 X 16/15 X 9/8 = 2/1**

moria:

10 + 7 + 12 + 12 + 10 + 7 + 12 (plus a little added on) = 72)

(Although Savas uses 8 moria rather than 7 moria for the half-steps, the interval is closest to 7 which was given as the Moria distance in the early 1800ds; see the calculations following the modes. There is a little extra between notes, adding to 72 moria. The interval of 8 moria is between 13/12 and 14/13, which is too large an interval for this scale. The 12 moria and 10 moria whole steps are closest to the intervals of 9/8 and 10/9.)

(Or, if finding the intervals from the starting note of the Dorian mode:

10/9, 32/27, 4/3, 3/2, 5/3, 16/9, 2/1.

The first “minor third” is a little flatter than 6/5. Finding a “common denominator” for both, the

ratio 32/27 is 160/135, and the ratio 6/5 is 162/135. It is also possible that the interval of the fifth (3/2) may be slightly flat if there is an interval of 10/9 between the 4<sup>th</sup> and 5<sup>th</sup>. In the case of the slightly flat fifth, the intervals are: 10/9, 16/15, 9/8, 10/9, 9/8, 16/15, 9/8. Starting from the first note, these intervals are: 10/9, 32/27, 4/3, 40/27, 5/3, 16/9, 2/1. Notice that 40/27 and 3/2 are not the same; using the “common demoninator,”  $40/27 = 80/54$ , which is flatter than  $3/2 = 81/54$ . Notice that some guitar makers state that they have trouble tuning “D” chords.

**Aeolian Mode, “Hypodorian,” “Plagal of the 1<sup>st</sup> Tone, or Tone 5” Western European and Byzantine :**

Savas says, page 58, that this tone’s character is merciful, stimulating, and dancing-like. The “natural minor,” similar to Dorian mode, but the top of the scale is different. Half-steps are between 2 and 3; then 5 and 6.

Western “Aeolian” mode:

A B(1/2) C D E (1/2) F G A A G F(1/2)E D C(1/2)B A  
 1 10/9 2 16/15 3 9/8 4 10/9 1 16/15 2 9/8 3 9/8 4

(Starting at the first note, the intervals are:

10/9, 32/27, 4/3, 40/27, 128/81, 16/9, 2/1.

These intervals in the scale are usually only used as a descending scale among the Byzantines, because of the flat intervals. Both the fifth and sixth are flat. See the Greek scale below, which reverses the intervals between the 4&5 with one of the upper tetrachord intervals. For the fifth: notice that 40/27 and 3/2 are not the same; using the “common demoninator,”  $40/27 = 80/54$ , which is flatter than  $3/2 = 81/54$ . For the sixth: 128/81 is flatter than the usual minor sixth, which is 8/5. Using the “common denonminator,” 128/81 is 640/405, and 8/5 is 648/405. For this reason, sometimes the different possibilities in tuning are illustrated by ascending the scale using more usual intervals, and descending the scale with the flattened minor 6<sup>th</sup> and 5<sup>th</sup>. Since Aeolian is the “plagal” mode of Dorian, sometimes it has a similar tuning, see Dorian above. (The “plagal” modes usually begin a fourth below the original mode, but the top tetrachord of the scale is different, usually flat on a different note compared to the original mode. In a plagal mode, sometimes an “accidental” sharp or natural is added at the top tetrachord of the scale so that the related mode can be recognized, although this is just an adjustment that turns the scale into its related scale. Therefore, plagal melodies often will add occasional notes that are outside the usual scale. This is not a new practice invented in the Baroque era. Different ascending and descending scales have been around for thousands of years. Sometimes “Aeolian” is called “minor,” and in Western music this “minor” mode acts exactly like a plagal, with at least three different scales, changing notes in the upper tetrachord.)

Byzantine Plagal Dorian, or “Aeolian” mode:

This is the scale that is derived from Savas, starting on D instead of A: The mode has a flat B, so it sounds like the “Aeolian” mode.

D E F G A B flat C D  
 10 + 7 + 12 + 12 + 7 + 10 + 12 = 72 (“8 moria” is 7.)  
 10/9 X 16/15 X 9/8 X 9/8 X 16/15 X 10/9 X 9/8 = 2/1

(Or starting at the first note,

10/9, 32/27, 4/3, 3/2, 8/5, 16/9, 2/1.)

This is almost the same as Dorian, but starts on the note that is a fourth below or a fifth above the usual starting note. So, instead of starting on “D,” it would start on “A.” This is also called

“Hypodorian.” Sometimes the sixth is a natural or major sixth to remind the listener of the Dorian mode. (Savas says, p 59, that all the “Diatonic” tones can have a natural or flatted B, depending on the melody, although he describes the notes in terms of the Greek names of the scale.) “Hypo” means “sub” or “under.” The intervals are, again with the “8” moria really being closer to 7. (The upper tetrachord seventh may be a little higher, reversing the 10/9 and 9/8.)

Or sometimes, in a few places, the same as Dorian:

$$10 + 7 + 12 + 12 + 10 + 7 + 12 = 72 \text{ (8 moria is 7 here.)}$$

$$10/9 \times 16/15 \times 9/8 \times 9/8 \times 10/9 \times 16/15 \times 9/8 = 2$$

(Or, starting from the first note: 10/9, 32/27, 4/3, 3/2, 5/3, 16/9, 2/1.)

This scale sometimes starts on A in certain melodies, and is the “Aeolian” mode.

A	B	C	D	E	F	G	A							
10	+	7	+	12	+	12	+	7	+	10	+	12	= 72	(8 moria is 7 here.)
10/9	X	16/15	X	9/8	X	9/8	X	16/15	X	10/9	X	9/8	= 2/1	

(Or, starting from the first note: 10/9, 32/27, 4/3, 3/2, 8/5, 16/9, 2/1.)

Some Greek chanters use the Western Aeolian flat fifth on some descending scales.

### Mixolydian Mode, Western European and Byzantine, “Tone 4:

Savas says (p 59) that this tone is attributed to the Lesbian musician Sappho, and is festive, dance-like, and joyous. This tone is widely used, as is Dorian. In both Western European and Byzantine music, it is similar to Ionian, but the seventh is usually flatted, and it usually starts on “G.” There are many places where the notes can be sharped or flatted (move up a half-step or down a half-step). Thought of as more holy because the seventh note was humbled or flatted unless an occasional sharp was added there. One of the “major” modes, used very often.

In Byzantine music, when the melody is “circulating” around the third above G, or around B, then the A, or second, becomes sharp. At the end of a melody, the seventh (F) does become sharp, as in the modern key of “G,” in other words, it becomes very much like the “Ionian” mode. Some melodies keep this sharp throughout. Also, when the melody circulates around the sixth (E), then the fifth (D) is sharp, which is very peculiar. If the melody goes up to the third, or “B” but returns back down again instead of going on up the scale beyond “B,” then the “B” is flatted, which would also require that the beginning of the scale would be tuned as the Dorian scale, not the Mixolydian scale. (One can see how some of the Bach chorales such as in the St. Matthew Passion and St. John Passion, used these sharps and flats. This would be thought of as “Mosarabic,” but this form may have been used in Medieval Europe as well. Some people who wrote the Medieval notation did not write all the “accidentals” that actually appeared; see the comment on the Byzantine “Plagal 2<sup>nd</sup> Tone,” also called “Tone 6.” The Baroque composer Handel did not use these “accidentals” much, and his runs are much more difficult to sing because some of the whole steps are very awkward.)

Half-steps between 3 and 4, then 6 and 7.

$$9/8 \times 10/9 \times 16/15 \times 9/8 \times 10/9 \times 16/15 \times 9/8 = 2$$

G	A	B (1/2)	C	D	E (1/2)	F	G							
12	+	10	+	7	+	12	+	10	+	7	+	12	= 72	(The “8 moria” are closer to 7.)
9/8	X	10/9	X	16/15	X	9/8	X	10/9	X	16/15	X	9/8	= 2/1	

(Starting at the first note, the intervals are: 9/8, 5/4, 4/3, 3/2, 5/3, 16/9, 2/1. Notice that this is the

usual major 6<sup>th</sup>, and is a different major 6<sup>th</sup> than Ionian. Mixolydian is the “plagal” mode of Ionian, although the Greeks call Ionian the “plagal” mode of Mixolydian, perhaps because the major 6<sup>th</sup> in Mixolydian is more usual, and not slightly sharp. Mixolydian acts more like a plagal than Ionian: expect to find some “accidental” sharps occasionally introduced occasionally in the Mixolydian mode; see the description of the Greek Mixolydian below.)

In the Byzantine mode, Mixolydian can also start on the note “D” in faster melodies, and the fastest melodies start on the note “E.” These faster and fastest melodies emphasize harmonies.

**Ionian Mode, Western and Byzantine, Plagal of the 4<sup>th</sup> Tone, or Tone 8, “Hypomixolydian”:**

On page 60, Savas says that this mode is humble in style, with appeasing, and suffering. (Remember that “Bach’s equal-temperment” is the “enharmonic Barys” tuning, not the Ionian, so the mood is different than the modern piano’s “Ionian” mode). The tuning used by some folk musicians of the modern melody “Michael Row the Boat Ashore” has that quiet insistent style. Savas says that this scale is the basis of European four part harmony. (Although Mixolydian is used as often in Europe.) Plagal of the 4<sup>th</sup> Tone, or the Ionian mode, uses the “natural diatonic scale,” and starts on “C.” (Usually a “plagal” begins one fourth below or one fifth above, but the plagal is supposed to sound like the originating mode. Therefore, the plagal for Mixolydian starts a fifth below or a fourth above. In some ways, Mixolydian is the plagal for Ionian.)

$$. C \quad D \quad E (1/2) F \quad G \quad A \quad B(1/2) C \quad C (1/2) B \quad A \quad G \quad F (1/2) E \quad D \quad C$$

$$12 \quad + 10 \quad + \quad 7 \quad + \quad 12 \quad + \quad 12 \quad + \quad 10 \quad + \quad 7 \quad = 72 \quad (\text{The “8” moria are closer to 7.})$$

$$9/8 \times 10/9 \times 16/15 \times 9/8 \times 9/8 \times 10/9 \times 16/15 = 2$$

(Or, if finding the intervals from the starting note:

$$9/8, \quad 5/4, \quad 4/3, \quad 3/2, \quad 27/16, \quad 15/8, \quad 2/1.$$

Notice that the 6<sup>th</sup>, or 27/16 slightly sharper than the usual major sixth, which is 5/3, as found in the Dorian and Mixolydian modes. The usual major sixth which is 5/3, times the usual minor third which is 6/5, is exactly 2/1. Comparing the two sixths by a “common denominator,” 27/16 is 81/48 and 5/3 is 80/48. Therefore, the major sixth found in the Ionian scale is slightly sharp compared to the usual major sixth. This sharp sixth has a drunken sound because it is wider than a usual sixth, and the drinking song from the Verdi opera “La Traviata” uses repeated major sixths to illustrate the condition of the singer. Other drinking songs often emphasize the sixth.

Byzantine Hypomixolydian (Ionian) can also start on the note “F.” When the melody circulates around the third (“E”), the second (“D”) is sometimes sharp. The seventh (“B”) is sometimes natural and sometimes flatted. Often, there is a harmony created on the third above the starting note, and some melodies have developed on this harmony. (Not to be confused with the “enharmonic” family of scales.)

**“Chromatic” Modes:** (An ancient term. The older term “Chromatic” does not mean a scale of twelve half-steps. I am using the Medieval term, i.e., a scale with more than two half-steps.)

**Lydian Mode: *Very different in the Western European and Byzantine Modes:***

**(Western European) Lydian, different from the Greek Lydian,** also called “Yemen” by the Indians, who thought of this as a mode of the Middle East. One of the “major” sounding modes. The fourth is a half-step sharp, which is unusual. (Very different from the Byzantine mode called

“Lydian,” in which the interval between 4&5 is still about 9/8, see below.) Half-steps between 4 and 5, then 7 and 8. There may have been confusion about where the jumps might occur: see the Barys tone.

F G A B (1/2) C D E (1/2) F  
 $9/8 \times 9/8 \times 10/9 \times 16/15 \times 9/8 \times 10/9 \times 16/15 = 2/1$

(Or, starting on the first note of the scale, 9/8, 81/64, 45/32, 3/2, 27/16, 15/8, 2/1. Although the interval 45/32 represents an entire half-step sharp above the 4<sup>th</sup>, other intervals are slightly sharp as well: the first major 3<sup>rd</sup> is sharp, and the sharp major 6<sup>th</sup> is the same sharp 6<sup>th</sup> found in the Ionian mode. Using common denominators for the major 3<sup>rd</sup>s, 81/64 is 81/64, and 5/4 is 80/64. Using common denominators for the major 6<sup>ths</sup>, 27/16 is 81/48 and 5/3 is 80/48. If the Ionian 6<sup>th</sup> is a bit drunk, this scale, with the sharp 3<sup>rd</sup>, the half-step sharp 4<sup>th</sup>, and the sharp 6<sup>th</sup>, sounds smashed. The Indians assign this scale to the evening. Although the wide steps of this scale seem drunk, the Greek “Lydian” uses wider intervals than these, and the feeling is beyond drunk, an other-worldly feeling that they use for reading the Gospel and special occasions. Although these wide seconds and very minor minor thirds seem unusual, listening to some jazz artists, the tuning is often in this kind of mood.

**“Lydian mode,” “Tone 2,” Byzantine different from the Western Medieval Lydian scale, “Chromatic” family:**

The most common and important Byzantine mode, Tone 2 (p 90 Savas), used in reading the Gospel or singing the “Holy, Holy, Holy” hymn in the Byzantine Rite, is a mode that has a jump of a minor third in the scale, and is called a “chromatic” tone. (P. 62 Savas, “This tone is distinguished by its moving, languid, and graceful character.”) This was confused with another mode in the Western Medieval area, or some of the intervals may have been switched. On the one hand, the Byzantine music requires that the interval between 4 and 5 is the larger Major Second, but on the other hand, the Western Europeans, who did print accidental sharps and flats in their music according to the “hexachord” system of notation and probably any system, seemed to forget that accidentals were also used in some modes.

Savas says that Alkman in the city of Sardies of Lydia taught this around 670 B.C., earlier than Pythagoras, and Savas states that the Western European Lydian is different and mis-named. (Pythagoras lived later than this Lydian scale is claimed to exist, from 570 to 504 B.C. in Taranto, Italy. I am not attempting to cover reasons why modes were much later mis-named in Europe, but it may have something to do with the fact that the Europeans did not always write the accidentals.) The names “Lydian” and “Mixolydian” seem to say that these scales are related; and in the Greek scales they both begin on the “G” (using western European letter names for the notes). One mistake that beginning musicians often make is not singing or playing the minor seconds as small enough intervals, so singers or instrumentalists might have used a scale such as the Greek Lydian before the other scales with the smaller minor seconds. For some strange reason, this scale does make pleasing harmonies. It is one of the only strange ancient scales to survive in the West through the Medieval era. Also, while the Indian musicians refer to the “Yemen” scale as one of their scales, which is the same as the Western European Lydian scale, the “Arabic” or Middle Eastern sounding scale in modern times is the Byzantine Lydian.

In modern usage, the “Impressionist” composers such as Debussy and Ravel tried to imitate something like Lydian by using some scales of entirely major seconds, and fewer notes per

octave. Even though there is little information about this mode used in Medieval settings, the sound of the impressionist composers has a Medieval sound with the feeling of widened seconds. (A piece such as Debussy's "Sunken Cathedral" almost puts one in the mood of Medieval France.) Lydian is a very beautiful mode, but very difficult to achieve. On the other hand, a few clergy can improvise in this mode while reading the Gospel lesson, which will get your attention even if the words are all familiar.

In the modern Greek description of most Byzantine scales, the intervals of 8 moria are usually closer to the 7 moria of the earlier 1800's, but in the Lydian scale, the 8 moria are actually approximately 8 moria. The 14 moria is closer to a slightly enlarged major second (8/7) than it is to the minor third (see list of intervals above). If the minor seconds are also slightly enlarged in this one scale, then it would have both a major and minor feeling.  $14/13 \times 8/7 \times 13/12 = 4/3$  (If the jump were more than just a slightly augmented major second, then it would be 7, 16, 7, and be expressed in perfect ratios  $15/14 \times 7/6 \times 16/15 = 4/3$ , which is found in one of the Barys scales.) Notice that the smallest intervals are not the same as each other, and the minor third is not quite as large as the usual minor third. (Maybe a hint was left in the Western European Lydian scale: the first intervals are  $9/8$  times  $9/8$  or  $81/64$ , which is wider than the major third. So, the feeling of an augmented interval is in the Western European scale as well.)

**Byzantine Lydian scale**, starting on "G" or the fifth, no half-step between 4 and 5, and the other intervals are unusual, the largest interval between a major second and a minor third:

G	(A half-sharp)	(B half-flat)	C	D	(E half-sharp)	(F half-sharp)	G
$13/12$	X	$8/7$	X	$14/13$	X	$9/8$	X
$8$	+	$14$	+	$8$	+	$12$	+
$8$		$14$		$8$		$12$	$8$
$= 72$							

(The 8 moria is actually 8 this time. "Half-sharp" or "half-flat" is between a half-step and a whole-step. F is half-sharp because the interval between E and F is usually a half-step. Listen to this scale on a computer. Starting on the first note of the scale:

$13/12,$        $26/21,$        $4/3,$        $3/2,$        $39/24,$        $39/21,$        $2/1.$ )

(Compare to Barys tone upper tetrachord  $15/14 \times 7/6 \times 16/15$ , which is one way to sing that part of Barys, and which might be one way to sing Lydian mode.)

**Byzantine Plagal of the Second Tone, or Tone Six, "Chromatic" family:**

Another scale similar to the Tone 2 scale is the plagal, also called Tone 6. It starts on "D." It is similar to Lydian, but the jump in the scale of Tone 2 is widened to 20 moria, slightly larger than a minor third, the seconds are minor seconds, and there is sometimes a different ascending and descending scale. The extra-wide jump may be a result of the scale starting on a different note than the usual Lydian Tone 2 which starts on G. Savas says, on page 65, that this tone has a funeral-like character and is sorrowful. However, this tone also can show great joy.

Through most of the year, the Byzantines sing a different "Tone" each week, a cycle of eight weeks. Since the Byzantine "Tones" consist of four scales and four "plagal" scales, or scales starting on the fourth below or fifth above, the eight mode cycle is actually a cycle of four and four. The Celtic cycle during the Pentecost season, June to mid-November, is a cycle of six, not eight, in the Bobbio Missal. These also may have used different scales each week in Celtic usages, perhaps dropping the more chromatic or controversial of the scales, or using those scales

only during certain times of the year. For example, Tone 6 or Plagal of the 2<sup>nd</sup> of the Byzantines is the same mode used as their Angelic Hymn at the Vigil of the Resurrection.

Translation of the Greek hymn used in the Vigil of the Resurrection and Tone 6: “The Angelic Powers were before Thy tomb, the watch became as dead, and Mary stood in the sepulchre and sought Thy Sacred Body. Thou despoiled Hades, for Thou wast not tempted by it; Thou came to the Virgin to give Life. O Lord, Who didst rise from the dead, glory to Thee.”

A slightly longer version is sung in the Vigil of the Resurrection of the Celtic Rite and old Roman Rite. (The words vary slightly, but occur at the same point in the candle procession.) In an old Roman service which used the traditional Medieval music, *Missale Romanum*, Benziger Brothers, Inc, Novi Eboraci (New York) typeset 1944, the four line Medieval staff tells the tale, and actually may have been in the Greek Tone 6 tuning. . Music on the “C clef” appears to show the starting notes of the 6th Tone mode, so it might have used an “F clef,” but not for Western “Lydian.” Then, the first note, a plagal, or the fourth below the clef note, is on the “G” space, indicating that it probably was a plagal mode, according to the rules of modes as followed in early Medieval music. (The first note of a piece would start on the first note of the scale expressed by the clef unless the mode was a plagal mode.) Sound like an approximation of Plagal Lydian in the Byzantine mode? The music begins with an imitation of the seconds and thirds of tone 6. Two modes were mixed together in an ancient hymn melody only approximately rendered here. It is possibly using the “mixed” scale, including some elements of the Dorian mode. It is common in Indian music to mix two different scales, but only using the best musicians, and usually for a special occasion. Of course, the Resurrection hymn on that day is a special occasion, and a “Mixed” scale that includes Dorian mode is given by Savas.)

The beginning of the Latin words for this hymn (to compare to the Greek):

“Exsultet jam Angelica turba caelorum: exsultent divina mysteria: et pro tanti Regis victoria, tuba insonet salutaris. Gaudeat et tellus tantis irradiata fulgoribus: et aeterni Regis splendore illustrata, totius orbis se sentiat amississe caliginem. Laetetur et mater Ecclesia, tanti luminis adornata fulgoribus: et magnis populorum vocibus haec aula resultet. ...”

Roman and Celtic translation: “Now let the Angelic host of the heavens rejoice: let the divine mysteries rejoice: and for the victory of the great King let the trumpet of salvation sound forth. Let that of which is illumined by the great lightning flashes, be glad: and enlightened and washed by the splendour of the eternal King, let all the world sense that she hath cast away darkness. Let our mother the Church rejoice, adorned with the lightening of the light: and let this courtyard resound with great voices of peoples. Wherefore, you who are standing here, dearly beloved brethren, in the wondrous clearness of this holy light, join with me, I beseech you, in calling upon the mercy of almighty God. That He who was pleased to graft us through the grace of His light, being poured, may He admonish us unto the completing of the praise of this Candle.”

Translation of the Greek words: “Angelic Powers did stand above Thy tomb, And they that guarded were as dead, And Mary stood at Thy grave searching for Thy precious body. Thou didst conquer Hades, and was not tempted thereby. Thou didst meet the Virgin and didst bestow life. O Thou that art Risen from the dead, O Lord glory to Thee.”



ironed all the life out of the earlier melodies, for some of the most traditional melodies it is possible to determine the correct mode, and re-introduce the correct accidentals.

(Most modern Byzantine choirs do not use the correct tunings of these tones, and some use modern organs which do not allow tuning adjustments. However, some older chanters still use these different tunings, and many Byzantine churches still use no musical instruments during services.)

Byzantine Plagal 2<sup>nd</sup>, or 6<sup>th</sup> Tone:

Ascending and Descending (upper tetrachord mirrors the lower tetrachord). (Page 64 of Savas)

D	E flat (jump)	F sharp	G	A	B flat (jump)	C sharp	D	
6	+	20	+	4	+	12	+	6
+	20	+	4	+	12	+	6	+
20	+	4	+	12	+	6	+	20
X	6/5	X	25/24	X	9/8	X	16/15	X
6/5	X	25/24	X	9/8	X	16/15	X	6/5
25/24	X	25/24	X	25/24	X	25/24	X	25/24

(Or, starting at the first note in the scale, the intervals are:

16/15, 96/75, 4/3, 3/2, 8/5, 48/25, 2/1.

The “mixed” scale ascends the same way at the bottom of the scale, but at the top is like Dorian.

In the mixed descending scale, both the upper and lower parts of the scale have the jump.

The upper tetrachord in the ascending mixed scale:  $10 + 8 + 12 = 30$ , or  $10/9 \times 16/15 \times 9/8 = 4/3$

Notice that 25/24ths is a very close interval. Also, the ascending upper tetrachord of the mixed scale is not like a major scale, but is the minor Dorian, so this scale does not resemble a scale that is “moved around on the white keys” at all. The estimate of 8 moria divisions for the part of the scale that is Dorian is exaggerated; see the comments on the Dorian scale. 16/15 is closer to 7 moria divisions, but each interval is a little larger or smaller than the perfect intervals, so the scale does work out to a perfect octave.

### “Enharmonic” Modes:

In modern terms, “enharmonic” means that the sharps and flats look the same as another scale when only counting half-steps, but in perfect tuning these are not exactly the same in distance in a scale. In modern music, there are only two “enharmonic” keys, and these have so many sharps and flats that the eyes cross, but the notes when played sound exactly the same. If these notes were in perfect tuning, however, the scales would have a very different sound. Tsaikovsky’s “1812 Overture” orchestral score has a place in it where there is a key change from one enharmonic key to the other, and although the orchestra either is stopping to apply eye-drops or they have memorized that section and have their eyes squeezed shut, it is the easiest key change because these two keys are actually exactly the same: the keys of F sharp and G flat. The use of “equal temperament” has made the term “enharmonic” meaningless in the modern tuning, but the music notation lives on to blind poor starving musicians who don’t even have medical insurance and can’t afford their coke-bottle glasses.

Some musicians have begun to try to use the real older enharmonic modes, which are any modes that change the usual distances between the notes. At the Oberlin Conservatory there is an organ which has two black keys between every two white keys so that at least the sharps and flats have some differences in them (tuned in a compromise tuning). There are 17 notes in the octave on that organ. String instruments and singers have much less of a problem tuning Medieval modes.

Usually the “enharmonic” modes change the usual order of the major seconds, either putting two larger major seconds together at the beginning of a tetrachord, or reversing the larger major seconds so that the scale begins with the smaller of them.

**Phrygian Mode is very different in Western European and Byzantine scales:**

**(Western European) Phrygian Mode:** another “mirror” scale in bottom and top tetrachords. Sometimes sounds minor, sometimes major, because it sounds like a harmony more than melody. It is hard to tell the difference between this mode and Ionian in modern tuning. (In the Greek tuning, this is not a “mirror” scale, or with usual half-steps.) The half-steps are between 1 and 2, and then 5 and 6.  $16/15 \times 9/8 \times 10/9 \times 9/8 \times 16/15 \times 9/8 \times 10/9 = 2$   
 E (1/2) F G A B (1/2) C D E Not exactly the order of intervals  
 $16/15 \times 9/8 \times 10/9 \times 9/8 \times 16/15 \times 9/8 \times 10/9 = 2/1$  in Ionian and Dorian: compare them. (The scale above reverses 9/8 and 10/9 between 3&4, 4&5, so that the intervals are more usual. Starting from the first note in the scale, the intervals would be: 16/15, 6/5, 4/3, 3/2, 8/5, 9/5, 2/1. If the 3&4 and 4&5 are not reversed, the scale would be: 16/15, 9/8, 9/8, 10/9, 16/15, 9/8, 10/9. Starting from the first note in the scale, the intervals would be: 16/15, 6/5, 27/20, 3/2, 8/5, 9/5, 2. Notice that 27/20 is not the same as the 4<sup>th</sup>, which is 4/3. Finding a common denominator, 27/20 is 81/60 and 4/3 is 80/60, so the Phrygian 4<sup>th</sup> is sometimes slightly sharp compared to the usual 4<sup>th</sup>. In the Greek mode, this is an “enharmonic” scale, which means that all the notes have a different tuning and sound than the usual “diatonic” scale. The Greek scales are described later, with an analysis of the “moria” or 72 divisions of the octave that are used in modern times to approximate them.)

**Byzantine Tone 3, “Phrygian,” Enharmonic Family:**

The “Third Tone” mode is named Phrygian for Mercien, son of Gnadius of Phrygia, a flute player, who was hung and flayed by Apollo, probably just a person named “Apollo.” (Savas p. 66). It has the character of “arrogance, bravery, and mature air.” The scale begins on “F,” and is also similar to the Western European “Lydian” in the first two intervals. The fourth, or “B,” is flat, however, so that the interval between the 4<sup>th</sup> and 5<sup>th</sup> is still a whole step. The seventh (E) below the first note (F), is natural, and there is a half-step between E and F. Above the lower tetrachord, in the upper tetrachord, is the same as the diatonic scale.

F G A B flat C D E F  
 $12 + 12 + 6 + 12 + 12 + 10 + 8 = 72$  (“8” is really closer to 7.)  
 $9/8 \times 9/8 \times 256/243 \times 9/8 \times 9/8 \times 10/9 \times 16/15 = 2/1$   
 [enharmonic intervals] [link] [diatonic intervals with a wide sixth]

(Or, starting at the first note of the scale, the intervals are: 9/8, 81/64, 4/3, 3/2, 27/16, 15/8, 2/1. This is considered to be the “Pythagorean” scale by some, with the strange 81/64 which is sharp compared to the major third. Also notice that the interval between A and B flat or the 3<sup>rd</sup> and 4<sup>th</sup> is a very strange interval, a little smaller than the 6 moria of the Byzantine scale. Although it is a perfect interval, it will not sound very pleasing. The sixth is the slightly sharp 6<sup>th</sup> found in the “Ionian” scale. The B is always flat in this scale, which we would call the “key of F” in modern terms, but the tuning is not “equal tempered,” and the sound is not like the modern “key of F,” making this an “enharmonic” scale. The major third that begins the scale will be slightly sharp compared to the major third (5/4). Sometimes the large first interval, the first major second, is achieved by making the F or first note slightly flat. This creates a slightly sharp 7<sup>th</sup> in the scale, and would change the distances to every other note as well: see the Barys tone below.)

### **Western European Locrian mode**

Added later in Western Europe, according to some sources. (Later is relative here; it means that in some places, Locrian was not used at all, or not until the Baroque era.) Half-steps are between 1 and 2, then 4 and 5, with a flat 5<sup>th</sup>; almost the opposite of Western Lydian, and very modal.

$16/15 \times 9/8 \times 10/9 \times 16/15 \times 9/8 \times 9/8 \times 10/9 = 2$

B (1/2) C    D    E (1/2) F    G    A    B

1 **16/15** 2 **9/8** 3 **10/9** 4 **16/15** 1 **9/8** 2 **9/8** 3 **10/9** 4

(Or, starting from the first note, the intervals are: 16/15, 6/5, 4/3, 64/45, 8/5, 9/5, 2/1.)

(The flatted fifth in the Locrian mode, or 64/45, is slightly more sharp than the sharp fourth of the Western Lydian scale, which is 45/32. Using common denominators, 64/45 is 2048/1440 and 45/32 is 2025/1440. Usually, a half-step sharp is not the same as a half-step flat. The two usual minor seconds, both 16/15 if they are together, are 256/225. This is sharper than as either the 9/8 major second or the 10/9 major second. Finding a common denominator for all of them: 256/225 is 2048/1800, 9/8 is 2025/1800, and 10/9 is 2000/1800. Therefore, a half-step between notes might be 16/15 times 25/24 in the case of steps between 10/9, or 16/15 times 135/128 in the case of 9/8. Since the intervals 25/24 and 135/128 are unusual, then the half-step minor seconds used as accidentals between intervals might be smaller than 16/15, as they are approximated in the Greek moria system. One such arrangement of half-steps between 9/8 would be 17/16 times 18/17. One such arrangement of half-steps between 10/9 would be 19/18 times 20/19. These half-steps are also unusual, which is why Medieval music usually did not use “accidental” sharps and flats, unless an entire scale was changed a little in the descending scale, or the mode was a “plagal” mode using the intervals of the original mode it was related to. Although “mean temperament” fixed this problem a little bit, and “equal temperament” simply makes all of the half-steps the same size, these tunings change all of the modes so that they no longer have their original emotions... which is explained below in the “Barys” mode of the Greek tuning.

“Equal temperament” is the closest to the “Barys” mode, which is an “enharmonic,” not a “diatonic” scale, and the Barys mood is low sounding and confident, unlike the true Ionian which is more subtle and humble. In modern music we would say that the “Barys” is a key that begins on a flat note.)

### **Byzantine Tone 7, “Hypophrygian,” Plagal of the 3<sup>rd</sup> Tone, or Barys Tone, “Enharmonic” family:**

This tone is thought of as having a manly character and strength of melody. (Savas p. 68). The term “Barys” means low, as a “Baritone” means a man who sings in a low voice range. The barys tone uses some intervals which are strange. The Diatonic Barys is not the same as the Western Medieval “Locrian” mode. Barys can start on three different notes, which means that it contains inside it three different scales, and is more like three modes at once, mixed on one composition:

1) Barys “Enharmonic” starts on the fourth (F) and is just like Tone 3 “Phrygian,” and this time the “F” is always a little flat, or “Barys.” The “B” is flat in this scale, just as in the Third Tone described above. The tuning may be better explained in the description of enharmonic Barys from the flatted B below, although the unusual part of the first Barys scale is at the bottom tetrachord, not the top tetrachord. (Savas does not give moria numbers for this scale.) (Since Savas does not describe the intervals at all for this scale, refer to the “Phrygian” scale above.)

2) “Diatonic” Barys does not have a flat “B,” and the notes in the upper tetrachord consist of a minor second, a Chromatic sounding smaller minor third jump, and another minor second, according to Savas’s first illustration of the moria on page 67 (although his later explanation is very different and does not have the jump at the same place) (8 moria 16/15 is actually 7 moria):

$$\begin{array}{cccccccc} \text{B} & \text{C} & \text{D} & \text{E} & \text{F sharp} & \text{G (jump)} & \text{A sharp} & \text{B} \\ 8 & + & 12 & + & 10 & + & 12 & + \\ & & & & 8 & + & 16 & + \\ & & & & & & 6 & = 72 \end{array} \quad (\text{“8” is closer to 7 moria.})$$

$$16/15 \times 9/8 \times 10/9 \times 9/8 \times 15/14 \times 7/6 \times 16/15 = 2/1$$

(Or, starting at the first note of the scale: 16/15, 6/5, 4/3, 3/2, 45/28, 15/8, 2/1. Notice that the minor sixth, or 45/28, is slightly sharp compared with the usual perfect minor sixth of 8/5.

Finding a common denominator for the minor sixths, 45/28 is 225/140, and 8/5 is 224/140.

Although the Byzantine moria description of the major seventh is sharp, this description is so that the moria numbers will add to 72. The main idea is so that the interval between F and G is slightly larger than the interval between A and B.

Since Savas says that the A is “attracted” to the B, it is possible that a smaller interval than 16/15 was used, and in this case the interval between the G and A would be still wider. In this case, the scale would be (8 moria 16/15 is closer to 7 moria):

$$\begin{array}{cccccccc} \text{B} & \text{C} & \text{D} & \text{E} & \text{F sharp} & \text{G (jump)} & \text{A sharp} & \text{B} \\ 8 & + & 12 & + & 10 & + & 12 & + \\ & & & & 8 & + & 16 & + \\ & & & & & & 6 & = 72 \end{array}$$

$$16/15 \times 9/8 \times 10/9 \times 9/8 \times 16/15 \times 85/72 \times 18/17 = 2/1$$

(Starting at the first note of the scale: 16/15, 6/5, 4/3, 3/2, 8/5, 17/9, 2/1. The interval 85/72 is wider than 7/6, which is 84/72 with common denominator of 72, a strange upper tetrachord.)

If the interval between A and B is very small, it is also possible to use 15/14 between the F and G, but the next interval, 476/405 is too strange an interval to put between the G and A. 17/9 is a sharp perfect major seventh which may be used in the “Diatonic Barys” scale. This would be close to the “equal tempered” major seventh, but only used for one of the “enharmonic” scales, and only then sometimes. (17/9 times 18/17 is 2/1.)

The fifth, or “F” is supposed to be “attracted” to the G, which usually would mean F sharp. On page 93, this seems confusing, but, because the major and minor seconds of a usual scale have a half-step between the “E” and “F,” the “F sharp” is actually the perfect fifth above the “B,” and therefore not a different scale given by Savas on page 93 than on page 67. It would be possible to play with other scales using “double sharps” etc., but those were ancient scales, and not used much in the Medieval era. The confusion caused by the usual half-steps of E to F and B to C, especially when accidental sharps and flats are added in the chromatic scales, may have caused the confusion of the names of some of the modes such as “Lydian.”

[This illustrates that, it is possible that this scale was easy to confuse. The conflict with the different scales in the “Lydian” or “Tone 2” mode may have been similar; in order to understand the note jump, the jump may have been moved to another location. If the F sharp is mistaken for an F double sharp, *not* a Medieval scale, but it is an ancient scale:]

$$\begin{array}{cccccccc} \text{B} & \text{C} & \text{D} & \text{E (jump)} & \text{F double sharp} & \text{G sharp} & \text{A sharp} & \text{B} \\ 16/15 & \times & 9/8 & \times & 10/9 & \times & 6/5 & \times \\ & & & & 16/15 & \times & 9/8 & \times \\ & & & & & & 25/24 & = 2/1 \end{array}$$

[(Or, starting from the first note of the scale, 16/15, 6/5, 4/3, 8/5, 128/75, 48/25, 2/1. Notice that the “F double sharp,” (Fx), is the same as the “G natural,” but that the other notes in the scale are a half note sharp, and that these sharps are more sharp than usual. The “A” is very sharp, with a

smaller interval to the starting “B” even than in equal temperament. The choice of 9/8 between G sharp and A sharp is so that the ratios are more usual, instead of becoming less usual with larger numerators and denominators, and so that these intervals sound pleasing next to each other.)]

3) “Enharmonic” Barys from the flatted B is based on the “B flat” and is called the “key of B flat major” today. The scale is of “two like enharmonic tetrachords” (Savas p. 68) with flats on the B and the E, as follows: B flat, C, D, E flat, F, G, A, B flat. This is closest to an Ionian scale in modern “equal-temperment” tuning (see the interesting relationship of the “Bach’s” to the moria above), but when a scale is moved from one key to another in perfect tuning, the notes will not sound exactly like a “major” scale. Savas does not describe the moria divisions for this scale, but he does use the Greek letter names, so assuming that a scale beginning on D would normally be “Dorian mode” with that tuning, I simply put those intervals and flatted the B and E. Perhaps that is just as well that Savas did not try to describe the moria, as his moria description of “Diatonic Barys” resulted in two very different scales, one with a G flat and the other with an F sharp on different notes of the scale. Using some of the intervals of the “Dorian” mode, a possible tuning, just switching the intervals between D and E with E and F, and the intervals between B and C with A and B:

B flat	C	D	E flat	F	G	A	B flat
10/9 )	X 9/8	X (16/15	X 10/9 )	X 9/8	X 9/8	X (16/15	= 2

(Or, starting from the first note,  
 10/9, 5/4, 4/3, 40/27, 5/3, 15/8, 2/1.)

And, yes, this is an enharmonic scale. The fifth above the starting note is a little flat as in the descending Aeolian mode; the bottom tetrachord has the smaller of the major seconds for the first interval between the first and second notes, not between the second and third notes as in the “Ionian” scale. The upper tetrachord is still more strange, with the two large major seconds together between the fifth and sixth and sixth and seventh, although the notes of the scale come out sounding like usual intervals but with an unusual mood. Perhaps this is the intention of the bottom tetrachord of the Third Tone enharmonic scale that Savas tries to describe. It will be much more interesting than a familiar modern scale with equal half-steps, and therefore no difference between the keys. (The enharmonic scales illustrate why an instrument with perfect tuning needs more adjustment than a simple adding of either sharps or flats to change keys.)

### The Usual Moria and Rational Intervals in a scale

(The way I calculated all the moria was, first finding 1 moria:

$2x^y(1/72)=1.00967353322851086219252140111861$  (using copy and paste for the long number when transferring it to this page). Then, that number  $x^y$  the number of moria. The  $x^y$  button on the calculator makes the number multiply by itself the number of times specified. There are other “Perfect” intervals not listed. To find frequencies in cycles per second, multiply times a known frequency, such as low “C” = 256 times the decimal number for the interval. The frequency of 256 cycles per second has a wavelength of about 4.4 feet at room temperature. The number 256 equals  $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$ , or eight octaves above a very low note. That very low note would have a wave-length of 1129 feet at room temperature, describing the distance of sound, perhaps the original “mile” of 1000 paces, but now a little over a fifth of a mile. At different temperatures, sound travels at different speeds, which might account for the

difference in distance. The note of thunder or a “sonic boom” when the “sound barrier” is broken at the moment when the speed of sound is passed might be this low note, although these notes might be the “Doppler effect” and not the wavelength of the speed of sound.)

A **Perfect Octave** is the ratio of  $2/1$ , or “2” in every rational and irrational, ancient, Medieval and modern musical system. **All musical systems are based on the Perfect Octave.** (An octave above the low “C” or 256 cycles per second, is 256 times 2, or 512 cycles per second, also called “middle C.”) **72 moria is: 2.** The octave is the **only rational** interval in the Greek moria system, or any other equal-temperment system. Even so, the moria often don’t exactly add to 72 in a scale because the moria actually represent more perfect intervals that aren’t exactly those moria numbers, so the system contains its own “fudging” problems.

71 moria is: 1.98083829493365251296603717899343 (irrational)

70 moria is: 1.96186017533782986940831147306182 (irrational)

69 moria is: 1.9430638823072117374865788316425 (irrational)

68 moria is: 1.92444767378829027927468160332778 (irrational, 4 moria under the octave.)

$48/25$  is 1.92 (rational). This is the **very sharp major seventh** found in the “Diatonic **Barys**” scale. After comparing different possible scales with the description of the “Diatonic Barys” scale given on page 93 of Savas’ book, together with the description of the sharp major seventh, this seems to be the only possible interval that fits the requirements for that scale. ( $48/25$  times  $25/24$  is  $2/1$ .)

67 moria is: 1.90600982441791542033966282093294 (irrational)

$17/9$  is 1.8888888 repeating decimals (rational). This is a **slightly sharp perfect major seventh** and may be used in the “Diatonic **Barys**” scale. This is close to the “equal tempered” major seventh, but the other intervals in a scale using this major seventh would be too strange, and therefore it is not likely that it is actually used. ( $34/18$  times  $18/17$  is  $2/1$ .)

66 moria is: 1.88774862536338699328382631333507 (irrational), the “equal tempered” major seventh (11 irrational half-steps of the modern equal tempered scale), and is sharp. There is an audible difference between this sound which is very harsh and the perfect major 7<sup>th</sup>. Modern Byzantine choirs use this irrational interval (6 moria under the octave, or 66 moria), although the older chanters use the slightly flatter perfect 7<sup>th</sup>.

$32/17$  is 1.882352941176470588235294 repeating decimals (rational). A **slightly sharp perfect major seventh** which may be used in the “Diatonic **Barys**” scale. ( $32/17$  times  $17/16$  is  $2/1$ .) This is probably not used, because the ratio of  $34/18$  is closer to the moria numbers for the Barys tone major seventh, if the moria are close to being accurate.

$15/8$  is 1.875 (rational) **Perfect Major Seventh**, if the next minor second to complete the octave will be  $16/15$ , which is the usual interval for the “half-steps” in a perfectly tuned scale. (Another way to express  $15/8$ : the fifth  $3/2$  times the major third  $5/4$ , which equals  $15/8$ . The sound is powerful but harmonious, which might be a reason that it is the Indian note of fire.)

65 moria is: 1.86966238416407893487841625405064 (irrational, 7 moria under the octave).

39/21 is 1.857142857142857 repeating (rational) (The Byzantine **Lydian upper seventh**, which is between a major and minor seventh.)

64 moria is: 1.85174942457458085840938192153953 (irrational, 8 moria under the octave).

63 moria is: 1.83400808640934246348708318958829 (irrational, 9 moria under the octave).

62 moria is: 1.81643672538880638485581340282457 (irrational, 10 moria under the octave).

9/5 is 1.8 (rational) (**Perfect minor seventh**, if the next major second to complete the octave will be 10/9.)

61 moria is: 1.79903371298701521968857776237515 (irrational, 11 moria under the octave).

60 moria is: 1.78179743628067860948045241118103 (irrational, 12 moria under the octave).

16/9 is 1.77777777 repeating decimal (rational) (**Perfect minor seventh**, if the next major second to complete the octave is 9/8, found in **Dorian** mode.)

59 moria is: 1.76472629779968638797272483510021 (irrational)

58 moria is: 1.7478187153790539405624214321281 (irrational)

57 moria is: 1.73107312201228605339018443755598 (irrational)

56 moria is: 1.71448796570614566176607011083207 (irrational)

55 moria is: 1.69806170933681403779988760708987 (irrational)

27/16 is 1.6875 (rational) (**Slightly sharp perfect major sixth** in the **Ionian** and Western Lydian modes.)

54 moria is: 1.68179283050742908606225095246643 (irrational)

5/3 is 1.6666666 repeating decimal (rational) (The usual **Perfect Major Sixth**, in the **Dorian** and **Mixolydian** modes, if the next minor third to complete the octave is 6/5.)

53 moria is: 1.66567982140698854382652707849107 (irrational)

52 moria is: 1.6497211886706050089421684970901 (irrational)

51 moria is: 1.63391545324109984367824405041208 (irrational)

39/24 is 1.625 (rational) (The perfect **Byzantine Lydian slightly lower sixth**, between the major and minor.)

415/256 (Another major sixth is 1.62109375, rational, if C is 256 cycles per second and A is 415 cycles per second, a common **Baroque tuning for "A."** This happens to be a perfect ratio, but is unusual, not in any Medieval or Greek scale as far as I could figure out, unless the Baroque "C" is not 256.)

50 moria is: 1.61826115023192312696393705779486 (irrational)

45/28 is 1.607142857142857... repeating (rational) (The perfect but **unusual minor sixth** in the diatonic "**Barys**" Greek scale, just slightly sharp compared to the usual perfect minor 6<sup>th</sup>.)

49 moria is: 1.60275682879138695035186766380562 (irrational)

8/5 is 1.6 (rational) Usual **perfect minor sixth**, if the Major third to complete the octave is 5/4.

48 moria is: 1.58740105196819947475170563927231 (irrational)

128/81 is 1.580246913580246913 repeating (rational) (The **flat but perfect minor sixth** sometimes used in the **Aeolian** descending scale.)

47 moria is: 1.57219239657828728553695254498996 (irrational).

46 moria is: 1.55712945307289370302816119480075 (irrational).

45 moria is: 1.54221082540794082361229186209073 (irrational).

44 moria is: 1.52743513091464318388133874971854 (irrational).

43 moria is: 1.51280100017136105617465196930365 (irrational).

3/2 is 1.5 (rational) **Perfect fifth**.

42 moria is: 1.4983070768766814987992807320298, an irrational number. (“Equal tempered” Fifth, multiply the equal tempered minor second times itself seven times: 1.4983070768766814987992807320298 the same as modern Greek Fifth.)

41 moria is: 1.48395201772371539799182071552534 (irrational).

40/27 is 1.48148148 repeating (rational) (The **perfect** but **slightly flat fifth** in the **Aeolian** descending scale and also the Barys enharmonic scale.)

40 moria is: 1.46973449227559885138420869818332 (irrational).

39 moria is: 1.45565318284218735435511556146793 (irrational).

38 moria is: 1.44170678435793136119838959813247 (irrational).

37 moria is: 1.42789400426092190253064156225768 (irrational).

64/45 (half-step flat from the perfect fifth, or 1.422222 repeating, rational, in Western Locrian)

36 moria is: 1.4142135623730950488016887242097 (irrational).

45/32 is 1.40625 (rational) (half-step sharp from a fourth, actually a whole step over the wide major third, found in the Western Lydian mode.)

35 moria is: 1.40066419078158411717423779530009 (irrational).

34 moria is: 1.38724463372120862541284011655567 (irrational).

33 moria is: 1.37395364745808910177665574774974 (irrational).

32 moria is: 1.36079000017437696425568037532481 (irrational).

27/20 is 1.35 (rational, the sharp fourth sometimes found in the Western Phrygian scale.)

31 moria is: 1.34775247185408878583549105907543 (irrational).

30 moria is: 1.33483985417003436483083188118445 (Irrational; Bach's Fourth, multiply his minor second times itself five times: 1.33483985417003436483083188118445 is the same as the modern Byzantine Fourth.)

$4/3$  is 1.33333333 repeating decimal (rational) **Perfect fourth**.

29 moria is: 1.32205095037182812070297490455364 (irrational).

28 moria is: 1.3093845751749734361791509600851 (irrational).

27 moria is: 1.29683955465100966593375411779245 (irrational).

26 moria is: 1.28441472611871163057969955331048 (irrational).

25 moria is: 1.27210893803633151226338489849189 (irrational).

$81/64$  is 1.265625 (rational), **larger than a Major Third**, this is  $9/8 \times 9/8$ , and is the **enharmonic wide third** found in the Byzantine **enharmonic** modes, and also Western Lydian. Some say that this is the Pythagorean third, found by going up only in fifths, then dropping the intervals to a lower octave. ( $81/64$  is closest to 24 moria in size.)

24 moria is: 1.25992104989487316476721060727823 which is an enharmonic wide major third (12+12) found in enharmonic Byzantine modes. (Bach's Major Third, familiar on a piano, multiply his minor second times itself four times. The Bach major thirds are intervals that are so wide that they belong in an enharmonic, not a diatonic, mode. It is slightly less than the rational enharmonic Major third, but closer to the enharmonic than the Perfect Major third. This is the brassy sound we think of as "major," too aggressive for the Ionian and Mixolydian modes.)

$5/4$  is 1.25 (rational) **Perfect Major third**, which is  $9/8 \times 10/9$ . Some say that this is the Ptolemaic third. (This is the closest to the approximation intended by the Byzantine moria 12+10, with some fudging. Since the perfect rational third is well known, it is assumed that it was used, rather than the flatter 12 + 10 moria. See the note under 22 moria. This interval is closer to 23 moria, but audibly less than the 24 moria of the equal-tempered Major third.)

23 moria is: 1.24784993211238894670850930473044 (irrational).

$26/21$  is 1.238095238095 repeating (rational) (The perfect **Byzantine Lydian interval** between a major and minor third, close to the Byzantine moria. The Lydian intervals are guesses, but some of the Lydian intervals are much easier to calculate. See the Lydian scale as worked out.)

22 moria is: 1.2358944659292892811918856605529 (irrational) (12+10), which is the first major third in the Byzantine Mixolydian and Ionian modes. This moria description is very flat, but the 12 is closest to the larger major second, and the 10 is closest to the smaller major second.

21 moria is: 1.22405354330465523913216021682604 (irrational).

20 moria is: 1.2123260668135445364260418308265 (irrational) (Found in the Plagal 2<sup>nd</sup> Byzantine mode, or Tone 6.)

19 moria is: 1.20071094954528142722093965150491 (irrational).

6/5 is 1.2 (rational). **Perfect Minor third**, same as  $9/8 \times 16/15$ .

18 moria is: 1.18920711500272106671749997056048 (irrational); Bach's minor Third, multiply his minor second times itself three times: the Bach thirds are the intervals that are closer to the enharmonic intervals. This interval is rarely if ever used in the Byzantine or any Medieval system.)

32/27 is 1.185185185 repeating, rational (flat **minor third** - in **Dorian and Aeolian** scales.)

17 moria is: 1.17781349700247900725696725951116 (irrational).

7/6 is 1.1666666666 etc. (rational) (**Perfect** interval between the Minor Third and Major Second. Found in Byzantine 7<sup>th</sup> Tone or "**Barys**" diatonic scale, according to one description, although another description is different.)

16 moria is: 1.16652903957611658089369263466067 (irrational). (Found in the 7<sup>th</sup> Tone, or "**Barys**" according to one description.)

15 moria is: 1.15535269687227301024533709868194 (irrational).

14 moria is: 1.14428343305973517715675197960117, (irrational) closer to the perfect interval below this. (Found in Byzantine 2<sup>nd</sup> Tone or "**Lydian**.")

8/7 is 1.142857142857, repeating decimals, etc. (rational) Perfect interval between the Minor Third and Major Second, not usually used. Found in **Byzantine Lydian**.

13 moria is: 1.13332022223143606561629714785171 (irrational).

9/8 is 1.125. (rational). **Perfect Larger Major Second**. First whole step, and between 4<sup>th</sup> & 5<sup>th</sup>.

12 moria is: 1.12246204830937298143353304967918 (irrational). (Bach's Major Second, multiply his minor second times itself two times; 1.12246204830937298143353304967918, same as the larger Byzantine Major Seconds.)

11 moria is: 1.11170790495043673643277239422772 (irrational).

10/9 is 1.1111111 (etc. rational). **Perfect Smaller major second**, the second whole step of Mixolydian and Ionian scales.

10 moria is: 1.10105679545314306934580208895145 (irrational).

11/10 is 1.1 (rational) Perfect Interval, not usually used.

9 moria is: 1.09050773266525765920701065576071 (irrational).

12/11 is 1.09090909090909 , repeating decimals, rational Perfect Interval, not usually used.

13/12 is: 1.0833333333 (etc.) (rational). Perfect interval, in Byzantine Lydian scale.

8 moria is: 1.0800597388923061698729308312886 (irrational).

14/13 is 1.076923076923 (rational repeating decimals) Perfect interval - Byzantine Lydian scale.

15/14 is 1.07142857142857, repeating decimals, rational). Perfect Interval, in Byzantine Lydian.

7 moria is: 1.06971184580696084631350706045429 (irrational)

16/15 is 1.0666666 (etc.) (rational) Perfect Minor Second used in the half-steps of most scales.

17/16 is 1.0625 (rational) Perfect interval, rare, not usually used.

6 moria is: 1.05946309435929526456182529494634 (irrational) (Bach's irrational "equal tempered" system of twelve equally distant intervals: Minor second: 1.05946309435929526456182529494634, the same as the Byzantine 6 moria in Phrygian mode.)

18/17 is 1.05882352941176470588235294117647 (etc. repeating, rational). Perfect interval, only used in Barys tone occasionally.

256/243 is 1.0534979423868312757201646090535, which repeats eventually, rational. This is the half-step in one enharmonic scale, similar to the Byzantine 6 moria. See the Phrygian scale.

5 moria is: 1.04931253468789891767012723399896 (irrational).

26/25 is 1.04 (rational). Perfect interval, rare.

4 moria is: 1.03925922603184339971013008316729 (irrational).

27/26 is 1.0384615384615 (etc. repeating, rational). Perfect Interval, rare.

3 moria is: 1.02930223664349202878237180077392 (irrational).

52/51 is 1.019607843137254901960784313725490 (etc. repeating; rational). Perfect, rare if ever.

2 moria is: 1.01944064370214482816981563263103 (irrational).

53/52 is 1.0192307692307692307 (etc. repeating. rational.) Perfect, rare if ever used.

105/104 is 1.00961538461538461538461538461538 (etc. repeating, rational). Perfect, rare.

Byzantine 1 moria ( $72^{\text{nd}}$  root of 2) is: 1.00967353322851086219252140111861 (irrational).

106/105 is 1.00952380952380952380952380952381 (repeating, rational). Perfect, but not used.

1/1 or 1.0 or 1 (rational). The first "fundamental" note. Multiply this, or any other decimal above, times the number of the cycles per second (frequency) of a pitch. So, if C is "1," then start with C 256, and multiply all of the rational fractions of a scale times 256. In this way, the pitches of the scale from 256 to the octave 512 (which is  $256 \times 2/1$ ) may be found. In actual performance, only an approximation of pitch is approached, and ornaments will slide between notes. However, the mood of a piece will be defined better if the melody returns to the actual pitches of a scale again and again. Listen to the actual pitches on the "scala" program.

The modern alphabet scale is actually related to the Greek scale: when we talk about the modes, the scale that starts on 6 is the “plagal” (plagiarized, or imitation) mode of the scale that starts on 2. (Byzantine music uses ancient modes, and influenced the West.) The lower notes in pitch are lower on this page.

Number Intervals (Major scale, starting on “C”)	Modern & European Alphabet (without “accidentals” that is, no sharps or flats)	Greek and Byzantine Alphabet (no “accidentals”) and abbreviations		Indian syllables	Medieval and Modern Italian syllables	
8 ( <u>half-step</u> )	C	eta	nec	sa	ut	do
7 (whole step)	B	zeta	zo	nec	-	(ti)
6 (whole step)	A	epsilon	ke	dha	la	la
5 (whole step)	G	delta	the	pa	sol	sol
4 ( <u>half-step</u> )	F	gamma	ga	ma	fa	fa
3 (whole step)	E	beta	vou	ga	mi	mi
2 (whole step)	D	alpha	pa	re	re	re
8 or 1 ( <u>half-step</u> )	C	eta	nec	sa	ut	do
7 (whole step)	B	zeta	zo	nec	-	(ti)
6 (whole step)	A	epsilon	ke	dha	la	la
5 (whole step)	G	delta	the	pa	sol	sol
4 ( <u>half-step</u> )	F	gamma	ga	ma	fa	fa
3 (whole step)	E	beta	vou	ga	mi	mi
2 (whole step)	D	alpha	pa	re	re	re
1	C	eta	nec	sa	ut	do

Indian names of great lights and elements: Fundamental (Sa), Sun (Pa or Fifth), Moon (Ma or Fourth), Water (Re or Second), Earth (Ga or Third), Wind (Dha or Sixth), Fire (Nec or Seventh). In each scale the melody revolves around two emphasis notes that give it a unique character. Compare the Tschickovsky “Sleeping Beauty” waltz with “Dies Irae:” major or minor? This is why a scale might be a faster melody of another mode; depending on what notes are emphasized.

