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DIATONICISM IN EASTERN  
& WESTERN ROMAN CHANT:

A Reconsideration  
of the Tonal Material

by

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A THESIS SUBMITTED IN PARTIAL  
FULFILLMENT OF THE REQUIREMENTS  
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in

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This thesis is dedicated to all my teachers. Especially to the loving memory of Lycourgos, Master of Masters; and to Demetrios Lekkas and Angelice, without whom I would not be who I am. To Ioannes Arvanites, the first to show me into the early history of chant, and to Constantinos Angelides for teaching me tempo, patience, and discernment. To my supervisor, Archon Mousikodidaskalos of the Great Church of Christ, Alexander Lingas, for his generosity, constant help, and endless patience. To the memory of my father Vassileios, for his aesthetic sense; and for teaching constant effort. To my mother, for her eternal unconditional acceptance. To my sister, for her love. To my grandfather Vassileios, for his silence. To my grandmother Stamatina, for her style.

I should like to extend my sincere thanks to the examiners of my doctoral viva committee, Professors Charles Atkinson and Alexander Khalil, for their thorough reading of my thesis' draft, and their insightful critique of its structural and other limitations. Their guidance, along with my supervisor's, has been of inestimable value to this work. Special and heartfelt thanks to Christos Christodoulou for his unwavering and prompt assistance in the aesthetically impeccable transcription of the troparia into staff notation; and to philologist At. Helioti-Baroufa for her extensive proofreading. I should also like to express my profound gratitude to the administrators and members of the online forum *Analogion* (*Ψαλλολόγιον*) for their generous and disinterested contributions of material and knowledge over the past two decades. It is greatly to their credit that they have inspired—and continue to inspire—critical reflection and scholarly debate, even on the most subtle questions of psaltic theory and practice.

And thank you, Claudia Molitor.

## ABSTRACT

This doctoral thesis addresses a central epistemic problem in the study and performance of Byzantine chant: how to reason responsibly about intervallic structure in a musical tradition transmitted predominantly through oral practice, preserved in notational systems that do not encode pitch with quantitative precision, and described by theoretical sources that are historically layered, heterogeneous, and often prescriptive only in retrospect. At the core of the study lies the proposal that the diatonic intervallic system articulated in the nineteenth century—specifically that of Chrysanthos of Madytos—may function as a legitimate and historically grounded reference tuning for the performance of selected medieval Byzantine repertoires, rather than as a direct reconstruction of medieval intonation.

The thesis argues that diatonicism must be understood not as a single fixed scale, but as a historically mobile family of intervallic structures shaped by perceptual constraints, arithmetic reasoning, and performance practice. We trace this family through time from Greek antiquity through Byzantine, Arabic, Persian, and Ottoman theoretical traditions, identifying Ptolemy's *ὁμαλὸν διάτονον* as a fundamental tuning model integrating numerical proportionality with melodic smoothness. Preserved and developed within this Eastern Mediterranean inheritance as a form of diatonicism including three-quarter-tone step structures, it became in the nineteenth century the default diatonic configuration of the New Method of Byzantine chant theory articulated by Chrysanthos of Madytos.

Within this framework chromaticism may arise not only through the introduction of non-diatonic intervals, but also through rearrangement of the same diatonic intervallic

values. A parallel logic appears in the medieval Latin West, where some theorists, increasingly committed to octave-based scalar systems and their associated hexachordal pedagogy, came to regard deviations from a purely diatonic octave framework as chromatic, even when the underlying intervallic sizes remained diatonic. This departure from ancient Greek genus-based definitions of chroma establishes a reconfigured concept of it, one implicit but not explicitly theorised in Byzantine sources of the nineteenth century, and here articulated as a central methodological contribution.

The study further argues that the ratio-based framework of the Chrysanthine intervallic system preserves structural, perceptual, and modal principles continuous with earlier Eastern Mediterranean traditions, including the persistent use of neutral interval regions. While not claimed as an authoritative witness to medieval practice, the system is advanced as a *least-wrong*, historical tuning suitable for controlled analytical and performative testing in the absence of definitive historical evidence.

This proposal is evaluated through performance-oriented staff transcriptions of selected thirteenth- and fourteenth-century heirmoi and stichera in the Second Modes, particularly from the Koukouzelian tradition. The analyses demonstrate a high degree of continuity in melodic contour, ambitus, cadential articulation, and modal syntax across medieval and neo-Byzantine sources.

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## LIST OF ABBREVIATIONS AND SYMBOLS

In this study, all intervallic ratios are expressed using fractional notation with a slash (e.g.,  $3/2$ ) rather than a colon (e.g., 3:2), in accordance with modern mathematical convention. Also, a very conservative system of Latin transliteration is adopted for Greek terms and names, except in the case of certain modern scholars, for whom standard academic transliterations are retained for the sake of clarity and citation consistency.

*Malako*/soft chroma/tic: the re-arranged set of diatonic intervals, which Chrysanthos uses as his “A” chromatic scale for byzantine chant (as opposed to the *sklero*/tense or hard chromatic scale, “B” in Chrysanthos)

Jl: just or pure intonation

PB: Palaeobyzantine notation (following ecphonetic signs, neumatic notation in its earliest stage; 10<sup>th</sup>–12<sup>th</sup> cc.)

MB: Middle Byzantine or Round notation (following PB, precise in notating rhythms and musical intervals, the neumes carry an intervallic charge with which every next note is detected, still pitch-non-precise; 12<sup>th</sup>–19<sup>th</sup> cc.)

NM: the notational reformation developed by Chrysanthos, the “New Method” (a simplified solmization version of MB, bearing characteristics of a post-enlightenment educational approach; 19<sup>th</sup> c. –)

T: interval of a major tone

ST: interval of a semitone

$\frac{1}{4}$ -tone or  $\frac{1}{4}$ -T: interval of one-quarter of a major tone

$\frac{3}{4}$ -tone or  $\frac{3}{4}$ -T: interval of three-quarters of a major tone

♭: reversed flat of a quarter of a major tone

#: equal-temperament sharp of a semitone

b: equal-temperament flat of a semitone

In the approximative Chrysanthine theory, which uses the commas system (alternatively known as *moria*):

- the octave generally equals 68 commas in Chrysanthos, with the exception of the “A” (soft) chromatic scale of 64 commas, corrected to 68 by Chourmouzius (see Chapter 4)
- the perfect fifth equals 40 commas
- the perfect fourth equals 28 commas
- the major tone of 9/8 equals 12 commas
- the minor tone of 12/11 equals 9 commas
- the minimum/lesser tone of 88/81 equals 7 commas

APPROXIMATIVE CORRESPONDENCE  
OF THE ZARLINIAN (JUST DIATONIC) SCALE NOTES  
AND THE CHRYSANTHINE (BYZANTINE DIATONIC)

C	D	E♭	F	G	A	B♭	c
do	Re	mi♭	fa	sol	la	si♭	do'
ne	Pa	vu	ga	di	ke	zo'	ne'





## Chapter 0

## INTRODUCTION

Modern debates about Byzantine intonation have often narrowed to the question of whether medieval chant contains *chromaticism*. This project began as an inquiry into the status of chromatic intervals in medieval Second Mode repertoires and its relation to the received traditions of Byzantine chanting embodied in the New Method. The investigation quickly showed that the problem cannot be posed coherently without previously specifying what *diatonic* means in each theoretical context and what kinds of diatonic organisation are historically plausible.

Our investigation encompasses harmonic theory; not because Byzantine chant is derived from, governed by or explained by ancient Greek musical theory — but because ancient theory is actively present, selectively reused, and recontextualized within Byzantine culture. In Troelsgård's view, Byzantine chant stands not as a continuation of ancient Greek musical theory, but as an autonomous vocal-liturgical practice within which ancient theory survives in transformed, selective, and pedagogically recontextualized forms.<sup>1</sup>

Troelsgård states that Byzantine theorists were not trying to reconstruct ancient Greek music, but not only the medieval mathematical musical treatises (be it Roman, Arab or Frankish) constantly use the ancient Greek harmonic theory and intervallic ratios as

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<sup>1</sup> Christian Troelsgård, "Ancient Musical Theory in Byzantine Environments," *Cahiers de l'Institut du Moyen-Âge Grec et Latin* 56 (1988): 228–238. Troelsgård identifies the Hagiopolitan treatises as the closest point of contact between chant and ancient theory.

a point of reference, but also nineteenth-century theorists, as the so-called *Three Teachers* (Chrysanthos of Madytos, Chourmouzius the Archivist and Gregorios the Protopsaltes, the three inventors of the reforming New Method for music notation by order of the Ecumenical Patriarchate of Constantinople) employ ancient Greek musical terms in their work.

Methodologically, the thesis combines historical musicology, modal/intervallic analysis, and performance-oriented testing, informed by comparative Eastern Mediterranean theory and practice of psalmody, as well as basic acoustical constraints.

Therefore, Chapters 1-2 establish the historical preconditions for the tuning problem by showing that diatonicism is not limited to a single scale, but is a family of intervallic models shaped by different priorities (mathematical, perceptual, instrumental, and vocal). The Eastern Mediterranean trajectory still preserves asymmetric and neutral-step diatonicisms capable of producing chromatic colour without positing an independent chromatic genus; this provides the conceptual basis for treating Chrysanthos' diatonic genus as a plausible reference system rather than a late aberration (Chapters 4-5). The Western reception (Chapter 3) increasingly privileged monochordal interval-definition and, later, notational pitch discretization; however, staff notation itself did not entail a single default tuning until the nineteenth-century normalisation of equal temperament.

The separate survey, undertaken in Chapter 4, concerns the scholarly literature on the existence and function of chromatic intervals in medieval chant repertoires. This discussion is not intended to be exhaustive, nor does it aim to resolve the question of chromaticism in itself. Rather, it serves to indicate the depth and persistence of the

intervallic problem, since chromatic intervals function here primarily as a point of departure. Their contested status in the sources and in modern scholarship helps to expose the broader indeterminacy surrounding intervallic realisation in medieval chant traditions.

In the rest of this Introduction we shall be covering necessary Definitions; the Literature Review, in order to frame the intervallic problem by exposing the instability of “diatonic” and “chromatic” terminology, the diatonic consensus institutionalised by the *Monumenta Musicae Byzantinae* series, its orientalist assumptions, and subsequent revisionist approaches; the Scope and Methodology of thesis; the Chapter Outline of the thesis; and finally the Aim and Contribution section, where we articulate a methodological originality: reframing chroma, applying least-wrong inference, and producing examinable performance propositions.

## Definitions

According to Alexander Lingas, the term *Byzantine music* is most commonly used to denote the eastern Mediterranean and Balkan traditions of monophonic Christian chant of the Byzantine rite; more broadly, however, it may refer to the full range of musical activity—practical and speculative, sacred and secular—cultivated within the Eastern Roman Empire centred on Constantinople.<sup>2</sup>

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<sup>2</sup> Alexander Lingas, “Music,” in *The Oxford Handbook of Byzantine Studies*, ed. Elizabeth Jeffreys, John Haldon, and Robin Cormack (Oxford: Oxford University Press, 2008). Needless perhaps to highlight here that the term “Byzantine chant” is employed throughout this study in accordance with established scholarly convention. The label itself, however, is historiographical rather than historical, applying a modern designation to a tradition whose practitioners did not identify themselves as “Byzantine” but as Romans (Ῥωμαῖοι). This anachronism, long recognised in Byzantine studies, does not invalidate the term’s analytical usefulness, but it does warrant a degree of conceptual caution: see Anthony Kaldellis, *Romanland: Ethnicity and Empire in Byzantium* (Cambridge, MA: Harvard University Press, 2019), 1–15; Averil Cameron, *Byzantine Matters* (Princeton: Princeton University

For Jørgen Raasted, who offers a more narrowly focused definition stressing historical continuity, Byzantine chant designates the unaccompanied vocal music of the Greek Orthodox Church originating in the Middle Ages and transmitted in an unbroken tradition to the present, rendering the political rupture of 1453 musically insignificant.<sup>3</sup>

The notational tradition of Byzantine chant developed through a long and internally differentiated historical process, documented in a substantial body of manuscripts from the tenth century onward. Early stages of notation were fundamentally adiastematic, functioning not as precise pitch records but as mnemonic signs intended to support an already existing oral tradition. Ekphonic notation, associated primarily with the chanting of biblical readings, represents one such early layer, indicating vocal gesture, accentuation, and delivery rather than melodic detail. These early

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Press, 2014), 1–8; Cyril Mango, “Byzantium : The Empire of New Rome,” in *The Oxford History of Byzantium*, ed. Cyril Mango (Oxford: Oxford University Press, 2002), 1–16.

<sup>3</sup> Jørgen Raasted, “Chromaticism in Medieval Byzantine Chant,” *Cahiers de l’Institut du Moyen-Âge grec et latin* 53 (1986), 15; cf. Kenneth Levy and Christian Troelsgård’s definition for the 2001 *New Grove* entry on “Byzantine Chant:” “Music of the liturgical rite of the Christian Roman Empire of the East from the time of the establishment of Constantinople (at the site of ancient Byzantium) in the early 4<sup>th</sup> c. and persisting beyond the interruption of the Eastern imperial succession by the Ottoman conquest in 1453. The rite is still practiced by tens of millions of Eastern Orthodox Christians whose native language, or liturgical language, is Greek. Through translation into Syriac, Coptic, Arabic, Armenian, Georgian, Church Slavonic and other languages, it has remained the dominant liturgy of the Christian East during the past 1500 years. Its influence at various times has spread as far west as Spain (in the 6<sup>th</sup> c.), and to north-east and south Italy (where isolated pockets still exist). It has prevailed in north-east Africa (Patriarchate of Alexandria), throughout Greece and Palestine (Patriarchate of Jerusalem), through most of the Christian Near East (Patriarchate of Antioch), all Russia, other Slavonic nations and Romania. The main focus of the following discussion is the music of the Greek rite before the fall of Constantinople. The Byzantine chant continued, however, to flourish after this event, specifically in monasteries throughout the former empire and at the patriarchal see of Constantinople. Almost all the medieval chant repertory survives in manuscript sources with musical notation, and in this respect Byzantine chant is wholly comparable to the repertories of the Roman and Ambrosian (Milanese) Churches in the West.” From Kenneth Levy and Christian Troelsgård (2001), “Byzantine chant,” in *The New Grove Dictionary of Music and Musicians*, 2nd ed., ed. Stanley Sadie and John Tyrrell (London: Macmillan), vol. 4, 734–735.

systems presuppose a trained singer and a stable performance practice, with notation operating as a reminder rather than an autonomous musical text.<sup>4</sup>

From roughly the tenth to the nineteenth centuries, Byzantine chant notation developed through two major historical phases reflecting two decisive changes in the logic of musical writing: (1) the shift from adiaSTEMATIC to fully diastematic notation, and (2) the shift from mnemonic shorthand (stenography) toward increasingly analytical “explanatory” writing.<sup>5</sup> The earliest phase, Palaeobyzantine notation (10<sup>th</sup> c.–late 12<sup>th</sup> c.), survives chiefly in two related families, the Hagiopolite/Coislin and the Athonite/Chartres traditions: both are fundamentally adiaSTEMATIC systems, i.e., their neumes function primarily as memory-aids that indicate melodic contour and formulaic movement but do not specify intervallic size with precision, so that performance remains strongly dependent on oral transmission. Coislin is generally more concise and economical (built from a limited set of core signs and their combinations), whereas Chartres is more complex, employing a larger repertory of compound symbols; yet the two share enough signs and principles to indicate a common origin. From the late twelfth century onward, these palaeobyzantine families converge historically into Middle Byzantine (“Round”) notation (12<sup>th</sup> c.–mid-19<sup>th</sup> c.), which becomes decisively diastematic in the Byzantine sense: neumes now encode the *intervallic distance from the immediately preceding pitch* (a relative intervallic

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<sup>4</sup> See Maria Alexandrou, *Palaeography of Byzantine Music* [Undergraduate textbook] (Kallipos, Open Academic Publications, 2017) (Αλεξάνδρου, Μ., *Παλαιογραφία Βυζαντινής Μουσικής* [Προπτυχιακό έγχειρίδιο], Κάλλιπος, Άνοικτὲς Ἀκαδημαϊκὲς Ἐκδόσεις, in Greek), <https://hdl.handle.net/11419/6487>, 52–54; Levy and Troelsgård, “Byzantine chant,” *The New Grove Dictionary of Music and Musicians*.

<sup>5</sup> The summary presented in this paragraph is derived primarily from: Alexandrou, *Palaeography of Byzantine Music*, 55–58; Troelsgård, *Byzantine Neumes*, 1–15; and Antonopoulos’ brief synthesis in <https://www.psaltikon.com/blog-3/byzantine-chant-notation>. The foundational studies of Oliver Strunk and Egon Wellesz, though written from earlier methodological perspectives, remain historically significant for establishing the systematic study of Byzantine musical sources and for shaping the subsequent scholarly discourse on Byzantine chant and its notation: Oliver Strunk, *Essays on Music in the Byzantine World* (New York: W. W. Norton & Company, 1977), and Egon Wellesz, *A History of Byzantine Music and Hymnography*, 2nd rev. and enl. ed. (Oxford: Clarendon Press, 1961; first published 1949).

script, rather than staff-based pitch-precise placement as in Western notation). Middle Byzantine notation is thus capable of transmitting the melodic skeleton with much greater reliability, while still leaving rhythm, ornamentation, expressive execution, and micro-intervallic nuance partly implicit and governed by oral tradition (including practices such as cheironomy). In the post-Byzantine period, especially from ca 1670 onward, the notation undergoes a strong tendency toward exegesis (analytical expansion), preparing the way for the reform of 1814/15.

The notational reform of the “New Method” reorganizes notation on a more explicitly intervallic and analytical basis. Although this reform increased the capacity of notation to transmit melodies with greater self-sufficiency, it’s role was not to displace oral tradition; rather, it reconfigured the relationship between memory and writing in the direction of pedagogical clarity and standardization. In this sense, Byzantine musical notation across its stages reflects shifting balances between oral transmission and analytic representation.<sup>6</sup> Regarding the validity of experimentation with the chrysanthine intervals to interpret repertoires notated in the Middle Byzantine Notation, which we essentially propose, Christian Troelsgård’s handbook under the title *Byzantine Neumes* carefully mentions that “the New Method treatises contribute some valuable information about the tradition of the post-byzantine period, and this is one of the sources we can use for establishing a plausible picture of the state of affairs in earlier times.”<sup>7</sup>

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<sup>6</sup> Alexandrou, *Palaeography of Byzantine Music*, 58–60; cf. the relevant study Gregorios Th. Stathis, *Τὰ Πρωτόγραφα τῆς Ἐξηγήσεως εἰς τὴν Νέαν Μέθοδον Σημειογραφίας* [The archetypes of the exegesis into the New Method of notation], vols. A–B (Athens: Ἴδρυμα Βυζαντινῆς Μουσικολογίας, 2016).

<sup>7</sup> Christian Troelsgård, *Byzantine Neumes: A New Introduction to the Middle Byzantine Musical Notation*, *Monumenta Musicae Byzantinae, Subsidia* 9 (Copenhagen: Museum Tusulanum Press, 2011), 24.

## Literature Review

### *On the intervallic problem in the performance of the medieval repertory*

In the course of our investigation it became evident that chromaticism could not be addressed responsibly without first establishing what, in each historical and theoretical context, counted as *diatonic*—and in particular which *varieties* of diatonic organization were at stake.

This gradually redirected the focus away from a narrowly Pythagorean model of “ditonic” diatonicism and toward a different diatonic paradigm—one rather under-examined that appears with notable persistence from Ptolemy, through medieval Arabic theorists, and ultimately into the reformulation of Chrysanthos in the nineteenth century. What emerged was that this particular diatonic configuration, when rearranged or reinterpreted within later theoretical frames, could readily be construed as *chromatic* (and in the 19<sup>th</sup>-c. theoretical work of Chrysanthos of Madytos is indeed designated as such), despite its construction from intervallic material that is fundamentally diatonic.

Consequently, the relationship between diatonicism and chromaticism began to appear less as a categorical opposition than as a shifting interpretive boundary—one that is deeply dependent on theoretical premises, naming conventions, and patterns of scalar reorganization. Costin Moisil in a 2003 short article cautions that the terms *diatonic*, *chromatic*, and *enharmonic* circulate in Byzantine-music scholarship in at least three non-equivalent senses: (1) Western tonal theory (pitch organization within a chain of fifths), (2) the Aristoxenian tetrachordal genera, and (3) later psaltic classificatory usage (including New Method descriptions and patriarchal measurements). Claims that Byzantine chant “is” chromatic, or “became” chromatic,

are therefore methodologically incomplete unless they specify which definition is intended, since the same intervallic behaviour may appear diatonic in one frame and chromatic or enharmonic in another.<sup>8</sup>

This conceptual instability is already visible in standard reference writing. According to Kenneth Levy and Christian Troelsgård's summary<sup>9</sup> of the prevailing scholarly compromise, the medieval Byzantine tonal organization was "basically diatonic," while allowing that some passages—especially in Second-Mode repertoires—may have been performed with chromatic colour. It also stresses the evidential limits of late medieval treatises, which were often written for singers already trained in oral practice and are consequently imprecise about "the exact tuning of scales." Most importantly for the present thesis, *Grove* links the appearance of explicit notational markers for chromatic alteration to the nineteenth-century reform: "New, special signs were introduced for chromatically altered intervals."<sup>10</sup>

Prompted by this combination of (i) a default diatonic consensus, (ii) recurrent suggestions of second-mode chromatic colour, and (iii) the absence of secure quantitative pitch information in medieval notation, the thesis proceeds by treating

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<sup>8</sup> Costin Moisil, "Diatonic, cromatic, enarmonic. Observații privind intonația în muzica bizantină," in *Acta Musicae Byzantinae V* (2003), 51-55: Moisil further notes that attempts to establish medieval chromaticism generally proceed along two research paths, each with significant limitations. One approach presupposes Western-style diatonic scales and searches the manuscripts for anomalous scale degrees, constitutive augmented seconds, or microintervals that would fall outside a diatonic organization; yet such investigation remains uncertain because explicit descriptions of musical scales only appear with clarity in the 19<sup>th</sup> c. The other approach begins from the chromatic and enharmonic scales described by Chrysanthos and seeks evidence that these were in use before 1800; however, Moisil cautions that continuity of melodic formulae in manuscript transmission cannot, by itself, demonstrate continuity of intonation, since pitch realization may vary across locations, institutions, and singers, and may change historically with relative speed. Indeed, he suggests that under favourable circumstances even two generations could suffice to alter an intonational system, given the social authority of influential elite singers and the mechanisms through which their practice can become normative. Most importantly, Moisil proposes that the underlying problem may lie not in the labels diatonic/chromatic/enharmonic, but in the inadequacy of fixed-scale models for describing a fundamentally vocal and orally transmitted musical practice.

<sup>9</sup> Levy and Troelsgård, "Byzantine chant," paragraph (ii) Middle Byzantine notation.

<sup>10</sup> *Ibid.*, paragraph (iii) The New Method ('Reformed' or 'Chrysanthine' notation).

chromatic intervals not as a primary datum to be “found” in manuscripts, but as a diagnostic problem that forces clarification of the relevant diatonic frameworks and their historically plausible variants. We treat diatonicism not as a fixed scalar category but as a historically variable spectrum of intervallic configurations, extending in some cases to include micro-intervals (such as neutral or three-quarter-tone steps) that modern scholars, particularly within Western theoretical frameworks, may perceive or classify as “chromatic.” In this sense, chromatic colour is understood as capable of arising internally from diatonic structures through processes of asymmetry, rearrangement, and perceptual effect, rather than requiring the introduction of a distinct chromatic genus. This position differs fundamentally from models such as those in which chromaticism is defined categorically and systemically—typically through phenomena such as transposition or scalar reconfiguration—rather than as an emergent property of diatonic intervallic organisation.

Therefore, what follows is a survey on the literature concerned with the nature of diatonicism in the medieval eastern orthodox chant repertories, correlating to a parallel debate on the existence of chromatic intervals. It is not exhaustive, but it will help our understanding of the intervallic problem in general; the chromatic intervals serve only as a starting point to proceed in the next chapters to an investigation of diatonicism as well.

This section sets out the methodological terrain within which the intervallic problem of medieval Byzantine chant has been debated in modern scholarship. It first outlines the transcriptional principles established by the *Monumenta Musicae Byzantinae*, especially the emergence of a practical diatonic consensus grounded in staff notation and in a manuscript-centred approach that often treated later Greek tradition as

discontinuous and affected by “Oriental” influence. It then follows the gradual revision of this position through later twentieth-century challenges—both Greek and Western—concerning accidentals, medial signatures, and the interpretive role of oral tradition. Finally, it introduces a cluster of modern methodological responses as representative strategies for handling the limits of Middle Byzantine notation in relation to tuning, chromatic colour, and the reconstruction of intervallic practice.

*On the Monumenta Musicae Byzantinae series' principles: the diatonic consensus and the politics of transcription*

Classicist and expert in Byzantine musicology Henry Julius Wetenhall Tillyard (1881-1968) argued that medieval Byzantine theoretical evidence for the tonal system is scanty: the Papadikai anthologies provide little beyond modal nomenclature, and even major figures such as medieval Eastern Roman theorist Manuel Bryennius are more concerned with ancient Greek theoretical schemes than with contemporary practice. He therefore interpreted Bryennius's modal system as essentially diatonic (tones and semitones), treating distinctions between "greater" and "lesser" tones as largely theoretical, and contrasted this with Chrysanthos' later, explicitly measured and perceptibly differentiated intervallic framework."<sup>11</sup>

Both Oliver Strunk and Tillyard formed their conclusions in good faith on the basis of the evidence available to them, and—for the purposes of transcription and research—proceeded on the assumption of "normal tones and semitones." This approach was subsequently institutionalised by the editors of the *Monumenta Musicae Byzantinae* (the foundational project for Byzantine chant studies established by Christian Høeg, Henry Julius Wetenhall Tillyard, and Egon Wellesz; hereafter MMB),<sup>12</sup> and later maintained by Jørgen Raasted (Høeg's successor at the University of Copenhagen), who will be discussed in the next pages.<sup>13</sup>

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<sup>11</sup> Noted in the 1916/1917-1917/1918 British School of Athens *Annual* from Tillyard Henry J. W. Tillyard, "The Modes in Byzantine Music," *Annual of the British School at Athens* 22 (1918): 149.

<sup>12</sup> *Monumenta Musicae Byzantinae* is an international scholarly series founded in 1935 under the auspices of the Union Académique Internationale and directed by a consortium of scholars primarily based in Copenhagen. Its aim is to produce critical editions, transcriptions, studies, and facsimiles of sources related to Byzantine chant and musical theory from Late Antiquity through the post-Byzantine period. The series includes notation manuals, theoretical treatises, musical manuscripts, and modern analytic studies, and is considered the authoritative corpus for the academic study of Byzantine musical heritage. Official website of the MMB Project: <https://mmb.ku.dk>

<sup>13</sup> Jørgen Raasted, *Intonation formulas and modal signatures in Byzantine musical manuscripts*, *Monumenta Musicae Byzantinae*, Subsidia 7 (Copenhagen: Ejnar Munksgaard, 1966), 7.

Maria Alexandrou mentions that the scholars under influence of Tillyard's *Handbook* assumed a discontinuity in chant tradition after the fall of Constantinople connected with a strong oriental influence, and a lively debate ensued between Western musicologists and Greek scholars and chanters during the early- to mid-twentieth century, specifically on the subject of transcription.<sup>14</sup>

By the 1930s the *Monumenta Musicae Byzantinae* (MMB) had reached a broad working consensus on the transcription of medieval Byzantine chant melodies: the *megalai hypostaseis* (“great signs”) were generally omitted from transcriptions;<sup>15</sup> the Second Modes (authentic and plagal) were interpreted within a diatonic framework; Western notation was treated as adequate for microtonal nuance; and the received Greek tradition was frequently characterised as the product of later “Oriental” accretions. Consequently, the principal evidentiary basis became the medieval manuscript record and theoretical treatises—sources that necessarily provide only a restricted view of intonational practice.

The transcriptional philosophy adopted by the MMB board is succinctly articulated by Tillyard in the concluding section of the MMB’s letter on the politics of transcription:

*We may reasonably assume that in some Byzantine melodies, particularly those of Oriental origin, chromatic or enharmonic mutations may have occurred. The Manuscripts give, as a rule, no indication of such practices, and we should accordingly, in the line of our musical text, disregard them. But, where the transcriber considers any alteration probable, this may be marked*

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<sup>14</sup> Maria Alexandrou, *Studie über die ‘grossen Zeichen’ der byzantinischen musikalischen Notation unter besonderer Berücksichtigung der Periode vom Ende des 12. bis Anfang des 19<sup>th</sup> c.*, PhD dissertation, 3 vols. (University of Copenhagen, 2000), 11f.

<sup>15</sup> Raasted cites Henry J. W. Tillyard, *Handbook of the Middle Byzantine Musical Notation*, *Monumenta Musicae Byzantinae*, Subsidia 1 (Copenhagen, 1970), 52; Tillyard developed a polemic against the “great signs” because they were “enigmatic and accidental,” and because their transmission into the present indicated a deterioration of the tradition; see Jørgen Raasted, “Thoughts on a Revision of the Transcription Rules of the *Monumenta Musicae Byzantinae*,” *CIMAGL* 54 (1987): 30.

*by an accidental above the staff. Fuller study of the Byzantine musical theorists will, it is hoped, clear up the remaining uncertainties on this point.*

*Signed:*

*Carsten HØEG, Copenhagen.*

*H. J. W. TILLYARD, Cardiff.*

*Egon WELLESZ, Vienna.<sup>16</sup>*

A few years later, Strunk published his seminal study “The Tonal System of Byzantine Music,”<sup>17</sup> which was among the first to articulate an assumption that would prove critical for later staff-notation transcriptions of medieval Byzantine chant. Strunk frames his intervention with notable directness: “This study then is a re-opening of the question. If its conclusions are old, its basis, at least, is new. It makes no attempt to reconcile the modal systems of medieval and ancient Greek.”

On the one hand, Strunk was careful enough not to limit the system to tonal and semitonal steps, when he interpreted the description of the medieval musical anthologies *Papadikai*:

The precise nature of the steps within this series remains for the present unknown; for all that we can learn from the *Papadikai*, the step  $\alpha$  [protos] to  $\beta$  [deuteros] may be a whole tone, a half tone, or some other larger or smaller interval. [...] If we may assume, however, that the interval  $\alpha$  [protos] to  $\delta$  [tetartos] is a perfect fourth – a reasonable assumption, to say the least, for a

<sup>16</sup> Published in Henry J. W. Tillyard, “Εωθινὰ Ἀναστάσιμα: The Morning Hymns of the Emperor Leo, Part II,” *Annual of the British School at Athens* 30-31 (1930–1931): 105–106.

<sup>17</sup> Oliver Strunk, “The Tonal System of Byzantine Music”, *The Musical Quarterly*, Vol. 28, No. 2 (Apr., 1942), 190-204.

tetrachordal system based on any other interval is virtually inconceivable – the interval  $\delta$  [tetartos] to  $\alpha$  [protos], as the difference between an octave and two fourths, becomes a whole tone and the remaining intervals fall readily into line.

In his Byzantine chant studies (collected in the *Essays on Music in the Byzantine World*)<sup>18</sup> Strunk never formulates an explicit theory of chromaticism, nor does he treat it as a distinct modal or scalar category; rather, his position emerges implicitly from a set of methodological constraints that effectively preclude most later scalar interpretations. He consistently rejects the identification of Byzantine modes with fixed scales, treating the *echoi* instead as melodic and functional categories defined by intonation formulas, cadential behaviour, and characteristic turns, and he understands Middle Byzantine notation as indexical and relational, presupposing an oral tradition rather than prescribing determinate pitch values. Within this framework, chromaticism can only appear as a local melodic effect—arising from expressive inflection, attraction, or modal colouring within an otherwise stable melodic grammar—and not as an autonomous genus legible from the notation itself. Strunk's refusal to posit chromatic scales or fixed chromatic intervals is therefore not an oversight but a principled stance: by insisting on the primacy of melodic behaviour and the descriptive, retrospective character of theory, he anticipates later critiques of scalar chromaticism without yet articulating them in the technical terms developed by Raasted and subsequent scholarship.

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<sup>18</sup> Strunk, *Essays*.

Tillyard while assuming a diatonic reading of the notation, allows however for the use of B flat, as it assists in avoiding the direct or indirect tritone between the notes F and B;<sup>19</sup> he nonetheless accepts some chromatic melodic passages, as well.<sup>20</sup>

The less flexible stance by Wellesz though suggests that even B flat should be rarely applied with the exception of the transposed fourth mode (due to its high original tessitura on d).<sup>21</sup>

The usual white-note transcriptions in staff-notation would appear as in the next Figure, a staff transcription of Mode 1 Trisagion by Neil Moran. Moran follows Wellesz's instructions, who rarely employed b flats to the staff, than Tillyard's, who allowed for a more frequent use of the b flat in order to avoid the triton.

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<sup>19</sup> Henry J. W. Tillyard, *Byzantine Music and Hymnography* (London: Faith Press, 1923; reprint, New York: AMS Press, 1970), 42. Also Tillyard, *Handbook*, 35; also Max Haas, *Byzantinische und slavische Notationen*, *Palaeographie der Musik I/2* (Cologne, 1973), 48.

<sup>20</sup> Tillyard, *Handbook* 35.

<sup>21</sup> Wellesz, *History*, 302.

Table VI

TRISAGION in echos Protos from Codex L

L f.55

ηχ. α Α γι ο ος .

ο θε ε ε ο ο ος . α γι ο

ος . ισ χυ υ υ πο ος . α α

α α γι ι ι ι ι ι ι ι

ο ο ο ο ος . α σα να

The image shows a musical score for the Trisagion in echos Protos from Codex L. It consists of five staves of music, each with a treble clef and a key signature of one sharp (F#). The music is written in a style that combines modern notation with traditional Byzantine neumes. Below each staff, the Greek lyrics are written in a stylized font. The lyrics are: ηχ. α Α γι ο ος ., ο θε ε ε ο ο ος . α γι ο, ος . ισ χυ υ υ πο ος . α α, α α γι ι ι ι ι ι ι ι, and ο ο ο ο ος . α σα να. The first staff is labeled 'L f.55'.

Fig.0.1. Transcription to staff by Moran from his *The Ordinary Chants*<sup>22</sup>

The MMB envisioned a high level of stylistic congruity between medieval Byzantine chant and early Latin plainchant,<sup>23</sup> while the purported discontinuity between

<sup>22</sup> Neil K. Moran, *The Ordinary Chants of the Byzantine Mass* Vol.II. Critical Edition. Verlag Der Musikalienhandlung K.D. Wagner, 1975, 53.

Byzantine and post-Byzantine practice owed to a biased orientalist view, according to which chromaticism identifies as an imposed set of foreign (Arab and/or Turkish) elements external and detrimental to the original tonal system.<sup>24</sup>

Charalambopoulos argues that Wellesz's interpretation of Byzantine chromaticism rests on an orientalist premise: Byzantine music is construed as "Semitic" in origin and therefore culturally remote from Greek tradition. He observes that this assumption shaped much Western scholarship, reinforcing two related axioms—an almost complete equivalence between Byzantine and Western chant, and an alleged post-1453 rupture caused by "Oriental" (Arab/Turkish) accretions, with chromaticism treated as their most conspicuous symptom. For Charalambopoulos, these premises reflect a failure to take living oral and written tradition seriously and are therefore in need of revision.<sup>25</sup>

The *Monumenta Musicae Byzantinae* suspended its *Scripta* series in 1958, thereby halting the systematic publication of staff-notation transcriptions; according to Raasted chief among the reasons, was the view that only a new set of transcription rules could make further publications possible.<sup>26</sup> A wholesome acceptance or denial of the "Byzantine chromatic modes" of the received tradition seemed to not work. Some years later Velimirovic would point out that

contrary to the Western European use of the term "Byzantine music," the Greeks to this day refer to the highly modified and richly chromatic chant used

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<sup>23</sup> As understood through the lens of the recent "restoration" of Solesmes: see Tillyard, *Handbook*, 13; Wellesz, *History*, 22. For Solesmes, see Pierre Combe, Theodore N. Marier, and William Skinner (2003), *The Restoration of Gregorian Chant: Solesmes and the Vatican edition* (Washington, DC: Catholic University of America Press).

<sup>24</sup> Wellesz, *History*, 22, 128.

<sup>25</sup> Nikos G. Charalambopoulos (2012), *Platonic Drama and Its Ancient Reception* (Cambridge: Cambridge University Press), ft. 179, pp. 236-237.

<sup>26</sup> See Raasted, "Thoughts on a Revision," 30.

in daily services as “Byzantine,” whereas Western scholarship considers the Medieval chant to have been diatonic.<sup>27</sup>

However, the preoccupation with identifying influence through putative Oriental accretions was widespread and not limited to non-Greek writers. Maureen Morgan in 1971<sup>28</sup> stressed the need for additional consideration on the theory of physic-mathematician Constantinos Maltezos, who examined the diatonic scale of Chrysanthos and posed grounded questions on its possible pre-dating of any Ottoman influence, but still called it “Turko-Greek.”<sup>29</sup>

*From MMB orthodoxy to revisionism: chromaticism, accidentals, and oral tradition*

Frank Desby in his dissertation gives a hint of an expanded diatonicism though by opening a possibility to more than one forms of it: “We have seen that Early and Middle Byzantine music was diatonic and that the tuning was either just, according to natural harmonics, Pythagorean, or close to some other “based” on antiquity, such as those tunings reported or contrived by Ptolemy (ca 140 AD) and other theorists.”<sup>30</sup> He also holds that avoiding accidentals in transcribing byzantine chant prior to the Turkish conquest of Constantinople in 1453 CE is a gross misconception, however he insists that “the oriental chromatics [sic] of the nenano [...] had to wait for the coming

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<sup>27</sup> Miloš Velimirović, “H. J. W. Tillyard, Patriarch of Byzantine Studies”, *The Musical Quarterly* LIV, no. 3 (July 1968), 342.

<sup>28</sup> Maureen M. Morgan, “The ‘Three Teachers’ and Their Place in the History of Greek Church Music”, in *Studies in Eastern Chant*. Vol.2, ed. Egon Wellesz and Miloš M. Velimirović (London & others: Oxford University Press, 1971), 86–99.

<sup>29</sup> Constantinos Maltezos, *Περὶ τῶν διατονικῶν κλιμάκων τῆς Ἑλληνικῆς ἐκκλησιαστικῆς μουσικῆς* [On the Diatonic Scales of Greek Ecclesiastical Music], *Praktika / Proceedings of the Academy of Athens*, 193? (digital item no. 7450), Ψηφιακή Βιβλιοθήκη Ακαδημίας Αθηνών. <https://digitalibrary.academyofathens.gr/archive/item/7450>.

<sup>30</sup> Frank H. Desby, *The Modes and Tuning in Neo-Byzantine Chant*, University of Southern California, 1974, 340-341.

of the Turks [...]. Just how it was tuned we have no idea.”<sup>31</sup> Elsewhere he mentions along the line of previous scholarship that “the chromatic character of nenano is not explicitly given in the theoretical treatises, but then neither are any of the tone – semi-tone progressions for the modes.”<sup>32</sup> He goes on noting that what we are provided with is only “subjective” descriptions (*sweetest, delicate, well-sounding phthora of nenano*) of writers such as Manuel Chrysaphes (wrongly referred to as a 16<sup>th</sup>-c. musician).<sup>33</sup> Interestingly, the insistence on the identity of a fixed augmented second with the chromatic genus’ tetrachord led Desby to cite Werner’s *The Sacred Bridge*<sup>34</sup> and its genealogy back (not mentioned exactly when) to the Jews of southeast Russia from which this mode was presumably carried to Central Europe.<sup>35</sup>

In a similar vein, Romanian musicologist Gheorghe Ciobanu in his article on the age of the chromatic genre in “byzantine” music,<sup>36</sup> discusses opinions which allow for the existence of chromatic genre in Byzantine music, but notes that, in Strunk’s spirit, the staff transcriptions of the published byzantine melodies used only diatonic intervals. Not independent of ideological bias concerning the chromatic intervals, he claims that from the seventeenth century onward, the number of chromatic melodies increases considerably, and these melodies are often marked with a maqām designation drawn from Turkish, Persian, or Arab musical practice. Partly on account of this, and partly because Byzantine and Gregorian chant continued to employ the ancient Greek modal denominations, it has been concluded that the Byzantine *echoi* originally made use

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<sup>31</sup> Ibid., 339.

<sup>32</sup> Ibid., 68.

<sup>33</sup> Ibid., 69.

<sup>34</sup> Eric Werner. *The Sacred Bridge: The Interdependence of Liturgy and Music in Synagogue and Church During the First Millennium*. London: Dennis Dobson, 1959.

<sup>35</sup> Desby, *Modes*, 68.

<sup>36</sup> Gheorghe Ciobanu, “Sur l’ancienneté du genre chromatique dans la musique byzantine,” in *Études de musique ancienne roumaine* (Bucarest: Editura Muzicală, 1984), 93-99.

only of the diatonic genus, while the chromatic genus is said to have appeared only after the Fall of Constantinople to the Turks.

In order to defend the thesis that a chromatic genus already existed in ancient Byzantine music, Ciobanu advances the following arguments: Hymnography—and with it Byzantine musical practice—was born in the cultural centers of the Middle East, that is, in a region where the chromatic genus plays an important role in folk tradition. Moreover, from the third century onward the Church protested against the use of this genus, though unsuccessfully, and by the ninth century it was compelled to recognize the existence of the *nenano* mode. Foreign as the chromatic genre might be to the practice of the peoples of the West, Ciobanu holds, the folklore of the peoples from south-eastern Europe, the Middle East and North Africa is however imprinted and still use it in traditional music. Finally, the lack of an explicit indication of the chromatic genus in early musical manuscripts may be explained by the imperfection of the notation; proof of this inadequacy can be found, for example, in the late appearance of the *nenano* phthora, and also in the fact that certain chants with liturgical texts from the second and sixth modes (second authentic and second plagal) have been transcribed, down to the present day, in chromatic style.

In the late 1970s, George Amargianakis challenged the Ottoman-influence narrative by defending a genuinely Byzantine chromatic genus involving an augmented second and by dismissing Wellesz's emphasis on "Turkishness" as ideologically biased. Referring to the often "stereotypically repetitive" papadic passages on modal succession, he accepts that they clearly map the placement of the modes onto the degrees of a diatonic framework (tones and semitones, whatever their precise sizes). However, he argues that these texts do not specify the internal intervallic structure of

each mode, nor its organising system (tetrachord, pentachord, diapason, etc.); this becomes known only through intonation (apechema/enechema), as implied by statements such as “ἐνήχημα δέ ἐστὶν ἡ τοῦ ἤχου ἐπιβολή.” Therefore, he concludes that such passages cannot be used as evidence for a strictly diatonic genus or against the chromatic genus.<sup>37</sup>

A few years later, an article on the analysis of the seventeenth-century musical setting of the troparion sticheron Τὸν ἥλιον κρύψαντα [Ton ilion krypsanta] by Gregorios Stathis was published in the limited series *Studies in Eastern chant*, the main Western journal on the Byzantine musicology.<sup>38</sup> This article marks a change in Western attitude toward the received tradition of the Byzantine chant and many Western musicologists, notably Raasted, started to admit that a diachronic approach has to be used.

Raasted represents an early Western attempt to accommodate the possibility of a distinct diatonic tonal framework while nevertheless allowing for the selective use of accidentals in the transcription of medieval repertoires, particularly chants from the Psaltikon. In this respect, Jørgen Raasted was among the first scholars to explore systematically whether medieval Byzantine chant might admit accidentals—or even, more radically, chromatic intervals in the strong sense of augmented seconds—in an

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<sup>37</sup> George Amargianakis, “The Chromatic Modes”, *XVI. Internationaler Byzantinistenkongress: Akten II/7 = Jahrbuch der Österreichischen Byzantinistik 32/7* (Vienna: Verlag der Österreichischen Akademie der Wissenschaften, 1982), 8.

<sup>38</sup> Gregorios Th. Stathis, “An Analysis of the Sticheron Τὸν ἥλιον κρύψαντα by Germanos, Bishop of New Patras [The Old ‘Synoptic’ and the New ‘Analytical’ Method of Byzantine Notation],” *Studies in Eastern Chant IV* (1979): 177–227.

effort to align more closely with Greek scholarly positions (such as Simon Karas, Grigorios Amargianakis, and Grigorios Stathis,) and with the existing oral tradition.<sup>39</sup>

In 1987, towards the end of his life, Raasted considered the idea of double readings of medieval melodies. In his “Thoughts on a Revision of the Transcription rules of the Monumenta Musicae Byzantinae”<sup>40</sup> he raises the possibility that a given melody could be realised in more than one intonational manner—diatonic (according to MMB) or chromatic—without altering its identity as a melodic line. He was triggered by some examples given to him by Coptic music scholar Ilona Borsai, the melodies of which, while performed by the same singer, in one take were performed in a diatonic manner, while in another in a chromatic. Borsai, according to Raasted suggested that “the chromatisation of a melody is a secondary phenomenon, just a “colour;” the important thing would then be the melody, not the interval sizes.” Relevant to this is Dalia Cohen’s research on the liturgical chant of Arab Christians in Israel; Moasil emphasizes that pitches in such traditions are not necessarily stable points but distributions around “polarizing” tones, with interval sizes fluctuating within limits.<sup>41</sup>

Peter Weincke pointed<sup>42</sup> to the medial signatures and phthorai, which are according to his reception the byzantine parallel to the western use of *musica ficta*; detecting therefore a common logic in the use of mi-fa accidentals and medial signatures he takes a strong anti-MMB stance making a case for byzantine *musica ficta* in the transcriptions and underlying the tetrachordal nature of the byzantine melos without further reference of such a scalar remark’s connotations.

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<sup>39</sup> Ioannis Arvanitis, “Phthora and Chromaticism in Early and Late Byzantine Chant” (unpublished paper, meeting of the international research group *Cantus Planus*, within the 17th International Congress of the International Musicological Society, Leuven, Belgium, August 1–8, 2002).

<sup>40</sup> Raasted, “Thoughts on a Revision,” 31.

<sup>41</sup> Moasil, “Diatonic, chromatic, enarmonic,” 54.

<sup>42</sup> Peter Weincke, “Some Observations on the Interpretation of Signatures and Accidentals in East and West,” *CIMAGL* 54 (1987): 61–72.

*The intervallic problem revisited: new approaches to tuning and chromatic colour*

Over the last decades, the study of Middle Byzantine notation has undergone a significant methodological reframing, particularly with regard to the question of tuning and intervallic measurement. Where earlier scholarship sometimes treated notational movement as sufficient evidence for identifying concrete scalar genera (diatonic, chromatic, enharmonic), recent approaches increasingly insist that the notation, though highly refined in melodic and structural signalling, does not in itself provide secure quantitative information about micro-intervallic size or temperament. This has shifted the debate from claims of direct reconstruction to a more cautious evaluation of competing interpretive models: how far later measured systems (above all the post-1814 Neo-Byzantine tradition) may be projected backwards, what kinds of inference are legitimate from palaeographic signs, and what role living psaltic practice and comparative modal frameworks may play in establishing “working tunings” that remain musically coherent. It is within this methodological landscape that the following positions—Arvanitis, Troelsgård, Alexandrou, Beyhom, and Lekkas—should be understood, each offering a distinct strategy for negotiating the limits of the sources while still accounting for the chromatic colour and modal behaviour that the repertory appears to require.

According to Arvanitis’ position medieval Byzantine chant was fundamentally diatonic, and its default modal organisation was “in principle” Pythagorean, in the sense that stable diatonic relations regulate the placement and interaction of the modes; for this reason, a diatonic framework constitutes the safest structural assumption for interpreting early notational evidence. From this standpoint, many modern “chromatic scale” readings appear methodologically weak, since

chromaticism is frequently inferred from graphic analogy (for example, the formal resemblance of *martyriai*) or from isolated palaeobyzantine signs such as *phthora*, rather than from musically coherent modal behaviour. This methodological problem is exemplified in Arvanitis' critique of Wolfram, where he argues that certain chromatic reconstructions demand contradictory tetrachordal assumptions and inconsistent scalar structures within the same piece, producing intervalllic "confusion" that finds no support in the repertory itself. Finally, Arvanitis maintains that chromaticism—where it genuinely occurs—need not be understood primarily as an "Oriental import," but can be interpreted as the result of internal historical development: over centuries, diatonic practice becomes softened in performance (from hard to soft diatonic), and in some cases, especially in second and plagal second, this process may develop augmented seconds and thus a specifically Byzantine chromatic colour, driven chiefly by the continuous force of praxis rather than by necessary external influence (in Chapter 4 and 5 we examine Arvanitis in greater detail).

Christian Troelsgård (long collaborator and present director, since 2017, of the editorial project MMB under the auspices of Royal Danish Academy) represents a mature stage of the MMB approach in contrast to earlier work associated with Tillyard. Troelsgård's handbook is the most recent addition to the studies relevant to the Middle Byzantine notation, dedicating some useful space to the problem of tuning. He identifies the ambiguity of the "step" as one of the central problems of interpretation and insists that it remains disputed how far back the Chrysanthine Neo-Byzantine modal system can be projected.<sup>43</sup>

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<sup>43</sup> Troelsgård, *Byzantine Neumes*, 23-4.

Alexandrou likewise emphasizes that micro-intervallic practice and genus-based scale structures cannot be confidently recovered from Middle Byzantine notation, since explicit measurements and systematic theoretical formulations appear only after the Reform of 1814–15, and staff transcription neither implies equal temperament nor reliably encodes microtonality; yet she argues that contemporary psaltic sound plausibly preserves a long-transmitted octoechos tradition that is stable in principle while flexible in realization, so transcription into staff should not be mistaken for an equal-tempered reading of medieval chant.<sup>44</sup> She notes, moreover, that microtonal accidentals are relatively uncommon in staff transcriptions of Middle Byzantine material, partly because systematic micro-intervallic measurement developed only later; accordingly, the question of micro-intervals in the Old System remains open. As a comparative anchor amid such uncertainty, she proposes that “natural” harmonic-series intervals offer a shared framework linking Byzantine modality to Eastern maqāmāt, medieval Western modal practice, and related systems.

Two exceptional modern cases—both to be examined in greater detail in Chapter 4—push the discussion beyond the entrenched polarities that have long governed debates on Byzantine tuning and chromatic colour: Beyhom situates Byzantine chant within a wider Eastern Mediterranean modal continuum shared with Arab and Ottoman traditions and argues that tuning cannot be reconstructed through theory alone, advocating instead a performance-oriented approach in which historically informed “working tunings” are judged by modal behaviour and perceptual stability rather than by claims of absolute correctness; polemically, he critiques what he sees as a Western-biased “zarlinisation” of diatonicism and argues that both Byzantinist and

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<sup>44</sup> Alexandrou, *Palaeography of Byzantine Music*, 413.

Orientalist scholarly habits distort analysis through ideological frameworks and arbitrary ditonic axioms.<sup>45</sup>

Lekkas, by contrast, resists the diatonic-versus-chromatic binary itself: neither reducing chromaticism to augmented seconds nor dismissing chromatic modes as late corruption, he proposes that for a part of the chromatic repertory, chromatic colour may arise internally from diatonic structure through asymmetry, scalar tension, and psychoacoustic mechanisms, including cochlear-perceptual illusion; in his published work<sup>46</sup> he develops this into a systematic model in which even strongly coloured modes remain architecturally diatonic, and “soft colour” emerges as an internal diatonic phenomenon rather than as chromatic genus insertion. By reframing chrōma as an emergent perceptual and structural condition rather than a fixed tetrachordal type, Lekkas offers a third interpretive pathway beyond entrenched polemics—a position that will be examined in detail in the Chapter 4.

### **Scope and Methodology**

The scope of the present thesis is deliberately limited in repertory, chronology, and analytical ambition. Its claims apply only to selected Second Mode repertories (authentic and plagal) whose melodic behaviour is demonstrably continuous with Neo-Byzantine Second Mode practice, thereby permitting controlled comparison

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<sup>45</sup> Amine Beyhom. “Byzantine Chant Theory and Practice in the Light of Ancient Greek Music Theory and Occidentism.” *Series Musicologica Balcanica* [Online], 1.1 (2020): 56-85. Web. 23 Feb. 2024; cf. idem, *Hellenism as an Analytical tool for Occidentism* (in *Musicology*) V2 (February 2017). NEMO-Online, 2017, 3 (5), 53-275. (hal-01447512v2)

<sup>46</sup> Demetrios Lekkas, “Η μαθηματική θεωρία της μουσικής” [The mathematical theory of music]. PhD Thesis, Athens: National University, 1995); idem, “Η διατονική βάση της βυζαντινής μουσικής: συστημική δομική προσέγγιση” [The diatonic basis of byzantine music: systemic structural approach]. *Πολυφωνία* 8 (Athens, 2006), 7-35; idem, “Βυζαντινό ‘μαλακό χρώμα:’ συστημική δομική προσέγγιση” [Byzantine ‘soft chroma’: systemic structural approach]. *Πολυφωνία* 17 (Athens, 2010), 139-165.

across medieval and later witnesses. The thesis therefore focuses on a circumscribed subset of chants that preserve stable modal grammar (ambitus, focal degrees, and cadential behaviour), and it does not generalise its findings either to the entirety of medieval Second Mode repertory or to Byzantine chant as a whole.

This thesis addresses an epistemic problem rather than a merely descriptive one: Middle Byzantine notation, even in its most mature medieval forms, is not a quantitative pitch script. It encodes relative melodic behaviour (direction, emphasis, formulaic identity, and cadence logic) within a culture of oral transmission. The consequence is underdetermination: more than one intonational realisation may be compatible with the same notated line. For that reason, the thesis does not pursue “reconstruction” of fourteenth-century interval sizes. Instead, it proposes a disciplined, testable way of approaching selected late-medieval Second Mode melodies through a historically grounded reference tuning—a framework designed to be *least-wrong* under conditions of limited evidence, not “perfectly true.”

Within this domain, the thesis holds constant a specific tuning hypothesis: the intervallic ratios articulated by Chrysanthos, applied in the Chourmouzian correction so as to preserve pure fourths and fifths (a necessity to facilitate performance) while retaining the characteristic soft diatonic(/chromatic) disposition. We thereby explicitly distinguish between chromaticism in the form of tetrachords featuring augmented seconds and wider definitions of diatonicism that include phenomena perceived by some in modern times – especially those with a background in common practice Western art music – as chromatic.

That reference is not treated as an anachronistic imposition, nor as a privileged witness to medieval practice, but as a historically stabilized system whose internal

intervallic logic can be tested against (a) the modal behaviour demanded by the medieval melodies, and (b) comparative Eastern Mediterranean constraints, including organological evidence. The methodological test is therefore: does this tuning sustain coherent Second Mode grammar—cadential intelligibility, degree hierarchy, and syntactic plausibility—across the selected medieval items without forcing ad hoc pitch decisions that contradict the melodic logic? Where it does, the model gains probabilistic weight; where it does not, it is rejected or limited.

The thesis draws on an extended investigation of Second Modes' repertoires in selected Heirmologion and Sticherarion manuscript sources from the thirteenth and fourteenth centuries, compared to corresponding nineteenth-century manuscript and printed book sources. From this broader investigation, the original transcriptions and performance-oriented modelling are concentrated in seven representative case studies (not intended to be exhaustive: three heirmoi, three stichera, and one kontakion), selected because (i) the overall ambitus and focal degrees align closely across medieval and later witnesses, (ii) cadences recur on the same structural tones with comparable approach patterns, and (iii) formulaic modules and syntactic turns remain recognisably related, even where medieval versions employ somewhat more frequent leaps than their Neo-Byzantine counterparts. These case studies are not presented as exhaustive, but as strategically chosen test points through which the proposed reference-tuning method can be evaluated under controlled conditions. In each case study, medieval notation is treated as encoding relative melodic behaviour rather than fixed pitch measurement. Intervallic interpretation proceeds indirectly, by applying the reference tuning as a constant framework and evaluating whether it sustains coherent modal behaviour (cadential intelligibility, degree hierarchy, and syntactic plausibility) without ad hoc pitch decisions.

Methodologically, the thesis proceeds through: (1) selection of chants on the basis of morphological continuity, (2) transcription of medieval witnesses, (3) alignment with later melodic witnesses for comparative orientation, (4) performance-oriented application of the Chrysanthine reference tuning in the Chourmouzian correction, (5) evaluation of modal coherence, and (6) formulation of testable transcriptional and performance propositions.

A fundamental premise of the present study is the non-identity between (i) theoretical formulations of intervallic structure, (ii) perceptual experience of intonation, and (iii) intonation as realised in vocal production. These three domains, although interrelated, do not coincide in practice. Middle Byzantine notation encodes relative melodic behaviour rather than quantitative pitch; theoretical treatises, whether ancient or post-Byzantine, articulate idealised intervallic schemes; and sung performance operates within flexible, context-sensitive pitch regions shaped by perception, training, and modality. Recent empirical research on vocal intonation—including work by Delviniotis and Panteli (see Bibliography)—has demonstrated precisely such divergences, showing that realised pitch does not reproduce theoretical systems in a mechanically exact manner but fluctuates within perceptually bounded zones. This condition of structural non-identity is not a limitation to be eliminated, but the starting point of the present methodology. It explains both the underdetermination of the medieval sources and the need for a controlled, historically grounded reference framework. The Chrysanthine system is therefore employed not as a reconstruction of medieval vocal intonation, but as a stable analytical and performative model whose plausibility is evaluated through its capacity to sustain coherent modal behaviour under these constraints.

The thesis is intentionally cautious in its claims. It does not attempt to reconstruct fourteenth-century pitch values, nor does it assume that the Chrysanthine system represents the only historically valid tuning for Second Modes' melodies. Instead, it proposes a disciplined and limited performance-oriented model whose plausibility can be judged by coherence and convergence, and whose conclusions remain proportionate to the evidence available.

### **Chapter Outline**

This thesis is organised into five chapters, each of which addresses a distinct but interdependent aspect of the central problem: how historically plausible intervallic frameworks may be constructed and evaluated for the performance of medieval Byzantine chant in the absence of prescriptive notational evidence. The progression of chapters reflects a deliberate movement from theoretical foundations, through comparative historical analysis, toward experimental performance-oriented testing.

**Chapters 1 and 2** provide the historical and theoretical groundwork by examining the concept of diatonicism from Greek antiquity through late Byzantium. Beginning with Pythagorean harmonics and proceeding through Aristoxenian empiricism and Ptolemaic systematisation, Chapter 1 demonstrates that “the diatonic” has never constituted a single, fixed intervallic system. Instead, it emerges as a field of competing theoretical models, shaped by differing priorities: mathematical elegance, perceptual plausibility, instrumental convenience, and vocal practice. By tracing the reception and transformation of these models in Byzantine and Arabic theoretical traditions, Chapter 2 establishes the historical depth and legitimacy of  $\frac{3}{4}$ -tone and neutral intervals. This historical plurality is essential for the thesis' later argument, as

it undermines the assumption that medieval chant must have operated within a uniform or strictly Pythagorean diatonic framework.

**Chapter 3** turns to the medieval Latin West, not as a parallel case study in chant, but as a contrasting solution to the same fundamental theoretical problem: how to stabilise pitch relations for sung repertoires. Through close examination of Boethius, Carolingian theorists, and the gradual emergence of pitch-specific notation, the chapter shows how Western theory moved toward increasingly prescriptive intervallic systems grounded in the monochord and, eventually, staff notation. This development is interpreted not as a natural or inevitable outcome, but as a culturally and institutionally conditioned response to pedagogical and political pressures. By highlighting the Western prioritisation of discrete pitch and scalar fixity, the chapter sharpens the contrast with Eastern traditions that continued to rely on oral transmission and modal behaviour. The purpose of this chapter is therefore not comparative synthesis, but methodological clarification: it delineates what Byzantine chant theory did *not* become, thereby reinforcing the plausibility of non-prescriptive intervallic models.

**Chapter 4** forms the theoretical core of the thesis by addressing the problem of intervallic reconstruction in medieval Byzantine chant under conditions of notational and historical under-determination. It situates the dissertation within ongoing debates over chromaticism and diatonicism, arguing that these disputes often depend less on recoverable pitch facts than on competing definitions of chroma itself. The chapter begins by examining modal signatures and phthorai—as functional indicators of modulation and tonal “corruption” relevant to the concept of chromaticism, expanding medieval modal practice beyond a strict octoechal framework. Against this background, the chapter turns to the nineteenth-century notational reform, and shows

that the New Method system of Chrysanthos of Madytos introduced a transformed understanding of chromaticism, in which chroma can arise from altered diatonic structures, rather than necessarily from augmented-second tetrachords—an interpretation further clarified through Georgios the Lesbian. On this basis, the tuning system articulated by Chrysanthos (major, minor, and minimum tones) is analysed not as a direct survival of medieval practice but as a historically referential ratio-framework that may function as a “least-wrong” model for experimental reconstruction. The chapter further examines how Chourmouziou Chartophylax and later theorists corrected Chrysanthos’ so-called “A” (soft) chromatic scale through re-ordering of Chrysanthine intervallic materials, producing a coherent tetrachordal structure while preserving its underlying ratios. Comparative evidence from Arabic, Persian, and Ottoman traditions—together with organological testimony—supports the broader claim that neutral and three-quarter-tone interval regions constitute long-standing structural features rather than modern anomalies. The chapter concludes by introducing observational error theory as a methodological justification for employing a later theoretical system as a historically grounded point of reference without collapsing into anachronistic reconstruction, while critically evaluating later standardising interventions such as the Patriarchal Committee of 1881.

**Chapter 5** tests the theoretical claims of the preceding chapters through close transcription and analysis of selected heirmoi and stichera around 1300 CE, associated with the Koukouzelian tradition. Circa 1300 is treated here as a watershed, since the manuscript evidence begins to reflect the emergence of the Koukouzelian “new style,” including Koukouzelian heirmologion traditions. This chapter does not aim to reconstruct medieval sound, but to assess whether a Chrysanthine soft diatonic or quasi-chromatic intervallic framework can sustain the modal behaviour, cadential

structure, and melodic syntax evident in the sources. Transcription is employed as an experimental space in which intervallic assumptions are evaluated against musical coherence rather than against notational literalism. By examining how modal centres, melodic attractions, and stepwise motion function under this framework, the chapter demonstrates both the possibilities and the limits of applying a historically referential tuning to medieval repertory. The thesis concludes by reflecting on the methodological implications of this approach for future research and performance practice, emphasising the value of controlled, historically grounded experimentation in the study of Byzantine chant.

### **Aim and Contribution of the Thesis**

At the core of this thesis lies the proposal that the diatonic intervals proposed in the nineteenth century may function as a legitimate and historically grounded reference tuning for the performance of selected Second Mode (*echos deuterios*) melodies of the medieval Byzantine repertory, particularly those transmitted from the Koukouzelian tradition (late 13<sup>th</sup> to early 14<sup>th</sup> cc.) onward. The thesis does not claim to reconstruct the medieval intonation in any definitive sense. Rather, it seeks to establish whether the Chrysanthine intervallic framework preserves structural, perceptual, and modal principles sufficiently continuous with earlier Eastern Mediterranean traditions to serve as a *least-wrong* model for historically informed performance practice today.

The thesis examines: (i) the conceptions of diatonic intervals diachronically through the Greek, Arab, Byzantine, and Ottoman traditions, and raises the questions (ii) under what conditions can diatonic structures generate chromatic perception; and (iii) whether Chrysanthos' measured system can function as a historically referential

tuning for specific late-medieval Second Mode melodies, judged by modal coherence and comparative constraints.

The thesis' major contribution is methodological and conceptual. It establishes and operationalises a historically grounded definition of chroma based on nineteenth-century Byzantine theoretical evidence (Chrysanthos, Chourmouzius, Phocaeus, and Georgios the Lesbian): *chroma* is not restricted to “chromatic genus” in the ancient Greek mathematical sense, nor reducible to the presence of augmented seconds. Rather, chromaticism can be additionally theorised as *any* deviation from the natural diatonic mother-scale, even when the intervals employed remain diatonic in size. This reframing matters because it explains why strongly “chromatic” perception may emerge from diatonic-like interval materials—precisely the phenomenon that repeatedly confuses both modern scholarship and practical transcription when it assumes that “chromatic” must mean “non-diatonic intervals.”

A second major contribution of the thesis is methodological. It advances a model of performance-oriented historical inquiry that treats Chrysanthos' tuning system neither as an anachronistic imposition nor as a direct witness to medieval practice, but as a coherent reference system whose intervallic logic can be tested against comparative theoretical evidence, organological data, perceptual constraints, and melodic behaviour preserved in medieval sources. By reframing Chrysanthine tuning as a referential rather than prescriptive system, the thesis provides a principled alternative to both strict diatonic reconstructions and speculative chromaticism unsupported by notational evidence.

A third contribution lies in the integration of interval theory, comparative modal studies (Greek, Arabic, Persian, and Ottoman), and close melodic analysis of

Byzantine chant. The thesis demonstrates that neutral and  $\frac{3}{4}$ -tone intervals—central to Chrysanthos’ diatonic and soft chromatic genera—are not late or arbitrary inventions, but acoustically stable and historically persistent features across Eastern Mediterranean musical cultures. By bringing these strands together, the study clarifies how chromatic perception may arise from diatonic-like structures without requiring the existence of a fully independent chromatic genus in Middle Byzantine notation.

Fourth, the thesis contributes the first sustained programme of performance-oriented testing of late-medieval Second Mode melodies under a Chrysanthine reference tuning, justified not by authority but by morphological continuity and comparative constraints. The claim is not that “this is how they sang,” but that for a delimited subset of melodies whose grammar persists, this tuning provides a musically coherent and historically plausible *working solution*—one that can be evaluated, reproduced, criticised, and refined. That examinability is the key: the thesis offers not taste but a method with constraints and failure conditions.

Fifth, the thesis introduces Observational Error Theory as an explicit epistemic warrant for historical tuning models. In measurement science, the aim is not perfect accuracy but minimisation and characterisation of uncertainty; historical musicology faces an analogous condition when sources underdetermine performance parameters. Applied here, the approach treats each tuning proposal as an “observational dataset” whose plausibility is judged by convergence: theoretical coherence, cross-traditional stability (notably of neutral intervals), organological feasibility, and success in sustaining the melodic behaviour of the corpus. This permits a rigorous “least-wrong” stance: Chrysanthos’ system is not assumed to be true; it is treated as a candidate that gains weight when it aligns resiliently with multiple independent constraints.

Sixth and closely related, is the thesis' refutation of the ideological and mathematical premises behind the 1881 Patriarchal Committee's attempted "correction" of Chrysanthos. The thesis shows that the Committee's method—mechanically applying a syntonic comma (also known as the Didymean comma; the amount by which Didymus corrected the Pythagorean major third,  $81/64$ , to arrive at the just major third, with the simpler epimoric ratio of  $5/4$ )<sup>47</sup> as a universal regulator to push selected degrees into preferred positions—confuses additive intuitions of "distance" with the multiplicative mechanics of interval ratios, and thereby generates a system that is not compelled by acoustical necessity, nor securely warranted by historically attested intervallic structures. This matters for the dissertation's overall approach because it clarifies a methodological principle: claims to "scientific correction" in late psaltic theory may themselves be historically situated interventions, and must be tested—like any tuning—against coherence, constraint, and comparative evidence, rather than accepted as unbiased mathematics.

Finally, the thesis contributes to ongoing debates on Byzantine chant performance practice by offering concrete, testable transcriptions and performance propositions grounded in historical reasoning. In doing so, it moves beyond purely speculative discussion of intervals and provides a framework through which performers and scholars may engage productively with the problem of intonation in medieval repertoires.

In sum, the thesis' original contribution to knowledge is not a claim to have recovered a lost medieval tuning, but a demonstrably replicable method for moving from

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<sup>47</sup> Andrew Barker, *Greek Musical Writings* II, 240–41. See especially Didymus' revision of Pythagorean intervals and the derivation of the Didymean comma from the difference between  $81/64$  and  $5/4$  (approximately syntonic comma, ~21.5 cents).

underdetermined notation to disciplined, historically grounded performance propositions: a reframed concept of chroma, a constrained reference-tuning test applied to a defined corpus, and an explicit epistemology (least-wrong inference) capable of satisfying the examination criterion of originality through method, argument, and examinable musical outputs.



## Chapter 1

## DIATONICISM IN ANCIENT GREEK MUSIC THEORY

This chapter surveys ancient Greek diatonic interval theory as the earliest framework within which later Byzantine and Near Eastern diatonic systems may be contextualised. It begins with the Pythagorean tradition, in which musical intervals are defined as numerical ratios and diatonic structure is derived from the consonant proportions of the octave, fifth, and fourth. The chapter then considers the standard Pythagorean “ditonic diatonic” division of the tetrachord ( $9/8 \times 9/8 \times 256/243$ ) and its role within later theoretical transmission.

The second part of the chapter turns to Aristoxenus, whose “harmonic science” rejects ratio-based derivation in favour of perceptual judgement and continuous intervallic space. This section introduces Aristoxenus’s definition of tetrachords, genera, and the concept of multiple diatonic colourings or hues (*χρόαι*), establishing the epistemological divergence between Pythagorean and Aristoxenian approaches.

Finally, the chapter examines Claudius Ptolemy’s *Harmonics*, which integrates mathematical ratio with perceptual verification and offers a systematic taxonomy of diatonic divisions. Particular attention is given to Ptolemy’s *homalon diatonon* (“smooth diatonic”), whose intervallic structure becomes a key historical point of reference for later modifications of diatonic tuning traditions in Byzantine and Arabic contexts.

## On the Pythagorean Tradition

Greek music theory is established with the mathematical view of the world attributed to Pythagoras.<sup>48</sup> It is commonly held that, in the sixth century BCE Pythagoras of Samos articulated a theory of acoustics based on numerical ratios,<sup>49</sup> embedding musical sound within a broader cosmological framework in which music was conceived as an expression of the order of the cosmos. This conception, although not preserved in direct writings by Pythagoras himself, survives through fragmentary and more extensive sources attributed to later Pythagorean and Pythagorean-influenced thinkers.<sup>50</sup> Among these are Pythagorean mathematicians, as the Tarantian Archytas (*fl* first half of the 4<sup>th</sup> c. BCE), Plato (ca 429-347 BCE),<sup>51</sup> as well as through the writings of the other known Tarantian, Aristoxenus (ca 375–360-? BCE), head of

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<sup>48</sup> “The mathematical background for the *Division of the Canon* and other Pythagorean treatments of music is explained in Nicomachus’ *Introduction to Arithmetic* (*Arithmetikē eisagōgē*) and in *On Mathematics Useful for the Understanding of Plato* (especially ‘On Music’) by Theon of Smyrna. Likewise, the *Manual of Harmonics* (6 and 8) of Nicomachus of Gerasa includes a discussion of the basic Pythagorean consonances (including the famous story of Pythagoras’s discovery of them, which also appears in a somewhat different version in the *Harmonic Introduction*, 11, of Gaudentius); the two means, harmonic and arithmetic, described by Archytas of Tarentum and employed by Plato in the *Timaeus* to construct his musical soul of the universe; and the scale of Philolaus. A group of excerpts attributed to Nicomachus in some manuscripts preserves further observations about the relationships between the 28 musical notes and the *harmonia* of the cosmos.” From Thomas J. Mathiesen, Dimitri Conomos, Grigorios Leotsakos, Stathis Chianis, and Rudolf M. Brandl, “Greece”, <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/grove/music/11694pg1>, retrieved January 12, 2026.

<sup>49</sup> Kathleen Schlesinger, *The Greek aulos: a study of its mechanism and of its relation to the modal system of ancient Greek music, followed by a survey of the Greek harmoniai in survival or rebirth in folk-music* (London: Methuen & Co., 1939), xx, argues that Pythagoras theorised on acoustics, introducing knowledge from Egypt.

<sup>50</sup> The four principal theoretical treatises are Aristoxenus’ 4<sup>th</sup> c. BCE *On Harmonics* (commonly known under the probably erroneous title *Harmonic Elements/Harmonika stoicheia*), pseudo-Plutarch of Chaeronea’s 1<sup>st</sup> c. CE dialogue *On Music* (*Peri mousikēs*), Claudius Ptolemy’s 2<sup>nd</sup> c. CE three-volume *Harmonics* (*Harmonika*), and Aristides Quintilianus’ *On Music* (*Peri mousikēs*, most probably 4<sup>th</sup> c. CE. For a discussion on this, see R. P. Winnington-Ingram, “Aristides Quintilianus, *On Music*. In three books: translation, with introduction, commentary, and annotations by Thomas J. Mathiesen. New Haven and London, Yale University Press, 1983. xiii + 217 pp.” *Early Music History* 4 (1984): 375–380).

<sup>51</sup> ‘Plato’s *Republic*, x.13–16, provides a general description of the ‘harmony of the spheres’, but in the *Timaeus* (34b–37c), Plato presents a much more detailed model for the creation of the soul of the universe, one that embodies characteristic Pythagorean ratios and means, which produce [a] kind of musical shape [...with] a series of ratios, represent[ing] such musical intervals as the octave (2:1), double octave (4:1) and triple octave (8:1) [and] the octave and a 5th (3:1), the triple octave and a tone (9:1) and the quadruple octave and a major 6th (27:1). Aristides Quintilianus paraphrases this material quite closely in *On Music* (iii.24), developing it with various Neoplatonist interpretations of the numbers and mathematical processes.’ From Mathiesen et al., “Greece.”

the rival school of musical thought. The Pythagorean system is a scientific system explaining musical intervals harmonically (*harmonics*) as ratios, based on measurements on the monochord. It is clear from the sources that *harmonics* is concerned with relations between pitches, and not with features of sounds taken individually; it is not an explanation or demonstration of music practice, but a scientific preoccupation.

As Barker notes

from the beginning, Pythagoreans were not typically interested in the study of music for its own sake. Their researches in harmonics arose out of a conviction that the universe is orderly, that the perfection of a human soul depends on its grasping, and assimilating itself to that order, and that the key to an understanding of its nature lies in number. [...] In basic epistemological thinking, Pythagorism essentially initiates the clear dialectic between archetype and mimesis pervading human perception and construction, design and application, perfection and imperfection and the deception of the senses. The two sides of this dichotomy are perhaps sharply demonstrated later in the breach between Plato and Aristotle.<sup>52</sup>

Using ratios to describe how the sound of a string length when plucked relates, and in what ways, to the sound of another plucked string length. When two similar strings under the same tension are sounded together, they give a pleasant harmonic sound if

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<sup>52</sup> Barker, *Greek Musical Writings II: Harmonic and Acoustic Theory* (Cambridge: Cambridge University Press, 1989), 6.

the lengths of the strings are in the ratio of two small integers.<sup>53</sup> For instance, when the length of the string is halved, and plucked, it produces a pitch an octave higher and the string vibrates at twice the frequency of the original (2/1). According to this system therefore, in simple words, a music interval is the relationship between the sounds of two unequal monochord lengths plucked successively. This explains also in a common sense way why music intervals are introduced in the form of divisions.

For the Pythagoreans, numbers appear to transcend mere quantification and assume a qualitative, even metaphysical, significance. One of the most widely cited examples of such a *figured number*, employed both in Pythagorean thought and later in medieval intellectual traditions, is the celebrated Pythagorean *tetractys* (quaternary or tetrad). This figure consists of the first four integers arranged in a triangular formation, a configuration that was understood not simply as a numerical sequence, but as a symbolic condensation of cosmic order, proportion, and harmony.<sup>54</sup>

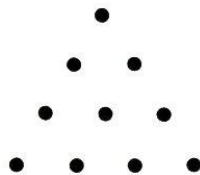


Fig.1.1. The Pythagorean *tetractys*

For the Pythagoreans the tetractys symbolized the perfection of Number and the elements which comprise it. In the realm of music, it contains the symphonic ratios

<sup>53</sup> Cf. Dave J. Benson, *Music: a mathematical offering* (Cambridge: Cambridge University Press, 2007), 138.

<sup>54</sup> For a relevant discussion, see M. J. Gazalé, *Gnomon: from pharaohs to fractals* (Princeton, NJ: Princeton University Press, 1999); and Elena Deza and Michel Marie Deza, *Figurate numbers* (New Jersey; London; Singapore: World Scientific, 2012).

which underlie the mathematical harmony of the musical scale: 1:2:3:4, that is the octave  $2/1$ , the perfect fifth  $3/2$ , and the perfect fourth  $4/3$ . This kind of ratios is known as super-particular (or *epimorios*), as its ratio is  $x+1/x$ .<sup>55</sup> As mentioned before according to Pythagorean theory, small integer ratios of frequencies are picked out as more consonant than other intervals.

The reason why early harmonic theory was concerned with only a limited set of musical intervals is also related to psychophysical considerations. In the act of listening to music, we are exposed to vibrations in the air, which cause the eardrum to oscillate and, in turn, generate neural impulses that travel along the auditory nerve to the brain. In harmonic sounds, the perceptual quality of these vibrations depends crucially on the nature of the intervallic relationships involved. Intervals are perceived as smooth and pleasant only when the ratios between their constituent frequencies are simple. Empirically, only intervals defined by small-integer ratios are sufficiently “pure” to avoid audible beating when sounded together. As these ratios become more complex—that is, as the integers involved increase—consonance generally diminishes, and perceptual roughness correspondingly increases. If the ratio is complex or slightly mistuned compared to a simple ratio, “there will be nearly coinciding harmonics that will interact to create a sensation of beating or roughness,” as E. M. Burns observes.<sup>56</sup>

It is precisely in this thoroughly physical and universally perceptible experience of aural purity that the entire Pythagorean rationale of harmonics and its insistence on small-integer ratios is grounded. The organic and causal relationship between

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<sup>55</sup> The ratio 2:1 constitutes both a multiple and a superparticular ratio, and is in fact the only case in which these two classifications coincide. Given the standard definition of a superparticular ratio, this conclusion follows directly.

<sup>56</sup> E. M. Burns, “Intervals, scales, and tuning”, in Diana Deutsch (ed.), *The Psychology of Music* (New York: Academic Press, 1982), 240–241.

Pythagorean theory, empirical experience, and—ultimately—physical reality has at times been denied or obscured, mischaracterized as abstract logic or mere numerology (see the following section on Aristoxenus).<sup>57</sup>

### *On the Pythagorean Ditoneic Diatonic Tuning*

While studying the Greek and Hellenistic temperaments one is impressed by the pluralism of what is conceived as diatonic. This pluralism is clearly demonstrated in Ptolemy's seminal *Harmonics* (mid-2<sup>nd</sup> c. CE).

In Greek music theory, a diatonic tetrachord is a sequence of three intervals spanning a perfect fourth and articulated by four pitches. It consists of two tones and one semitone (of variable size) and forms the basic unit of melodic construction. Bower notes that “Ptolemy does include the Pythagorean scale as one of his five *chroai* (hues, see next subchapters) of the diatonic genus, but the ‘ditoneic diatonic’ chroa is included almost like an afterthought and plays no central role in his derivation of genera and chroai.” Bower points to a tetrachordal division almost forsaken by the Greeks already as early as 400 BCE, from when the first documentation of Pythagorean tetrachordal divisions survives.<sup>58</sup>

This Pythagorean diatonic tetrachord is unusually simple in comparison with most other diatonic divisions, since it employs only two interval sizes: two major tones (T) of 9/8 and the diatonic semitone (ST), the *leimma* (256/243).

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<sup>57</sup> Frederick V. Hunt, *Origins in acoustics: the science of sound from antiquity to the age of Newton* (New Haven: Yale University Press, 1992) presents a relevant discussion on the psychophysics of small-integer ratios. See also Ville Pulkki and Matti Karjalainen, *Communication Acoustics: An Introduction to Speech, Audio and Psychoacoustics* (Hoboken, NJ: John Wiley & Sons, 2015).

<sup>58</sup> Calvin M. Bower, “Boethius and Nicomachus: An Essay Concerning the Sources of *De institutione musica*,” *Vivarium* 16, no. 1 (1978): 22; Richard L. Crocker, “Pythagorean Mathematics and Music,” *The Journal of Aesthetics and Art Criticism* 22, no. 2 (1963), 197. For Archytas' tetrachord divisions, see Barker, *Greek Musical Writings II*, 46; and Lekkas, “Βυζαντινό ‘μαλακό χρώμα.’”

According to Barker, the instrumental tuning containing two equal tones, known as the Pythagorean *ditonic* tetrachord ( $9/8 \times 9/8 \times 256/243$ ) is implied by Philolaus, Plato, Euclides, Ptolemy and many later sources. Ptolemy's account suggests that in some sense his tense diatonic tetrachord division ( $10/9 \times 9/8 \times 16/15$ ) is the correct form of a tetrachord in the system intended, and is indeed what is sung, while the usual Pythagorean ditonic diatonic is adopted only for convenience in tuning an instrument (since that can be done purely by the “method of concordance.”)<sup>59</sup> Book I of *Harmonics*, presents an interesting implication, where Ptolemy informs us that when musicians sing in certain modes (*Lydia* and *Iastian*), they actually sing in a tuning mixing two tetrachord divisions, the tonic diatonic ( $9/8 \times 8/7 \times 28/27$ ) and the tense diatonic ( $10/9 \times 9/8 \times 16/15$ ), *but* while they sing like this they tune their instruments to the *ditonic* version in place of the *tense*:

[...] the mixture of tense diatonic with tonic will fit the *metabolika* characters, which the kitharodoi call Lydian and Iastian, except that while they sing in accordance with the tense diatonic that has been set out, as can be seen from a comparison with the ratios proper to that genus, they actually tune to another genus, close to that one, but plainly different: for they make the two leading intervals tones [ $9/8$ ] and the remainder, as they think, a half-tone, but as reason implies, what is called the *leimma* [ $256/243$ ].<sup>60</sup>

One may therefore raise concerns regarding the identification of the “Pythagorean tetrachord” solely with its ditonic version, which constitutes just one performing possibility, the ratios of which have remained virtually unchallenged in speculative

<sup>59</sup> Barker, *Greek Musical Writings II*, 312-313.<sup>60</sup> Ibid., 358.

<sup>60</sup> Ibid., 358.

music theory until the fifteenth century, and actively used by music theorists and musicians up to the beginning of the sixteenth century.<sup>61</sup> We shall attempt investigate the reasons behind this in the next paragraphs.

The mathematical economy behind the ditonic chroa of a diatonic tetrachordal construction tries to reduce the occurrence of any other-size tone except for the epogdoos, that is the major tone of  $9/8$ , and it is truly very elegant, because the only other interval that occurs is leimma (literally remainder, Greek for what remains), which is represented by the ratio of  $256/243$ , the difference between a perfect fourth ( $4/3$ ) and two whole tones ( $9/8 \times 9/8 = 81/64$ ).<sup>62</sup>

What we most commonly encounter as *the* description of the diatonic genus in sources that are not strictly mathematical—namely treatises and compilatory theoretical works (as is typical of many Hellenistic authors)—is a tetrachordal structure comprising only two intervallic sizes: the epogdoos ( $9/8$ ) and the leimma ( $256/243$ ). This is presented not merely as a standard diatonic tetrachord, but very often as the only diatonic form.

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<sup>61</sup> See Catherine Nolan, “Music theory and mathematics”, in *The Cambridge History of Western Music Theory*, ed. Thomas S. Christensen (Cambridge: Cambridge University Press, 2002), 276; also Mark Lindley, “Pythagorean intonation,” *Grove Music Online*, 2001, accessed February 12, 2016, Oxford University Press, <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/grove/music/22604>.

<sup>62</sup> On the construction of the diatonic tetrachord in Pythagorean harmonic theory as consisting of two whole tones of  $9/8$  and a residual leimma of  $256/243$ , and on the systematic preference for minimizing intervallic variety through the repeated use of a single tone size, see Euclid’s *Sectio canonis*, esp. propositions concerning the tone and the division of the fourth; Barker, *Greek Musical Writings II*, 38 and 60, where the leimma is discussed explicitly as a necessary remainder resulting from the arithmetic structure of consonances; and Thomas J. Mathiesen, *Apollo’s Lyre: Greek Music and Music Theory in Antiquity and the Middle Ages* (Lincoln: University of Nebraska Press, 1999), who emphasizes the conceptual economy and physical grounding of small-integer ratios in Pythagorean harmonic thought, in contrast to later Aristoxenian approaches.

### On the Aristoxenian deviation

The oldest work of music theory for which substantial fragments exist is *Ἀρμονικὰ στοιχεῖα* [Elements of Harmonics] by Aristoxenus of Tarentum (fl. 4<sup>th</sup> c. BCE). His views on interval measurement are less dependent on mathematics and more on empiricism. The reasons behind this seem to be both educational (the practical application of music theory to facilitate faster learning) and ideological (the reaction of a former Aristotelian, to the rival school of thought of Plato, whose affiliation to the Pythagorean worldview was clear).<sup>63</sup> Aristoxenus argued that music theory

should be a self-standing mode of inquiry (not a sub-area of mathematics). It should focus on sound, not simply on numerical proportions, and it should be subject to scientific principles of understanding as put forward by Aristotle.

[...] Aristoxenus developed the idea of genus, according to the disposition of intervals within a tetrachord, and defined three genera (enharmonic, chromatic, and diatonic) based on the ordering of intervals. He also developed a concept of *tonoi* as “positions of the voice . . . [used] in singing a melody.”

While that part of the treatise describing the *tonoi* has been lost, the term apparently refers to what we would today call transpositions of a scale.<sup>64</sup>

Aristoxenus introduced the concept of the performer’s ear as a tool for deriving conclusions about music opposed to the strict mathematic approach of ratios. His *Elements* was intended for use as a practical treatise prioritising empiricism. By

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<sup>63</sup> Aristoxenus’ *Harmonics* remains the earliest surviving Greek treatise on music theory. There he rejects the Pythagorean reliance on numerical ratios and insists on the ear as the basis for musical judgment, an approach both pedagogical and ideological in contrast to the mathematical abstraction of the Platonic school. See Mathiesen, *Apollo’s Lyre*, 156–159; Barker, *Greek Musical Writings II*, 13–15.

<sup>64</sup> Judy Lochhead, “Music theory and philosophy,” in *The Routledge companion to philosophy and music*, ed. Theodore Gracyk and Andrew Kania (London; New York: Routledge, 2011), 506–516.

refusing to focus on mathematics however, Aristoxenus assists practical musicians by providing them with easily comprehensible instructions, crossing thus a well-defined to his day line between practice and theory.

He rejected ratios altogether, declaring that musical knowledge should be based on sensory experience and reasoning upon it. In this sense he substitutes ratios with their quotients, a tactic which does not promote an understanding of the music interval as the relationship between two string pluckings, but rather describes it as a simple number, like a space between two points. His empirical approach was very influential and by some he is considered the father of equal temperament, because of his reference to a division of the octave in six tones or twelve semitones.<sup>65</sup> Problems with interval measurement occur with Aristoxenus' approximate definitions of a tone, as the difference between a perfect fifth and a perfect fourth, and of a semitone as exactly half that interval. In reality, the tone is the difference between a perfect fifth ( $3/2$ ) and a perfect fourth ( $4/3$ ) is represented by the ratio  $9/8$  [ $= (3/2)/(4/3)$ ]; and "since the ratio  $9/8$  cannot be equally divided unless we use surds ( $3/2\sqrt{2}$ ), there can be no interval which when taken twice will produce such a  $9/8$  tone."<sup>66</sup> This correction, confirmed by modern acoustics, seems like something that Pythagoreans would have told Aristoxenus.

About the different schools of thought (the Pythagoreans and the Aristoxenians) Barker comments that "one theory [is] set in terms of ratios and characteristic of 'Pythagorean' harmonics, the other [is] staying closer to musical experience and used

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<sup>65</sup> Ibid. For further reading on Pythagorean criticism of Aristoxenian rationales concerning intervals and genera, see Boethius' *De institutione musica* ii, 3. For a very clarifying demonstration on Pythagorean proportional analysis displayed by Archytas, see Ptolemy's *Harmonics*, Book I, chs 12 & 13 in Barker, *Greek Musical Writings II*, 301-304.

<sup>66</sup> Schlesinger, *The Greek aulos*, xxi.

principally by theorists engaged professionally in musical practice.”<sup>67</sup> Aristoxenus’ bold, approximate conceptions were attacked by theorists throughout antiquity and the Middle Ages as empirically faulty and mathematically impossible; his application and development nevertheless of Aristotelian principles and categories ‘established a philosophical alternative to the Pythagorean (and Platonic) view of music.’<sup>68</sup>

Contrary to the mathematical precision of the Pythagoreans, the Aristoxenian approach rejects strict mathematical ratio-based tuning in favour of perception-based evaluation.<sup>69</sup> The size of the intervals composing a tetrachord may therefore vary not only according to the tetrachord’s genus, but also according to the specific subdivision within that genus. In ancient Greek music theory, the term genus designates classes of intonation determined by the disposition of the two movable notes within the fixed framework of a tetrachord; these inside notes of a given tetrachord offer potential for melodic expression.

### *Tetrachords, Genera, Chroai*

On the practical level, Aristoxenus explains that a tetrachord is a set of four tonal pitches, and a composition of stacked tetrachords constitutes the arch-scale called the Perfect Immutable System (*Systema Teleion Ametabolon*), which contains in turn two similar sub-structures; the Greater Perfect System (*Systema Teleion Meizon*), and the

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<sup>67</sup> Andrew Barker, *The Science of Harmonics in Classical Greece* (Cambridge: Cambridge University Press, 2007), 274-275.<sup>68</sup> Thomas J. Mathiesen, “Antiquity and the Middle Ages,” in *The Routledge companion to philosophy and music*, ed. Theodore Gracyk and Andrew Kania (London; New York: Routledge, 2011), 265; for a fuller treatment of Aristoxenus, see Mathiesen, *Apollo’s Lyre*, 294–344.

<sup>68</sup> Thomas J. Mathiesen, “Antiquity and the Middle Ages,” in *The Routledge companion to philosophy and music*, ed. Theodore Gracyk and Andrew Kania (London; New York: Routledge, 2011), 265; for a fuller treatment of Aristoxenus, see Mathiesen, *Apollo’s Lyre*, 294–344.

<sup>69</sup> Mathiesen, *Apollo’s Lyre*, 311–312; Barker, *Greek Musical Writings II*, 4-5.

Lesser Perfect System (*Systema Teleion Elasson*), two series of stacked tetrachords differing from each other in the incorporation or not of a disjunctive major tone.<sup>70</sup>

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<sup>70</sup> Mathiesen, *Apollo's Lyre*, 358–359.

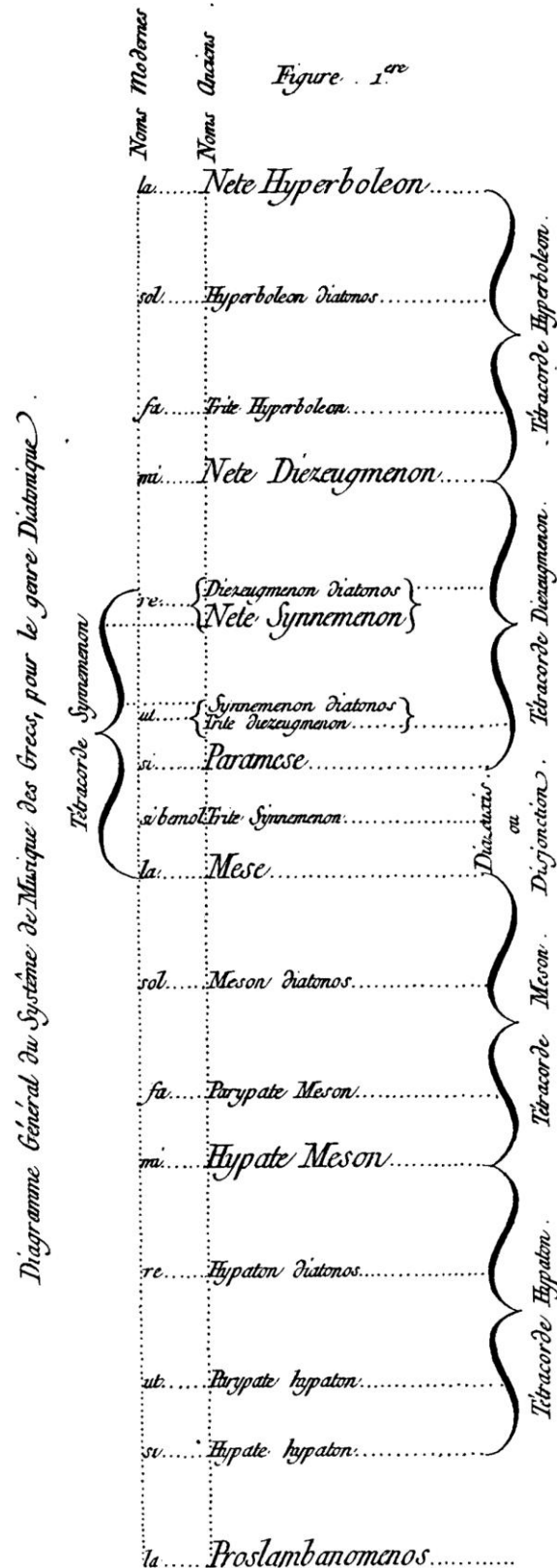


Fig.1.2. The Ancient Greek “Greater Perfect System” consisting of multiple tetrachords, denoted by curly brackets – from Diderot and d’Alembert’s *Encyclopédie* (1751-1772), entry on “Musique” by

Jean Jacques Rousseau

The three basic *genera* (principal tonal systems firstly described by Aristoxenus)<sup>71</sup> are the diatonic, the chromatic, and the enharmonic. Each of these genera comprises a limited set of intervallic configurations, distinct to the genus, which together normally span a perfect fourth ( $4/3$ ): the diatonic is characterized by tones and semitones; the chromatic genus by semitones in combination with a minor third; and the enharmonic genus by a major third together with two very small intervals, conventionally referred to as *dieses*.<sup>72</sup> They were distinguished from one another by the positions of the two inner, ‘moveable’ notes of the tetrachord, the outer ‘fixed’ ones always forming a perfect fourth. It follows then that the exact sizes of the relevant intervals, or their ratios, remained to be established every time one tuned their stringed *kithara* or *lyra*.

The more thorough of the theorists regularly claim that there are several equally correct variants called *chroai* (‘hues’ or ‘colourings’ of a genus by Aristoxenus) of the chromatic and the diatonic, each with its own aesthetic peculiarities (the restrictive character of the microtonal intervals of the enharmonic genus made it impossible to allow for variation). For Aristoxenus these hues were dynamic: not fixed in an ordered scale and flexible along a continuum within certain and defined limits. Due to this flexibility opinions differ among Greek theorists about the number of variants in each genus, and about the ways in which their divisions are to be quantified.<sup>73</sup> The fact is that among all these calculations of the tetrachords, the differences in mathematical language between Aristoxenus’ formulations and those of all the other theorists is “outstanding,” according to Levin, for the reasons we explained some paragraphs earlier: “[t]he ratios of everyone *but* Aristoxenus are clearly and

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<sup>71</sup> And subsequently by theorists as Cleonides, Bacchius, Gaudentius, Alypius, Aristides Quintilianus, Manuel Bryennius.

<sup>72</sup> See for example Cleonides in Ubaldo Pizzani, *Studi sulle fonti del “De institutione musica” di Boezio* (Steenbrugge: Martinus Nijhoff, 1965), 35–36.

<sup>73</sup> In principle, according to Aristoxenus (*Elementa* 26.8ff), there is no limit to the number of variants there can be. Those described in detail by Aristoxenus himself are only the ‘most familiar’ (50.19–22).

unambiguously defined in such a way that each term means the same thing to each theorist named – to Archytas, to Didymus, to Eratosthenes, and to Ptolemy himself.”<sup>74</sup>

### **On Claudius Ptolemy**

Authors belonging to the philosophical and religious tradition of Middle Pythagoreanism<sup>75</sup> elaborated and expanded Pythagorean principles, even to the point of incorporating some elements of Aristoxenian theory. The Alexandrian Hellenist Claudius Ptolemy (after 83-161 CE) partially accepted the empiricism of Aristoxenus. Defending the sovereignty of the hearing in the domain of musical experience, Ptolemy addressed in a highly original way the complementary roles of reason and perception, subtlety and sophistication. Andrew Barker argues that

[t]he ‘Pythagorean’ tradition was not monolithic, and Ptolemy's method diverges in important respects from one branch of it at least, that most closely allied to Platonism. Though it is through reason that the form of harmonic structures is discerned, its findings are subject to the test of perception. [...] The ‘appearances’ are not to be rejected. The task of harmonics is to explicate the mathematical foundations of systems whose beauty and excellence is evident to the ear, not those of some other, purely theoretical constructions. It seeks, in fact, to show that it is on rationally coherent mathematical patterns of order that the perceived beauty of real music rests.<sup>76</sup>

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<sup>74</sup> Flora R. Levin, *Greek reflections on the nature of music* (Cambridge; New York: Cambridge University Press, 2009)214-215.

<sup>75</sup> Middle Pythagoreanism refers to a revival and reinterpretation of Pythagorean philosophy roughly from the 1<sup>st</sup> c. BCE to the 2<sup>nd</sup> c. CE, situated chronologically and intellectually between early (archaic/classical) Pythagoreanism and late Neoplatonism. It is not a single school with a fixed doctrine, but a tendency or movement characterized by the systematic re-reading of Pythagorean ideas through a Platonic lens, with particular emphasis on number, harmony, cosmology, and metaphysics.

<sup>76</sup> Barker, *Greek Musical Writings* II, 271.

Such an approach by a Pythagorean was not uncharacteristic, Hagel adds, since it lies behind the analyses of others before Ptolemy too as Archytas, Eratosthenes, Didymus and Adrastus.

*The “Smooth” Diatonic tetrachord (Homalon Diatonon)*

Ptolemy also wrote an influential work, *Harmonics*, on music theory and the mathematics of music. After criticizing the approaches of his predecessors, Ptolemy argued for basing musical intervals on mathematical ratios (in contrast to the followers of Aristoxenus and in agreement with the followers of Pythagoras), backed up by empirical observation (in contrast to the overly theoretical approach of the Pythagoreans). Ptolemy wrote about how musical notes could be translated into mathematical equations and vice versa in *Harmonics*. He presented along with the canonical ones, his own divisions of the tetrachord, which he derived with the help of a monochord. Ptolemy's astronomical interests also appeared in a discussion of the “music of the spheres.”

Ptolemy made *canonia* (tables) with tunings of string lengths for all three genera and their subsets, comparing those of past theorists (Pythagoreans, including Philolaus and Archytas, plus non-Pythagorean Aristoxenus) with his own.

## The diatonic genera

According to Archytas	According to Aristoxenus		According to Eratosthenes	According to Didymus
	soft diatonic	tense diatonic		
60	60	60	60	60
$67\frac{1}{2}$	70	68	$67\frac{1}{2}$	$67\frac{1}{2}$
$77\frac{1}{7}$	76	76	$75\frac{15}{16}$	75
80	80	80	80	80
90	90	90	90	90
$101\frac{1}{4}$	105	102	$101\frac{1}{4}$	$101\frac{1}{4}$
$115\frac{5}{7}$	114	114	$113\frac{29}{32}$	$112\frac{1}{2}$
120	120	120	120	120
$9:8 \times 8:7$ $\times 28:27$ $= 4:3$	$15+9+6$ $= 30$ $7:6 \times 38:35$ $\times 20:19$ $= 4:3$	$12+12+6$ $= 30$ $17:15 \times 19:17$ $\times 20:19$ $= 4:3$	$9:8 \times 9:8$ $\times 256:243$ $= 4:3$	$9:8 \times 10:9$ $\times 16:15$ $= 4:3$

According to us				
soft diatonic	tonic diatonic	ditonic diatonic	tense diatonic	even diatonic
60	60	60	60	60
$68\frac{4}{7}$	$67\frac{1}{2}$	$67\frac{1}{2}$	$66\frac{2}{3}$	$66\frac{2}{3}$
$76\frac{4}{21}$	$77\frac{1}{7}$	$75\frac{15}{16}$	75	$73\frac{1}{3}$
80	80	80	80	80
90	90	90	90	90
$102\frac{6}{7}$	$101\frac{1}{4}$	$101\frac{1}{4}$	100	100
$114\frac{2}{7}$	$115\frac{5}{7}$	$113\frac{29}{32}$	$112\frac{1}{2}$	110
120	120	120	120	120
$8:7 \times 10:9$ $\times 21:20$ $= 4:3$	$9:8 \times 8:7$ $\times 28:27$ $= 4:3$	$9:8 \times 9:8$ $\times 256:243$ $= 4:3$	$10:9 \times 9:8$ $\times 16:15$ $= 4:3$	$10:9 \times 11:10$ $\times 12:11 = 4:3$

Fig.1.3. Ptolemy's diatonic genera tables - from Barker, *Greek Musical Writings II*, 349-350

Among these variant forms of diatonic tetrachords, particularly notable for our argument is the one Ptolemy named *homalon diatonon*, translated as the smooth, or even diatonic tetrachord (ὁμαλός, -ή, -όν = “of equal, like degree”).<sup>77</sup>

It differed qualitatively both from the tense diatonic (with ratios of 10/9x9/8x16/15) and the tonic diatonic (9/8x8/7x28/27) by being a structure that Ptolemy described as “foreign and rustic” (see translation below). Yet it deserved its appellation “smooth” due to its employment of solely  $\frac{3}{4}$ -tone proportions, “smoothly” ascending in consecutive natural numbers: 9/10/11/12. These proportions (12/11x11/10x10/9) have the smallest-number consecutive ratios able to form a four-fold division of the 4/3. The top interval is thus the 5-limit<sup>78</sup> 10/9 “lesser” tone, the middle interval is the

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<sup>77</sup> A brief note is required on Aristoxenus’s own *μαλακὸν διατονικόν*, his “soft/smooth” chroa or the diatonic genus. Unlike Ptolemy, Aristoxenus does not define the tetrachord through fixed monochord ratios, but through perceptual magnitude and regulated bounds for the movable degrees. For this reason, no single ratio-realisation can be extracted directly from Aristoxenus’s text; nevertheless, the category itself is important, since it shows that “soft/smooth diatonic” is not unique to Ptolemy’s *homalon diatonon*, but already exists in Aristoxenus as a recognised diatonic variant. Modern reconstructions therefore offer only approximate numerical translations of Aristoxenus’s intervallic conception: in Ellis’s influential attempt to render Greek genera into measurable terms, the *malakòn diatonikon* may be represented as a relatively wide semitone (e.g.,  $\approx 16/15$  or  $25/24$ ), a larger tone ( $\approx 9/8$  or  $10/9$ ), and a slightly smaller remaining interval (often  $\approx 8/7$  or  $9/8$ ), though such values remain heuristic and do not carry the status of Aristoxenus’s own ratios.

For a classic modern numerical realisation of Greek genera (including Aristoxenian diatonic variants) in measurable acoustic terms, see the relevant intervallic tables in Alexander John Ellis, “On the Musical Scales of Various Nations,” *Journal of the Society of Arts* 33 (1885). For the methodological distinction between Aristoxenian harmonics (intervals as perceptually judged magnitudes) and ratio-based mathematical harmonics, see Barker, *Greek Musical Writings II*, 4–5.

<sup>78</sup> Limit tuning refers to a system of pitch organization in which the frequency ratios between notes are constrained by a defined set of prime numbers, known as the harmonic limit. For example, in a 5-limit system, only the prime factors 2, 3, and 5 are permitted in intervallic ratios, resulting in acoustically pure intervals such as the just major third (5/4) and perfect fifth (3/2). This approach, foundational to systems of just intonation, prioritizes the use of simple, whole-number relationships to achieve consonance perceived as natural or “pure” by the ear. The Pythagoreans, by contrast, favoured diatonic tetrachords constructed exclusively from octave (2/1), perfect fifth (3/2), and perfect fourth (4/3) ratios—corresponding to a 3-limit system. Ptolemy, however, adopted a more flexible approach, incorporating intervals up to the fifth harmonic, which places his tetrachordal divisions and scalar constructions within the 5-limit framework. As the prime limit increases—moving to 7-limit, 11-limit, and beyond—the system allows for more complex and nuanced intervals, though often at the cost of increased dissonance and practical difficulty in modulation. Limit tuning thus represents a crucial intersection of acoustic theory, mathematical rationality, and perceptual clarity in both ancient and modern tuning practices. See Hermann Helmholtz, *On the Sensations of Tone as a Physiological Basis for the Theory of Music*, 4th ed., trans. Alexander J. Ellis (New York: Dover Publications, 1954), 212–

11/10 “undecimal” tone, and the bottom interval is the 12/11 “neutral” second, a very wide semitone. The relative equality of such an intervallic succession led to its naming. In Ptolemy’s words, it is

another genus, when we set out from the melodiousness [*emmeleia*] that is constituted in accordance with equalities, and investigate the question whether there is any appropriate ordering of the tetrachord when it is initially divided into the three nearly equal ratios, again in equal excesses. The ratios comprising this sort of genus are 10/9, 11/10 and 12/11, when we have again tripled in the same way the first numbers that display the ratio 4/3, making the successive numbers 9, 10, 11 and 12, and the successive ratios that have been set out. When here too the greater ratios are put first in order, there arises a tetrachord close to the tense diatonic, and more even than it, both in itself and still more in association with the filling-out of the fifth. For when the [interval of] disjunction, which makes an epogdoic ratio [9/8], is conjoined with the 'leading' note, the characteristic of equality is no longer produced only in the three excesses, but in the four that are contained by the successive ratios from the epogdoic to the ratio 12/11. [...]

When a division is taken in [strings] of equal pitch on the basis of these numbers, the character that becomes apparent is rather foreign and rustic,<sup>79</sup> but exceptionally gentle, and the more so as our hearing becomes trained to it, so that it would not be proper to overlook it, both because of the special character of its melody, and because of the orderliness of the division. Another reason is

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230, 233–246; and Kyle Gann, *The Arithmetic of Listening: Tuning Theory and History for the Impractical Musician* (Urbana: University of Illinois Press, 2019), chs 2 and 4.

<sup>79</sup> “ξενικώτερον μὲν πῶς καὶ ἀγροικότερον ἦθος καταφανήσεται, προσηγὲς δ’ ἄλλως καὶ μᾶλλον συγγυμναζόμενον ταῖς ἀκοαῖς,” Barker, *Greek Musical Writings II*, 311-12.

that when a melody is played in this genus by itself, it gives no offensive shock to the hearing, which is true, pretty well, only of the intermediate one of the other diatonics, the others being attuned by forcible constraint [bia] when taken by themselves, but capable of being successful in a mixture with the diatonic just mentioned, when those softer than it are taken in the tetrachords lower than the disjunctions, the tenser in those that are higher. So let us call this genus the 'even diatonic', from the characteristic it has."<sup>80</sup>

Ptolemy's description does not read as mathematically abstract or otherworldly; rather, it points to what he characterizes as an *exceptionally gentle* sound. One may therefore ask whether this sonority corresponds to actual musical practice of his time—something he may have genuinely heard. While this question is not decisive for the present discussion, Martin L. West remarks that the construction appears to be Ptolemy's own experimental realization, without further explanation ("He has tried it out, and reports [its] effect").<sup>81</sup> In either case, the very concreteness of this species is significant for the purposes of this thesis. As will be shown in the following paragraphs and chapters, Pythagorean numerical manipulation of ratios is repeatedly encountered in both Arab and Eastern Roman theoretical environments, but this specific tuning seems to have also entered (if not already belonging to) the realm of real music.

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<sup>80</sup> Ptolemy: I:16, in Barker, *Greek Musical Writings II*, 311-12.

<sup>81</sup> Martin L. West, *Ancient Greek music* (Oxford: Oxford University Press, 1992), 171. West could be reproducing Winnington-Ingram (left unexplained by the latter as well) on this: "the homalon diatonic of Ptolemy (*Harm.* I. 16), [...] does not occur in the lyre scales he describes in *Harm.* II. 16. In fact, the account suggests that Ptolemy had invented it himself." from R. P. Winnington-Ingram, "The Spondeion Scale. Pseudo-Plutarch *De musica* 1134f–1135b and 1137b–d," *The Classical Quarterly* 22, no. 2 (1928): 90.

The following table shows the smooth-diatonic intervals under discussion, in reference to the basis of the tetrachord:

<i>Note</i>	<i>Ratio</i>
<i>Mese</i>	1/1
<i>Lichanos</i>	10/9
<i>Parhypate</i>	11/9
<i>Hypate</i>	4/3

Tab.1.1. The smooth diatonic ratios in reference to the basis of the tetrachord

It is remarkable that none of these ratios is an epogdoos, although by the addition of a 9/8, a perfect pentachord is instantly formed, producing the abovementioned succession 12:11:10:9:8 in all its mathematical glory.

## Conclusions

This chapter has shown that “diatonicism” in ancient Greek theory is not a single intervallic construction, but a family of historically coexisting realizations, negotiated between two epistemologies: the Pythagorean commitment to small-integer ratios as the ground of consonance and cosmic order, and the Aristoxenian insistence on perceptual continuity and practical intelligibility. The apparent stability of the canonical consonances (octave, fifth, fourth) does not entail a stable internal division of the fourth, and the diatonic genus—far from being uniquely identified with the ditonic  $9/8 \times 9/8 \times 256/243$ —appears in multiple *chroai*, each with its own mathematical logic, sonority, and implied relation to practice. The plurality of diatonic tetrachords thus forms the necessary conceptual backdrop against which later “standard” tunings must be assessed: not as self-evident inheritances, but as selective crystallizations within a much wider theoretical field.

Within this field, Ptolemy’s smooth diatonic (*homalon diatonon*) occupies a structurally distinctive position. Its succession of super-particular ratios ( $12/11 \times 11/10 \times 10/9$ ) exhibits a striking internal regularity (9:10:11:12), yielding a fourth that is mathematically coherent and aurally “gentle” in Ptolemy’s own description, even if he frames it as unusual or “foreign.” Precisely because it is both rationally orderly and perceptually motivated, the smooth diatonic becomes an ideal test case for the present thesis: it clarifies how numerical economy, auditory plausibility, and instrumental feasibility can converge in a single tetrachordal model. At the same time, its intrinsic limitation—its problematic behaviour when extended downward by an added tone—prepares the central historical problem that follows:

how and why later theorists modified, tempered, or recast this Ptolemaic structure in order to make it operational within real modal practice.

The plurality of ancient diatonic realizations established in Chapter 1 implies a necessary methodological caution: no single tetrachord can be assumed to have functioned as *the* diatonic in later musical practice, and alternative tunings must have coexisted, fluctuated, and been applied contextually in ways that cannot now be reconstructed with certainty. Yet the historical record is not indifferent. From the moment Ptolemy documents the *ὁμαλὸν διάτονον* as a structurally coherent and perceptually “gentle” division of the fourth, this intervallic profile reappears with striking insistence in the learned traditions that transmit Greek harmonic discourse into the medieval Eastern Mediterranean—above all in Alexandrian-derived theory, in Arabic philosophical treatises, and in Eastern Roman compilatory writings. The next chapter follows this particular line of persistence and transformation, showing how the Ptolemaic tetrachord, this “smooth” diatonic construction, is not merely preserved as an abstract specimen, but rendered operational through the “Zalzalian correction” as we will see in the next chapter, thereby forming a historically intelligible bridge between late antique harmonics and the diatonic genus for the Byzantine chant later codified by Chrysanthos of Madytos.



## Chapter 2

“SMOOTH” DIATONICISM IN THE MEDIEVAL EASTERN  
MEDITERRANEAN: ARAB AND EASTERN ROMAN SOURCES

Having offered in the preceding chapter a survey of the common foundations provided by Ancient Greek music theory, a historical division in our narrative becomes necessary. Music theory’s reception (through Ptolemy) in the Eastern Roman and Arabic worlds will be addressed immediately below, while the fate of its traditions in the Latin Christendom will be the focus of Chapter 3. The present chapter proceeds with the reception and transformation of Ptolemy’s smooth diatonic tetrachord ( $12/11 \times 11/10 \times 10/9$ ) as it passed from the late antique theoretical tradition into the intellectual and musical cultures of the medieval Eastern Mediterranean. While Ptolemy’s intervallic structure constitutes an internally coherent super-particular division of the fourth, its historical significance lies not merely in its mathematical elegance but in the ways later theorists re-interpreted and subtly adjusted it in response to instrumental practice and modal function.

In the early Abbasid period, the Iranian oud virtuoso Jafār Manṣūr Zalzal al-Ḍārib appears as the first figure to articulate a decisive mutation of Ptolemy’s model—one that restores a structurally operative perfect fourth across transpositional contexts and enables concordant interaction between tetrachords. The later codification of this “Zalzalian” correction in Arabic philosophical treatises (especially in al-Farabi and Ibn Sina), and its survival in Eastern Roman theoretical compilations, provides an

essential historical bridge for understanding something of special relevance to the present thesis.

The Zalzalian correction of Ptolemy's smooth tetrachord is identical to the set of intervals documented in *Εἰσαγωγή εἰς τὸ θεωρητικὸν καὶ πρακτικὸν τῆς ἐκκλησιαστικῆς μουσικῆς: συνταχθεῖσα πρὸς χρῆσιν τῶν σπουδαζόντων αὐτὴν κατὰ τὴν νέαν μέθοδον* [Introduction to the theoretical and practical aspects of Ecclesiastical Music, composed for the use of those studying it according to the New Method] (1821) by Chrysanthos of Madytos,<sup>82</sup> that is the first handbook of eastern orthodox chant providing explicit intervallic ratios and sizes. We are about to examine why the diatonic genus of Chrysanthos seems to be not an arbitrary selection among possible diatonic species, but the outcome of a long-standing eastern logic in which numeric simplicity, acoustic consonance, and instrumental feasibility converge.

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<sup>82</sup> Chrysanthos of Madytos, *Εἰσαγωγή εἰς τὸ θεωρητικὸν καὶ πρακτικὸν τῆς Ἐκκλησιαστικῆς Μουσικῆς, συνταχθεῖσα πρὸς χρῆσιν τῶν σπουδαζόντων αὐτὴν κατὰ τὴν νέαν μέθοδον, παρὰ Χρυσάνθου τοῦ ἐκ Μαδύτων, Διδασκάλου τοῦ Θεωρητικοῦ τῆς Μουσικῆς* [Introduction to the theoretical and practical aspects of Ecclesiastical Music, composed for the use of those studying it according to the New Method, by Chrysanthos of Madytos, Teacher of the Theory of Music] (Paris: Rigniou, 1821). This set for diatonic intervals is repeated in Chrysanthos of Madytos, *Θεωρητικὸν Μέγα τῆς Μουσικῆς* [The Great Theoretical Treatise of Music] (Triest: Michele Weis, 1832). English translation of the latter is Chrysanthos of Madytos, *Great Theory of Music*, trans. Katy Romanou (New Rochelle, NY: Axion Estin Foundation, 2010). For a critical edition of Chrysanthos' theoretical work, see Chrysanthos of Madytos, *Θεωρητικὸν μέγα τῆς μουσικῆς: Τὸ ἀνέκδοτο αὐτόγραφο τοῦ 1816. Τὸ ἔντυπο τοῦ 1832* (The Great Theoretical Treatise of Music: the unpublished autograph of 1816; the printed edition of 1832), critical edition, ed. Georgios N. Konstantinou (Athens: Holy Great Monastery of Vatopedion, 2007). Corresponding theoretical work by Chrysanthos' colleagues repeat this diatonic set - see Georgios Chourmouzios Chartophylax, *Εἰσαγωγή εἰς τὸ θεωρητικὸν καὶ πρακτικὸν τῆς Ἐκκλησιαστικῆς Μουσικῆς* [Introduction to the theoretical and practical aspects of Ecclesiastical Music], ed. Georgios N. Konstantinou, *Vatopaidinē Mousikē Biblos – Musicologica Meletemata 2* (Mount Athos: Holy Great Monastery of Vatopaidion, 2014); Emmanouil St. Giannopoulos, *Θεωρητικὲς ὑπηγήσεις καὶ μουσικὲς κλίμακες Γρηγορίου τοῦ Πρωτοψάλτου* [Theoretical intonations and musical scales of Gregorios the Protopsaltēs] (Thessaloniki: University Studio Press, 2011).; cf. Stathis, *Τὰ Πρωτόγραφα*.

### On tempering Ptolemy

Ptolemy's smooth diatonic tetrachord  $12/11 \times 11/10 \times 10/9$  is an intervallic structure incorporating a perfect fourth ( $4/3$ ). If a major tone is added on the top end of this structure (in terms of pitch), then a pentachord occurs; however if the major tone is added (*proslambanomenos*) at the tetrachord's bottom end, creating a new base note, then the fourth between this new basis and the lichanos of the previous tetrachord is not perfect. Jafār Manṣūr Zalzal al-Dārīb (زلزل من صور; died after 842 CE) or simply Zalzal or Zulzul<sup>83</sup> was an Iranian musician who lived during the early Abbasid period. Zalzal's contribution to tuning history seems to be exactly the tempering of the smooth diatonic tuning to secure an additional pure fourth from its *proslambanomenos*' basis, facilitating thus the easy and concordant melodic alteration between the two tetrachords, of the tonic and the subtonic.<sup>84</sup>

Zalzal's diatonic tetrachord of  $12/11 \times 88/81 \times 9/8$  has sizes nearly identical with Ptolemy's smooth diatonic, with just one difference: he added a Didymean comma ( $81/80$ ) to the interval of  $10/11$  subtracting it from the  $11/10$ . This results in a tetrachord of  $88/81 \times 12/11 \times 9/8$ , a corrective mutation allowing for a perfect fourth to be formed between the third note of the tetrachord and the optionally added (*proslambanomenos*) major tone below the tetrachord's fundamental.<sup>85</sup>

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<sup>83</sup> Rodolphe d'Erlanger, *La Musique Arabe 6 Tomes.*: vol. I, *Al-Fārābī* (1930); vol. II, *Al-Fārābī et Ibn Sīnā* (1935).

<sup>84</sup> See Lekkas, "Η διατονική βάση," 18.

<sup>85</sup> Chrysanthos, *Great Theory*, 113. Unless explicitly stated otherwise, quotations of Chrysanthos translated into English used in the present thesis are drawn from Romanou's translation.



al-Farabi; ca 870-950/951), known in the Latin West as Alfarabius and Al-Farabi, and even “the Second Teacher” (in allusion to his dependence on Aristotle, revered among medieval Muslim scholars as “the First Teacher”).

Drawing parallels to real music practice, Al-Farabi describes two diatonic tetrachord divisions and their transpositions on the *oud* keyboard: the ditonic diatonic, simply called the “Pythagorean” (which is referred naturally by every theorist), and a softer one defined after the ring finger fret of Zalzal, the famous oud player from Baghdad.<sup>87</sup>

This “neutral” third lies roughly midway between the minor third (approximately 300, in the cent system)<sup>88</sup> and the major third (approximately 400 cents), typically ranging between 350 and 370 cents depending on the tuning system. It does not occur in standard twelve-tone equal temperament but appears in various non-Western musical systems, as well as in just intonation and microtonal contexts. The interval plays a significant role in the music of cultures such as those of the Middle East and North Africa, where tuning systems permit more nuanced pitch distinctions than in Western classical music. As explained by Michael Hewitt, neutral intervals challenge the rigid

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<sup>87</sup> See D’Erlanger, *La musique arabe* I, 173-193. According to Beyhom, “the *oud* was the favoured theoretical tool for musicologists at that time and also the favourite instrument for most of the Abbasid musicians. Among them [...] Mansur Zalzal who introduced the ‘neutral third’ [...] Later, Avicenna called it the ‘Zalzalian wusta’ – the Zalzalian middle finger ligature.” See Amine Beyhom, Hamdi Makhoul. Fretage du ‘Ūd (*luth arabe*) dans la théorie musicale arabe et influence sur la pratique. The fifth Conference on Interdisciplinary Musicology (CIM09), Oct 2009, Paris, France. Web source: [https://www.academia.edu/70545834/Fretage\\_du\\_%CA%BF%C5%AD\\_luth\\_arabe\\_dans\\_la\\_th%C3%A9orie\\_musicale\\_arabe\\_et\\_influence\\_sur\\_la\\_pratique?utm\\_source=chatgpt.com](https://www.academia.edu/70545834/Fretage_du_%CA%BF%C5%AD_luth_arabe_dans_la_th%C3%A9orie_musicale_arabe_et_influence_sur_la_pratique?utm_source=chatgpt.com).

<sup>88</sup> Thomas D. Rossing, F. Richard Moore, and Paul A. Wheeler give the following concise summary of the cent system :

In music theory and acoustics, the cent is a logarithmic unit used to measure the size of musical intervals independently of any specific tuning system. It was introduced in the late 19<sup>th</sup> c. to allow precise comparison between intervals expressed as frequency ratios. By convention, the octave—corresponding to a frequency ratio of 2 : 1—is divided into 1200 equal parts, each part being one cent. Because pitch perception is approximately logarithmic, equal differences in cents correspond closely to equal perceived pitch distances. Any interval expressed as a frequency ratio  $r$  may be converted into cents by the formula  $c = 1200 \log_2(r)$ , allowing intervals derived from just intonation, historical temperaments, or empirical performance practice to be compared on a common perceptual scale. (*The Science of Sound*, 3rd ed. (Harlow: Pearson Education, 2013), 93–95).

Cf. Alexander J. Ellis, “On the Musical Scales of Various Nations,” *Journal of the Society of Arts* 33 (1885): 485–527.

binaries of major and minor by introducing a middle-ground sonority that is neither fully consonant, nor dissonant by Western standards.<sup>89</sup>

In his discussion of Islamic music theory in Volume 1 of *The New Oxford History of Music*, Henry G. Farmer demonstrates that unequal and intermediate intervallic divisions were not marginal anomalies but structurally integrated elements of Eastern Mediterranean musical thought.<sup>90</sup> Presenting his historical evidence within a modern analytical framework of cent-value calculations, Farmer notes that Zalzal's fretting system explicitly recognises intervals -- including the category later described as *mujannab* -- that cannot be reconciled with a reduction to modern Western semitones.<sup>91</sup> These intervals are not theoretical curiosities, but melodic conventions embedded in instrumental technique, representing historically attested practices and theoretical reflections within the Islamic intellectual tradition. Farmer was therefore one of the first modern Western scholars to acknowledge that modal coherence in Arab music did not depend on equal division of the octave, but on functionally defined pitch relationships.

Equally significant is Farmer's insistence on the primacy of musical practice in shaping theoretical discourse. He repeatedly notes that medieval Islamic theorists such as al-Kindi, al-Farabi, and Ibn Sina engaged critically with Greek harmonic theory precisely because inherited frameworks were insufficient to explain the realities of living musical practice. The systems they produced did not aim at abstract

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<sup>89</sup> Michael Hewitt, *Musical Scales of the World* (London: The Note Tree, 2013), 16–18.

<sup>90</sup> Henry George Farmer, "The Music of Islam," in *Ancient and Oriental Music*, ed. Egon Wellesz, *The New Oxford History of Music*, vol. 1 (London: Oxford University Press, 1957), 460–463.

<sup>91</sup> *The New Oxford History of Music*, vol. I (*Ancient and Oriental Music*), is cited here with full awareness of its mid-20<sup>th</sup>-c. historiographical framework and its methodological limitations. It is not employed as a primary analytical authority, nor as a source for reconstructing specific Byzantine tuning practices. Rather, it is used selectively as corroborative evidence that unequal intervallic divisions, neutral tones, and function-oriented modal systems were widely recognized—already in mainstream scholarship—across the Eastern Mediterranean and Near Eastern musical cultures. Where its interpretations are dated or schematic, they are supplemented and critically reframed through more recent, practice-centered studies, particularly those of Eustathios Makris and Amine Beyhom.

numerical elegance but at accommodating contemporary melodic conventions, instrumental constraints, and established modal habits. Farmer thus anticipates later practice-oriented critiques of rigid scalar theory and supports the view that tolerance of intervallic variability was a defining feature of Eastern modal systems rather than a sign of theoretical imprecision. The legitimacy of neutral and non-equal intervals thus emerges not as a speculative reconstruction, but as a historically grounded response to musical reality.<sup>92</sup>

In a section entitled “The Influence” Farmer situates these intervallic and modal concepts within a broader historical process of cultural interaction across the Eastern Mediterranean. He explicitly acknowledges sustained Arab–Persian influence on Byzantine musical culture, extending beyond speculative theory to encompass practical musicianship, modal conception, and melodic behaviour. Instead of claiming that specific theoretical systems were either directly or uniformly transmitted, he emphasised the long-term circulation of musical knowledge within a shared cultural environment. This perspective provides a plausible historical framework for understanding later developments within Byzantine chant, including shifts in modal emphasis and intervallic usage, as part of a wider Eastern modal ecology. Within such a context, a persistence of soft and non-equal intervallic structures in Byzantine and post-Byzantine traditions may be understood as historically continuous rather than as late or isolated innovations.<sup>93</sup>

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<sup>92</sup> Henry George Farmer, “The Music of Islam,” 463–466.

<sup>93</sup> *Ibid.*, 466–468.

Notes	First Octave.
<i>C</i>	FIRST : open . . .
<i>D</i> <sup>♭</sup>	ancient near index . . .
	Persian near index . . .
	Zalzal's near index . . .
<i>D</i>	index . . .
<i>E</i> <sup>♭</sup>	ancient middle . . .
	Persian middle . . .
	Zalzal's middle . . .
<i>F</i> <sup>♭</sup>	. . .
<i>E</i>	ring . . .
<i>F</i>	little = SECOND : open . . .
<i>G</i> <sup>♭</sup>	SECOND : ancient near index
	Persian near index . . .
	Zalzal's near index . . .
<i>G</i>	index . . .
<i>A</i> <sup>♭</sup>	ancient middle . . .
	Persian middle . . .
	Zalzal's middle . . .
<i>B</i> <sup>♭♭</sup>	. . .
<i>A</i>	ring . . .
<i>B</i> <sup>♭</sup>	little = THIRD : open . . .
<i>C</i> <sup>♭</sup>	THIRD : ancient near index
	Persian near index . . .
	Zalzal's near index . . .
<i>C</i>	index . . .

Fig.2.2. "Earlier notes on the Arab lute as reported by Prof. Land:" the three main variables out of the six Zalzalian thirds reported by Ibn-Sina - from Helmholtz, *On the sensations of tone*, 516

Having established the historical persistence of Zalzalian diatonicism in Arab music, we can return now to the diatonic genus as defined by Chrysanthos at the beginning of the nineteenth century. Why did Chrysanthos choose this specific ratio succession, and not any other, for his diatonic genus? And why is this Chrysanthine intervallic sequence also prominent in the current Arabic and Turkish maqam *rast*? The answer leads us into the playful realm of mathematics, which favors small-integer ratios, as well as into the domain of acoustics.

*On the “Spondeion” Tetrachord*

So far we have seen that Ptolemy’s “soft” or “smooth” diatonic tetrachord – one of his variations or *chroai* for the diatonic genus – employs three  $\frac{3}{4}$ -tone intervals. We then noted that its later Zalzalian mutation, allowing for a perfect fourth to be formed between the third note of the tetrachord and the optionally added (*proslambanomenos*) major tone below the tetrachord’s fundamental, became a widely accepted diatonic species in Arab musical theory and practice, before Chrysanthos of Madytos eventually adopted it, as we shall discuss at some length below in Chapter 4, as “our” diatonic. Moving forward, we shall adopt the pseudo-Plutarchian term *spondeion* (or *spondeiac*) as a conventional designation for scalar constructions employing  $\frac{3}{4}$ -tone intervals.<sup>94</sup> The propriety of our use of both this term and its equivalent appellation *spondeiasmos* (*σπονδειασμός*) in this way was defended by Hagel in the course of a dispute with Barker over its meaning in the pseudo-Plutarchian *De Musica*.<sup>95</sup> Hagel concludes that “[t]his discrepancy proves beyond doubt that the characteristic of the *spondeiasmos* was [...] its size of (approximately) three quartertones.”<sup>96</sup> Bearing this in mind, we shall now embark on a brief survey of

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<sup>94</sup> E.g. Lekkas, *Byzantine Church Chant*; on the  $\frac{3}{4}$ -tone connection see also Reginald P. Winnington-Ingram in Winnington-Ingram, “The Spondeion Scale. *Pseudo-Plutarch De Musica 1134f-1135b and 1137b-D*.” *The Classical Quarterly* 22.2 (1928): 83–91. For a more recent study on the origins of the *spondeion*, see Athina Katsanevaki, “The evolutionary pentatonism in Nicomachus, the extant fragments and an ancient Greek musical praxis,” *Greek and Roman Musical Studies* 11 (2023), esp. 158–160: there, Katsanevaki’s interpretation of the *spondeion* provides an essential conceptual framework for situating the *spondeiasmos* discussed in the Pseudo-Plutarchian text. While Hagel has convincingly shown—against Andrew Barker—that *spondeiasmos* cannot denote the diatonic configuration traditionally assumed and instead points to an intervallic discrepancy of approximately three quartertones, Katsanevaki shifts the discussion to a deeper structural level. She treats the *spondeion* not as a single, fixed micro-interval but as a primary trichordal formation belonging to a pre-diatonic stage of musical organization, grounded in melodic behavior and perceptual focality rather than in later genus-based interval theory. In this sense, Hagel’s identification of a characteristic intervallic “size” corroborates Katsanevaki’s broader claim that *spondeiasmos* reflects an early musical logic irreducible to diatonic norms: the former isolates the measurable symptom of this logic, while the latter reconstructs the underlying musical process that produced it.

<sup>95</sup> Barker, *Greek Musical Writings II*, 490–91.

<sup>96</sup> Hagel, *Ancient Greek Music*, 405. He then goes on explaining the relation between *spondeiasmos* and *eclisis*.

the spondeion in the medieval Arab and Byzantine sources that form the historical background to the Chrysanthine diatonic.

### **On the Spondeion in the Arab Sources**

*In what follows, terms such as Arab, Persian, and Islamic are employed with deliberate caution. They are not intended as rigid ethnic or national designations, but as historically situated descriptors referring to language of transmission, cultural affiliation, and intellectual context. The principal music theorists discussed in this chapter—among them Manṣūr Zalzal, al-Farabi, and Ibn Sina—worked within the multilingual and cosmopolitan environment of the Abbasid world, in which Arabic functioned as the primary scholarly language regardless of ethnic origin.*

*While figures such as al-Farabi and Ibn Sina were of Persian or Persianate background, their musical writings belong to an Arabic-language theoretical tradition that consciously engages Greek harmonic science, particularly Ptolemy, while responding to contemporary instrumental practice. Conversely, earlier practitioners such as Zalzal, whose ethnic identity remains uncertain, are best understood through their documented role in shaping instrumental technique and tuning within this shared milieu rather than through retrospective ethnic categorization.*

*Accordingly, the present study uses Arabic theory to denote a body of writings composed in Arabic and embedded in Abbasid scholarly culture, while acknowledging the decisive contribution of Persian-speaking intellectual traditions to its formation. This terminological choice reflects current historiographical practice and avoids projecting modern notions of ethnicity or nationhood onto pre-modern theoretical activity, which operated within a fundamentally transregional Eastern Mediterranean and Near Eastern musical ecology.*

In the eastern Mediterranean and Near Eastern worlds following the death of Alexander the Great in the late fourth century BCE, political fragmentation did not entail a corresponding rupture in cultural or intellectual life. As has been emphasized

by Anthony Kaldellis, the eastern Roman world before Islam was characterized by long-term continuities in education, scholarly practice, and the transmission of technical knowledge, largely independent of changes in imperial administration. Musical practice, like other forms of learned and artisanal knowledge, remained embedded in inherited traditions sustained through pedagogy, performance, and instrument making rather than imposed political uniformity. By the late antique period, and particularly under the Sassanid Empire, these enduring traditions interacted productively with local Persian intellectual cultures, in which music was increasingly discussed in mathematical, cosmological, and metaphysical terms. Within this context, long-established instruments such as the ancient Persian lute (*barbat*) functioned not as novel theoretical inventions, but as material frameworks through which pre-existing intervallic concepts could be articulated, explored, and systematized.<sup>97</sup>

Greek Pythagorean harmonic theory provided an important numerical and conceptual point of reference for later Arab and Persian musical thought, without ever constituting an exclusive or comprehensive description of musical practice. In pre-Islamic Persia, particularly under the Sassanid dynasty (226–651 CE), this inherited mathematical framework increasingly interacted with long-standing instrumental and oral traditions, resulting in the stabilization of intervallic categories that cannot be generated by a simple cycle of fifths alone. These developments did not represent

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<sup>97</sup> See Kaldellis, *Romanland*, where the author emphasizes the persistence of Greek education, scientific discourse, and technical knowledge in the eastern Roman world before Islam, arguing against models of abrupt cultural rupture tied to political change. This framework supports an understanding of late antique eastern musical thought as continuous with earlier traditions rather than as a product of sudden post-Hellenistic realignment. Cf. Bo Lawergren, “Music History i. Pre-Islamic Iran,” *Encyclopaedia Iranica*, last modified August 15, 2000, <https://www.iranicaonline.org/articles/music-history-i-pre-islamic-iran>; idem, “Music History ii. The Islamic Period,” *Encyclopaedia Iranica*, last modified August 15, 2000, <https://www.iranicaonline.org/articles/music-history-ii>; Hugh Kennedy, *The Early Abbasid Caliphate: A Political History* (London: Croom Helm, 1981), 61–70; Marshall G. S. Hodgson, *The Venture of Islam, Volume 1: The Classical Age of Islam* (Chicago: University of Chicago Press, 1974), 212–225.

refinements of a strictly Pythagorean system, but rather its integration into a broader, practice-oriented conception of musical structure in which perceptual and instrumental considerations played a decisive role.

The religion of Islam emerged in the seventh century CE<sup>98</sup> and by the eighth century the cultural and political center of the Middle East had been transferred to Baghdad.<sup>99</sup> In the following centuries, two great philosophers would dominate musical thought there: the Sufi al-Farabi (872-950) and Ibn Sina, known in the West as Avicenna (980-1037). Both quoted long lists of the Greek tetrachords and scales, adding their own observations and constructions, expanding the Greek Theory with original contributions largely inspired by the sounds of their time.

Between the eleventh and early fifteenth centuries, several Persian and Persianate theorists provided explicit discussions of tuning and interval structure, generally expressed through numerical ratios.<sup>100</sup> Ibn Sina classified intervals in terms of super-particular ratios and even addressed approximate quarter-tone values, while his disciple Ibn Zaylā (d. 1048) consolidated these ideas in the *Kitāb al-kāfi fī al-mūsīqī*. The most influential figure was Ṣafī al-Dīn al-Urmawī (ca 1216–1294), whose *Kitāb al-Adwār* established the canonical 17-degree scale generated from Pythagorean fifths, complete with abjad notation and detailed lute tunings. Quṭb al-Dīn al-Šīrāzī

<sup>98</sup> Fred M. Donner, *Muhammad and the Believers: At the Origins of Islam* (Cambridge, MA: Harvard University Press, 2010), 1–5; Jonathan P. Berkey, *The Formation of Islam: Religion and Society in the Near East, 600–1800* (Cambridge: Cambridge University Press, 2003), 38–45.

<sup>99</sup> Hugh Kennedy, *The Early Abbasid Caliphate: A Political History* (London: Croom Helm, 1981), 61–70; Marshall G. S. Hodgson, *The Venture of Islam, Volume 1: The Classical Age of Islam* (Chicago: University of Chicago Press, 1974), 212–225.

<sup>100</sup> On this paragraph's content, see literature as Amnon Shiloah, *The theory of music in Arabic writings (c. 900–1900)* (Munich: G. Henle Verlag, 1979); Owen Wright, *The modal system of Arab and Persian music, A.D. 1250–1300* (Oxford: Oxford University Press, 1978); Erlanger, *La Musique Arabe: vol. I, Al-Fārābī* (1930); vol. II, *Al-Fārābī et Ibn Sīnā* (1935); vol. III, *Commentaires sur le Livre des cycles de Ṣafīyy al-Dīn al-Urmawī* (1938); Ann E. Lucas, *Music of a thousand years: A new history of Persian musical traditions* (Oakland: University of California Press, 2019); Jean During, *La musique iranienne: tradition et évolution* (Paris: Buchet/Chastel, 1984); Hormoz Farhat, *The dastgāh concept in Persian music* (Cambridge: Cambridge University Press, 1990).

(1236–1311) refined Urmawī’s materials by combining Pythagorean and super-particular ratios, while ‘Abd al-Qādir al-Marāghī (ca 1360–1435) preserved much of this system in works such as the *Jāmi‘ al-alḥān* and *Sharḥ al-Adwār*, though his emphasis shifted more toward modal organization and repertory than the creation of new numerical schemes. After Marāghī, however, Persian writings gradually ceased to present ratio-based tuning systems. From the Safavid period onward (16<sup>th</sup>-18<sup>th</sup> cc.), treatises such as the *Nasīm-e ʿtarab*, the *Taqṣīm al-naḡamāt*, Najm al-Dīn Kawkabī’s twelve-chapter text, and the *Resāla-ye Karāmīya* of Dawra Beg Karāmī prioritized modal classification, dastgāh inventories, rhythmic cycles, and performance practice. Later works by figures such as ‘Abd al-Bāqī Nā’īnī, Amīr Khān Gorjī, and Darvīsh ‘Alī Changī continued this trajectory, offering valuable information on modes, instruments, and pedagogy but little in the way of explicit interval arithmetic. Thus, in the period 1000–1840, ratio-based discussions of tuning belong chiefly to the Avicennan and Systematist authors up to Marāghī, after which Persian theory turned decisively toward descriptive modal frameworks rather than numeric temperament.

Ibn Sina, as John Chalmers notes in his landmark study of intervals,<sup>101</sup> lists tetrachords utilizing intervals of approximately  $\frac{3}{4}$  of a tone and smaller:

The resemblance of these to Ptolemy’s even diatonic seems more than fortuitous and further supports the notion that *three-quarter-tone* intervals were in actual use in Near Eastern music by Roman times (2<sup>nd</sup> c. CE). These tetrachords may also bear a genetic relationship to neutral-third pentatonics<sup>102</sup> and to Aristoxenus’s hemiolic chromatic and soft diatonic genera as well as

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<sup>101</sup> John H. Chalmers is a methodical, and visionary theorist whose work is essential in microtonal and scale theory circles, especially among experimental composers. Though not conventional in its academic form, *Divisions of the Tetrachord* (1993) is a landmark work in the systematic exploration of tuning systems and remains influential and respected in its niche.

<sup>102</sup> Pentatonic scalar constructions containing the interval of a neutral third (27/22).

Ptolemy's intense chromatic. [...] Lou Harrison<sup>103</sup> has pointed out that tetrachords such as [...] the equable diatonic yield scales which approximate the 7-tone equal temperament, an idealization of tuning systems which are widely distributed in sub-Saharan Africa and Southeast Asia.<sup>104</sup>

And in another passage, Chalmers highlights the proximity of the smooth diatonon in Ptolemy and Zalzal's mutation. Discussing the neutral third interval (27/22), he writes:

The[se] tetrachords [...] were used by Al-Farabi to express 3/4-tone scales similar to Ptolemy's equable diatonic in Aristoxenian terms. [...] The tuning [12+9+9] is similar to others of Al-Farabi and Avicenna consisting of a tone followed by two 3/4-tone intervals.<sup>105</sup>

In his *Kitab al-Shifa*, Ibn Sina presents a fascinating survey of what we would here term "Zalzalian diatonic" tetrachords. For Ibn Sina, as for al-Farabi and all theorists, the importance of super-particular ratios was special; we already discussed this preference. It mainly follows the tradition of Ptolemy, as Ibn Sina himself emphasizes in a remarkable passage describing the division of the 4/3 fourth into 16/14/13/12;<sup>106</sup> the "very noble jins (as the tetrachordal structures are called in the arab tradition)" seem to struggle for super-particular steps.

Omar Khayyam (Persian: **عمر خیام** ; 1048–1131) was a Persian mathematician, astronomer and poet, writing within the Arabic-language philosophical tradition of harmonics, though himself working in a Persian intellectual milieu. As a

<sup>103</sup> American composer (1917-2003), a key figure in microtonality and tuning research.

<sup>104</sup> Chalmers, *Divisions*, 14.

<sup>105</sup> *Ibid.*, 21.

<sup>106</sup> D'Erlanger, *La musique arabe* II, 148.

mathematician, he is most notable for his work on the classification and solution of cubic equations.

Although Omar Khayyam was not a music theorist in the practical sense, his contribution to music theory is a short treatise on tetrachordal genera in music *Al-qawl 'ala ajnas alladhi bi-al-arba'a* [Discussion on the Genera Contained in a Fourth], which belongs to the same Arabic-language philosophical discourse as al-Farabi and Ibn Sina, and functions within the broader musical ecology as a mathematical validation of intervallic species already established through earlier theoretical and instrumental traditions; there he gathers, in the fashion of Farabi and Sina, the mathematically acceptable tetrachords in all three genera. Like Ibn Sina, Khayyam includes among his acceptable options a tetrachord similar to Ptolemy's smooth diatonic.<sup>107</sup> Khayyam gives precedence to the pythagorean ditonic tuning, characterizing it as a strong one, because of its economic intervallic sizes. He turns next to a second strong species:

which doubles [the interval]; it consists of one whole unit plus one eighth of a unit [ $9/8$ ], with one whole unit plus one eighth of a unit [ $9/8$ ], and one whole unit plus thirteen out of two hundred and forty-three parts [ $256/243$ ] [...]. This is a species that is very close to normal practice, and as a result, it is the only one that is [commonly] used in most countries[.]

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<sup>107</sup> The following excerpts are from the English translation of Khayyam's in Marco Barontini and Tiziana M. Tonietti, "Umar al-Khayyām's contribution to the Arabic mathematical theory of music," *Arabic Sciences and Philosophy* 20, no. 2 (2010): 257-258.

Khayyam then proceeds to “the best of all” in his opinion, which is the Ptolemaic tense:

the fifth is the strong conjunct of the second species, and is made up of one whole unit plus one eighth of a unit [ $9/8$ ], one whole unit plus one ninth of a unit [ $10/9$ ], and one whole unit plus one fifteenth of a unit [ $16/15$ ]; [...] This species is the best of all, in my opinion.

He concludes his demonstration of diatonic tetrachords with this statement:

Among the conjuncts of the third species, the sixth is made up of one whole unit plus one ninth [ $10/9$ ], one whole unit plus one tenth [ $11/10$ ], and one whole unit plus one eleventh [ $12/11$ ]. [...] This, too, is a good species.

From this brief survey, we are able to conclude that medieval Arab tradition did not treat the Ptolemaic smooth diatonic as a museum-piece to be preserved only in philosophical theory. On the contrary, it adopted it actively, correcting and stabilising its tetrachord through Zalzalian practice. When we turn to East Roman sources, however, we shall see that ancient harmonics survived mainly as inherited mathematical doctrine. Greek music theory was a cultural patrimony to be transmitted through the channels of higher education rather than developed as a descriptive science of living musical practice. For this reason, Byzantine musical treatises rarely offer functional theories of intervals related to contemporary practice. Nevertheless, the medieval Greek transmission of ancient harmonics ensured that knowledge of Ptolemy’s smooth diatonic remained current among East Roman scholars, preserving it for later reactivation in post-Byzantine chant theory.

### On the Spondeion in the East Roman Sources

In the twilight of antiquity—marked politically by the dissolution of the Western Roman Empire in 476 CE and, more broadly, by the gradual Christianization of public culture—the institutional and aesthetic locus of “art music” in the Greek-speaking East shifted decisively toward ecclesiastical worship. While popular and secular musicking necessarily continued outside these frameworks, the prestige repertory increasingly became liturgical, and over time developed into the complex phenomenon of Christian chant for the Greek liturgical rites later that modern scholars have labelled “Byzantine.”

Whereas the Arab traditions surveyed above, like those of the Latin West to be discussed in Chapter 3, often took account of contemporary melodic practice, music theory in the East Roman world persisted chiefly in higher education and scholarship. Counted among the mathematical sciences (*μουσική* as quadrivial discipline), it focused on authoritative expositions of inherited ratio-theory to the virtual exclusion of practical questions relating to tuning, intonation, and performance. Gerda Wolfram succinctly observes: “All Byzantine authors teach harmonics as a mathematic science without any concern over contemporary composition.”<sup>108</sup> Furthermore Wolfram notes that:

The only classical author, who is mentioned in Byzantine treatises, is the Alexandrian Claudius Ptolemy. In the course of all Byzantine centuries, his three books of the *Ἀρμονικά* were used as the most important source for ancient Greek theory. As a mathematician, Ptolemaios makes a critical

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<sup>108</sup> Gerda Wolfram, “Fragen der Kontinuität zwischen antiker und byzantinischer Musiktheorie,” *Cantus Planus: Papers read at the ninth meeting* (Budapest: Magyar Tudományos Akadémia, 2001), 575–584.

analysis of the theory of the Pythagoreans on the one side and the Aristoxenians on the other side. His commentator Porphyrios (233 - ca 304) gave the Ἀρμονικά of Ptolemaios an authoritative influence on the early Christian and Byzantine time within the scope of general education.<sup>109</sup>

Richter concurs with Wolfram that “Ptolemaic teaching on harmony strongly influenced the archaizing tendencies in Byzantine writings on music theory,” adding “no intermediate stages can be found between Ptolemy” and the treatise attributed to the eleventh-century intellectual Michael Psellos.<sup>110</sup> Furthermore, the small group of surviving Greek-language treatises of harmonic science from the end of the Middle Ages – (pseudo)-Psellos, Georgios Pachymeres (13<sup>th</sup> c.), and Manuel Bryennios (14<sup>th</sup> c.) – provide little or no information about details of contemporary practice that could assist us in reconstructing how pitch and intonation were conceptualized in performance.

They do not discuss, for example, the scalar organization of living repertoires, microtonal shifts within a given melos and its echos, or any possible elementary harmonic support such as drone (*isokratema*). Instead, Byzantine theoretical writing of this period largely consists of restating what had already been articulated by the ancient Greeks through Ptolemy, regarding musical genera, intervals and tetrachords. The only significant exception to this preoccupation with numerical ratios, and diagrammatic representations of tetrachords is the section on musical composition in the treatise of Manuel Bryennios (completed around 1300) contains a section on

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<sup>109</sup> Gerda Wolfram, “The Byzantine Modal System in Relation to Ancient Greek Music Theory,” *Series Musicologica Balcanica* [Online], 1.2 (2021): 200-208. Web. 23 Feb. 2024 .

<sup>110</sup> Lukas Richter, “‘Psellos’ Treatise on Music’ in Mizler’s ‘Bibliothek’” in Velimirović, Milos, and Egon Wellesz. *Studies in Eastern Chant. Volume 2*. London: Oxford University Press, 1971.

musical composition.<sup>111</sup> Bryennius, however, remains fairly abstract in his approach to the topic, particularly when compared to the technical discussion of chant composition by Manuel Chrysaphes in his significantly later treatise on application of the modulatory signs (the autograph of which is dated 1458).<sup>112</sup>

Yet is significant that, even in this infertile environment for practical musical instructions, the Ptolemaic smooth diatonon persists. It appears, for example, in this illustration from Bryennius's treatise (Figure 2.3).

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<sup>111</sup> See Goverdus Henricus Jonker, ed. and trans., *The Harmonics of Manuel Bryennius* (Groningen: Wolters-Noordhoff, 1970). In "Ancient Musical Theory in Byzantine Environments," *Cahiers de l'Institute de Moyen-age Grec et Latin* 56 (1988): 228-38, Christian Troelsgård notes that Bryennius connects the Ancient Greek and Byzantine ecclesiastical music theory in the same way as observed in the *Hagiopolites* treatise (see Jonker: 164, 304, 308) and that his collation of sources was a 'conscious redaction'.

For a discussion on Manuel Bryennius, which, similarly, argues for an interpretation of his treatise as not a mere collection of copied texts from ancient Greek treatises on music, but rather a serious scholarly attempt at understanding the tradition of music theory as understood by the ancients and an attempt at relating them to his own theoretical structures, see Thomas J. Mathiesen, "Aristides Quintilianus and the 'Harmonics' of Manuel Bryennius: A Study in Byzantine Music Theory," *Journal of Music Theory* 27, no. 1 (1983): 31-47.

<sup>112</sup> Dimitri Conomos, ed., *The Treatise of Manuel Chrysaphes, the Lampadarios: [Περὶ τῶν ἐνθεωρουμένων τῆ ψαλτικῆ τέχνης καὶ ὧν φρονοῦσι κακῶς τινες περὶ αὐτῶν] On the Theory of the Art of Chanting and on Certain Erroneous Views that some hold about it (Mount Athos, Iviron Monastery MS 1120, July 1458), Monumenta Musicae Byzantinae: Corpus Scriptorum de Re Musica*, vol. 2 (Vienna: Verlag der Österreichischen Akademie der Wissenschaften, 1985). See also Spyridon Antonopoulos, *The Life and Works of Manuel Chrysaphes the Lampadarios, and the Figure of Composer in Late Byzantium* (PhD Thesis, City, University of London, 2014).

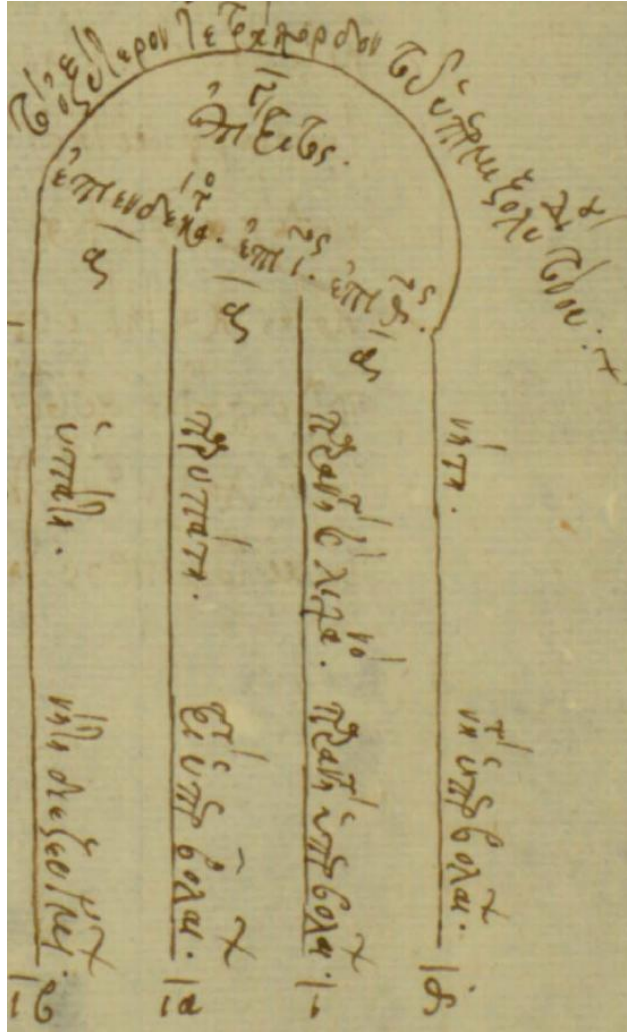


Fig.2.3. Bryennius' smooth diatonic tetrachord after Ptolemy with the ratios 12 ( $\iota\beta$ ), 11 ( $\iota\alpha$ ), 10 ( $\iota$ ), and 9 ( $\theta$ ) from the Magd. Ms. Gr. 13, fol.61r, Oxford Magdalene College

One finds it too in Pachymeres' (1242 – ca 1310) *Σύνταγμα τῶν τεσσάρων μαθημάτων, ἀριθμητικῆς, μουσικῆς, γεωμετρίας καὶ ἀστρονομίας* [Treatise on the four mathematical sciences: Arithmetic, Music, Geometry, and Astronomy], a work best known today under the concise title *Quadrivium*. Incorporating a wide variety of ancient sources including Nicomachus, Diophantus, Euclid, Aratos, Archimedes,

Aristotle, Cleomedes, and Theon,<sup>113</sup> the *Quadrivium* is a kind of encyclopaedia based on ancient works offering “probably the best surviving Byzantine compilation on the four disciplines.”<sup>114</sup> With regard to music, Pachymeres draws both on both Ptolemy and Porphyry’s commentary on the latter. When repeating Ptolemy’s *chroa*, he naturally includes the smooth diatonon among them. Unlike pseudo-Psellos and Bryennius, he adds three further tetrachord divisions to the Ptolemaic ones,<sup>115</sup> probably drawn from the Arab sources.<sup>116</sup>

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<sup>113</sup> See Gianna Katsiampoura, “The *Quadrivium* of 1008 and Pachymeres’ *Syntagma*: Comparing Two Byzantine *Quadrivia*,” in *Libri di scuola e pratiche didattiche, dall’Antichità al Rinascimento*, vol. II, ed. Lucia del Corso and Oronzo Pecere (Cassino: Edizioni Università di Cassino, 2010), 412; also Athanasia Megremi and J. Christianidis, “Georgios Pachymeres, Reader of Nicomachus: The Arithmetical Theory of Ratios as a Means for Solving Problems” [in Greek], *Neusis* 22 (2014): 53–85.

<sup>114</sup> C. N. Constantinides, *Higher Education in Byzantium in the Thirteenth and Early Fourteenth Centuries, 1204–ca. 1310* (Nicosia: Cyprus Research Centre, 1982), 157.

<sup>115</sup> The added divisions into three super-particular steps happens for the sake of theory though; as he states, they are unused by musicians. See Pachymeres *folio* 52v in Paul Tannery (1940), ed., *Quadrivium de Georges Pachymère*, texte révisé et établi par R. P. Elpidios Stéphanou A.A., *Studi e Testi* 94 (Città del Vaticano: Biblioteca Apostolica Vaticana) [Greek], 111.

<sup>116</sup> Influenced nonetheless by the Arab philosophers al-Farabi and Ibn Sina, Pachymeres takes for granted the possibility of each tetrachord existing in two versions: one normal (“towards the low”), but also one inverted (“towards the high”); cf. Lekkas, *Theorem*, 59.

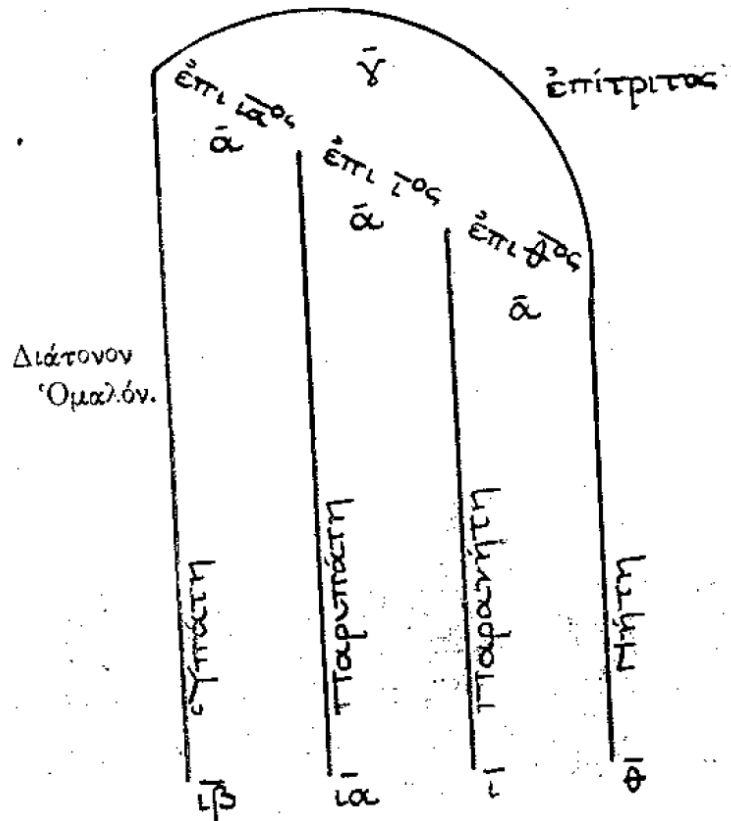


Fig.2.4. Pachymeres' smooth diatonic tetrachord after Ptolemy with the ratios of 12 ( $\iota\beta$ ), 11 ( $\iota\alpha$ ), 10 ( $\iota$ ), and 9 ( $\theta$ ) - from Tannery (ed.), *Quadrivium de Georges Pachymère*, 114

Outside of the academic tradition of medieval Greek harmonic science that culminates in the treatises of Pachymeres and Bryennius, one finds scattered attempts to integrate elements of ancient music theory in Byzantine treatises relating to the practice of ecclesiastical chant. These appear most frequently in the prefatory didactic sections of the late medieval anthologies variously called *Akolouthiai* or *Papadikai*.<sup>117</sup> With the peculiar case of the Hagiopolites as the lone exception<sup>118</sup> these writings never quantify intervals as such. They also differ markedly in scope and intention, with

<sup>117</sup> See Edward V. Williams and Christian Troelsgård, "Akolouthiai," in *The New Grove Dictionary of Music and Musicians* (Oxford: Oxford University Press, 2001), <https://doi.org/10.1093/gmo/9781561592630.article.00384>; and J. Raasted and Christian Troelsgård, "Papadikē," *Grove Music Online* (Oxford: Oxford University Press, 2001), accessed 8 February 2026, <https://www.oxfordmusiconline.com/grovemusic/view/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000020844>

<sup>118</sup> See below, Chapter 4, Section I.

some consisting of little more than solmization exercises and a few others, dating from the fifteenth century onwards, addressing particular aspects of notation, composition, or performance with varying degrees of specificity.

One of the most systematic attempts to provide a theoretical foundation for the practice of Byzantine chanting is the treatise of Manuel Chrysaphes *Περὶ τῶν ἐνθεωρουμένων τῆ ψαλτικῆ τέχνης καὶ ὧν φρουνοῦσι κακῶς τινες περὶ αὐτῶν* [On the Theory of the Art of Chanting and on Certain Erroneous Views that some hold about it], that we have already mentioned above in passing. In it Chrysaphes offers a technical exposition of compositional procedures in the repertoires of ‘beautiful sounding’ (kalophonic) chant cultivated by St John Koukouzeles and many other late Byzantine composers. Yet when it comes to explaining the use of the modulatory signs called *phthorai*<sup>119</sup> Chrysaphes manages to provide an account that still lacks precision with regard to the scales and intervals being altered.<sup>120</sup>

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<sup>119</sup> See Chapters 3 and 4 of present thesis.

<sup>120</sup> Mathiesen, *Apollo's Lyre*, 545–547; Diane Touliatos-Banker, “The Byzantine Kalophonic Repertory and the Theory of Manuel Chrysaphes,” *The Musical Quarterly* 76, no. 2 (1992): 177–179.

## Conclusions

This chapter has examined how Ptolemy's *smooth diatonic* tetrachord was received and transformed in the medieval Eastern Mediterranean, focusing on Arabic and Eastern Roman sources. The main aim was to show that this specific diatonic structure did not simply remain a theoretical legacy from antiquity, but continued to shape intervallic thinking in the East in ways that are historically relevant to later chant theory.

A key result of the chapter is that the most important development occurs in the early Abbasid period with Jafâr Manşûr Zalzal. Zalzal's intervention can be understood as a practical correction of the Ptolemaic model: a small redistribution of intervallic values (at the level of the comma) that stabilizes the fourth and makes the tetrachord function more consistently when extended or transposed. This is significant because it shows a clear case in which theory adapts to instrumental and melodic requirements, especially in relation to 'ūd practice.

The chapter has also shown that Arabic theorists such as al-Farabi and Ibn Sina preserved and systematized this corrected form of the tetrachord. Their writings treat the Ptolemaic material not as a "museum" inheritance but as a framework connected to real musical usage. Within this tradition, intermediate intervals (including neutral thirds and three-quarter-tone steps) appear as structurally meaningful elements rather than exceptional deviations from a purely Pythagorean system.

By contrast, Eastern Roman theoretical sources preserved the musical theory of Ptolemy mainly as part of the mathematical sciences, often repeating his genera without applying them to contemporary musical practice. Although this limits their usefulness for reconstructing Byzantine chant intonation directly, it remains

historically important: it demonstrates the continuous presence of Ptolemy's harmonic doctrine within Greek scholarly culture, ensuring the survival of this diatonic model in the Eastern Roman intellectual environment.

Overall, the chapter points towards an important interpretive conclusion of this thesis: namely that the close resemblance between the *Zalzalian* correction of Ptolemy's smooth diatonic and the intervallic framework later codified by Chrysanthos is best understood as part of a longer Eastern Mediterranean continuity. In this context, Chrysanthos's diatonic genus can be read not as an arbitrary theoretical choice, but as the late formalization of an intervallic logic in which numerical simplicity, consonant structure, and practical musical function converge.

Before turning to Chrysanthos, we need to consider the parallel development of ancient music theory in the medieval Latin West.



LIST OF PRINCIPAL MUSIC THEORISTS & WRITINGS  
FROM THE PYTHAGOREAN TRADITION (5<sup>TH</sup> c. BCE) TO ZARLINO (15<sup>TH</sup> c. CE)

Name	Date	Major writing
<b>BCE</b>		
Archytas	428-347	[fragmenta]
Alypius	fl.360	<i>Introduction to Music (Εἰσαγωγή Μουσική)</i>
Aristoxenus	c.375/fl.335	<i>Elementa harmonica</i>
Euclid of Alexandria	fl.c.300	<i>Division of the Canon (Sectio canonis)</i>
Eratosthenes	276-c.195/194	[fragmenta]
Didymus	1 <sup>st</sup> c.	-lost-
<b>CE</b>		
Cleonides	probably 1 <sup>st</sup> c.	<i>Introduction to Harmonics (Εἰσαγωγή ἁρμονική Eisagōgē harmonikē)</i>
Ptolemy	c.100-c.170	<i>Harmonics (Harmonica)</i>
Boethius	480-524 or 525	<i>De institutione musica</i>
Al-Kindi	801-873	<i>Al-risāla al-kubrā fī al-ta'rif</i> (Grand treatise on composition)
Aurelian of Réôme	fl.840-850	<i>Musica disciplina</i>
Johannes Scotus Eriugena	c.815-877	<i>De divisione naturae</i> (also called <i>Periphiseon</i> )
Hucbald	c.840 or 850-930	<i>De musica</i> (formerly known as <i>De harmonica institutione</i> )
Anonymous 8	9 <sup>th</sup> c.	<i>Musica &amp; Scolica Enchiriadis</i>
Anonymous 7	9 <sup>th</sup> -10 <sup>th</sup> c.	<i>Alia musica</i>
Regino of Prüm	d. c.915	<i>Epistola de armonica institutione</i>
Al-Farabi	872-950	<i>Kitāb al-mūsīqī al-kabīr</i> (كتاب الموسيقى الكبير, Great book on music)
<i>pseudo</i> -Odo	11 <sup>th</sup> c.	<i>Dialogus de musica</i>
Guido Aretinus [Guido of Arezzo]	c.991- after 1033	<i>Micrologus</i>
Avicenna (Ibn-Sīnā)	c.980-1037	<i>Danishnama-i 'Alai</i> (علائمی دانان شدنامه), the Book of Knowledge for [Prince] 'Ala ad-Daulah)

Berno of Reichenau	d.1048	Tonaries and <i>De consona tonorum diversitate</i>
Hermannus Contractus	1013-1054	<i>Musica</i>
Michael [Konstantin] Psellus [Psellos]	1018-after 1078	various
Aribo Scholasticus	fl.1068-1078	<i>De musica</i>
Wilhelm of Hirsau	d.1091	<i>De musica</i>
Frutolfus of Michelsberg	mid-11th century-1103	<i>Brevarium</i>
Theogerus of Metz	c.1050-c.1120	<i>Musica</i>
Coussemaker, doc. 1	2 <sup>nd</sup> half of 11th c.	<i>Ad organum faciendum</i>
-	12 <sup>th</sup> c.	<i>Hagiopolites</i> treatise (presumably transmitting earlier tradition, even 9 <sup>th</sup> c.)
Johannes Cotto [Johannes Affligemensis ]	fl.1100	<i>De musica</i>
Guido of Eu	fl.1130s	supposed author of <i>Regule de arte musica</i>
Theinred of Dover (Theinredus Doverensis)	12 <sup>th</sup> c.	<i>De legitimis ordinibus pentachordorum et tetrachordorum</i>
Georgios Pachymeres	1242-c.1310	<i>Syntagma tōn tessarōn mathēmatōn, arithmētikēs, mousikēs, geōmetrias kai astronomias</i> (treatise on the <i>Quadrivium</i> )
Franco of Cologne (also Franco of Paris)	fl.mid to late 13th century	<i>Ars cantus mensurabilis</i>
Manouēl Bryennios	c.1275-c. 1340	<i>Harmonica</i>
Johannes Tinctoris	c.1435-1511	<i>Terminorum musicae diffinitorium &amp; Proportionale musices</i>
Gioseffo Zarlino	1517-1590	<i>Le istituzioni harmoniche &amp; Dimostrationsi harmoniche</i>

Tab.3.1. List of Principal Music theorists & writings from the Pythagorean tradition to Zarlino

## Chapter 3

## DIATONIC INTERVALS IN THE MEDIEVAL LATIN WEST

In the preceding chapter we charted the reception of ancient Greek conceptions of diatonicism in medieval Arab and East Roman music theory and practice, noting especially the continuing recognition a variety of normal micro-mutations (*chroai*) within the diatonic genus. In the present chapter we will follow parallel developments in Latin Christendom starting in Late Antiquity with the Roman philosopher Boethius (6<sup>th</sup> c. CE) and concluding with the Renaissance music theorist Gioseffo Zarlino. Whereas Boethius in his *De institutione musica* treats music as a mathematically based science of harmonics infused with Pythagorean ideas and embedded within a Neo-Platonic cosmology, later Latin theorists reinterpreted and reoriented his system toward their contemporary needs as composers or performers of monophony and/or polyphony.

### On the *De Institutione Musica* of Boethius

Music theory in the medieval Latin West essentially begins with the incomplete *De institutione musica* by the Roman statesman and polymath Anicius Manlius Severinus Boethius (c.480 – 524). Boethius composed this work early in his career (c. 500) as a translation of and commentary on the *Manual of Harmonics* by Nicomachus of Gerasa (*fl* late 1<sup>st</sup> – early 2<sup>nd</sup> c. CE) and the *Harmonics* of Ptolemy.<sup>121</sup> It fell into oblivion after Boethius' time, but was rediscovered during the Carolingian Renaissance and thoroughly studied thereafter. A mark of the subsequent popularity of *De institutione musica* is that today it is preserved in more medieval Latin manuscripts than all but one other theoretical treatise on music<sup>122</sup> (the sole exception being the *Micrologus* by Guido d'Arezzo).<sup>123</sup>

Boethius produced *De institutione musica* as a bridge between Hellenistic civilization and the culture of his own period.<sup>124</sup> As a philosopher steeped in Neoplatonism he

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<sup>121</sup> Calvin M. Bower and Ubaldo Pizzani agree that Book V of Boethius is a paraphrased translation of Ptolemy. Bower concludes that the source for the modal theory of Boethius was not Ptolemy but Nicomachus, and he argues that *De institutione musica* was to consist of seven books, the first four based on Nicomachus's *Eisagoge* and the last three on Ptolemy's *Harmonica*, the two most viable theorists known to him, and that the now-lost treatise of Nicomachus might survive in these first four books of Boethius's *De institutione musica*. For an investigation of the translation and the discussion of Boethius's modal theory see Anicius Manlius Severinus Boethius, *De institutione musica liber III* (Cambridge, Trinity College MS 505), ed. and trans. in Calvin M. Bower, *Fundamentals of Music* (New Haven, CT: Yale University Press, 1989), xxvi, xxviii–xxix, 148–61; Bower, "Boethius and Nicomachus," 5, 27–38, 41–45; idem, "The Modes of Boethius," *Journal of Musicology* 3, no. 3 (1984): 252–63; Ubaldo Pizzani, *Studi sulle fonti del "De institutione musica" di Boezio* (Steenbrugge: Martinus Nijhoff, 1965), 126–37, 139–56; Lucas Kunz, "Die Tonartenlehre des Boethius," *Kirchenmusikalisches Jahrbuch* 31 (1936): 5–24; and Lawrence A. Gushee, "Questions of Genre in Medieval Treatises on Music," in *Gattungen der Musik in Einzeldarstellungen: Gedenkschrift Leo Schrade I* (Bern/München, 1973), 376–82.

<sup>122</sup> M. Bernhard, *Das musikalische Fachschrifttum im lateinischen Mittelalter* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1990), 72–73.

<sup>123</sup> Charles M. Atkinson, *The Critical Nexus: Tone-System, Mode, and Notation in Early Medieval Music* (Oxford: Oxford University Press, 2009), 9.

<sup>124</sup> Nicomachus' *Manual of Harmonics* is the first work on Greek music that survives between the *Harmonic Elements* of Aristoxenus and Euclid's *Division of the Canon* (4th century BCE), and the *Harmonics* of Nicomachus's contemporary Claudius Ptolemy (2nd century CE). For a detailed analysis, see Bower, "Boethius and Nicomachus," *Vivarium* 16, no. 1 (1978).

generally followed Pythagorean traditions of music theory,<sup>125</sup> but chose to base his incomplete Book V on the beginning of Ptolemy's *Harmonics*.<sup>126</sup> Furthermore, Boethius accepts the judgement of Aristoxenus that both sense experience and numerical rationalization have to be satisfied in music theory.<sup>127</sup> When discussing the mathematical aspect of music, Boethius warns his readers that he is discussing only music that is "constituted," "arranged or disposed," or "fixed" on instruments with discrete pitches such as the kithara, tibia, organ, and bells.<sup>128</sup> It is these instruments, the harmonic principles of which can be demonstrated on the monochord, that facilitate precise definitions of the abstract, proportionate, and quantitative relationships governing music.

Boethius consequently devotes considerable space to explaining the always unequal division of the tone (a  $9/8$  superparticular ratio) into a minor semitone of  $256/243$  (*leimma* or diatonic semitone), slightly less than half of a tone, and a major semitone of  $2187/2048$  (*apotome* or chromatic semitone) slightly larger than half of a tone. He does so in part, as Fuller observes, to clarify the straightforward lexical problem of ambiguous nomenclature that arises from regarding a semitone as half a tone.<sup>129</sup> This places him in succession to theorists going back to Aristoxenus who, when taking

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<sup>125</sup> The philosophical tradition from the 3<sup>rd</sup> c. BCE to roughly the 6<sup>th</sup> CE heavily influenced mainly by Plato's and Plotinus' (c.204/5 – 270 CE) teachings and worldview.

<sup>126</sup> Calvin Bower, "Boethius," Grove Music Online. 2001; Accessed 9 Feb. 2026. <https://www.oxfordmusiconline.com/grovemusic/view/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000003386>.

<sup>127</sup> Barker, *Greek Musical Writings* II, 270–75.

<sup>128</sup> Boethius, *De institutione musica*, bk. I, chap. 2, in Atkinson, *Critical Nexus*, 11ff. See also Susan Rankin, "On the Treatment of Pitch in Early Music Writing," *Early Music History* 30 (2011): 106–7.

<sup>129</sup> Sarah Fuller, "Concerning Gendered Discourse in Medieval Music Theory: Was the Semitone 'Gendered Feminine?'," *Music Theory Spectrum* 33(1) (2011), 66.<sup>130</sup> Barker discussing Quintilianus in Barker, *Greek Musical Writings* II, 410.

account of the interval sizes occurring in his *chroai*, accepted that Pythagorean tones and semitones cannot be exactly halved.<sup>130</sup>

Boethius tacitly, but naturally, accepts the fact that strings without frets, wind instruments,<sup>131</sup> and especially the human voice, are much more flexible in producing pitches than fretted stringed instruments, making them less stable for the purposes of mathematical measurement.<sup>132</sup> He rests this judgement on the clear distinction that ancient theorists made between continuous and discrete sound production (*continuum* and *discretum*). According to Aristides Quintilianus (*fl* late 3<sup>rd</sup>-early 4<sup>th</sup> centuries CE), for example, “All voice production is divided into two categories: continuous and discrete. The continuous is found in flowing conversation; the discrete is used in music.”<sup>133</sup> He furthermore distinguishes three distinct modes of vocal expression:

<sup>130</sup> Barker discussing Quintilianus in Barker, *Greek Musical Writings* II, 410.

<sup>131</sup> Plato’s (and consecutively Boethius’) Pythagoreanism on the matter of wind instruments is apparent in this partial rejection of winds; see Aristotle, *Politics*, trans. C. D. C. Reeve (Indianapolis and Cambridge: Hackett Publishing Company, 2017), bk. VII., where he characterises “The Socrates of the Republic” as wrong in retaining only the Phrygian mode as ethically worthy of being studied and taught (the only one along with the Dorian), and that is because Socrates is rejecting at the same the flute. But the Phrygian, according to Aristotle, is to the modes what the flute is to musical instruments, both exciting and emotional. And additional proof of this comes through Poetry, for Bacchic frenzy and all similar emotions are most suitably expressed by the flute, and are better set to the Phrygian than to any other mode.

<sup>132</sup> Relevant to this: [our translation from the Greek original] “during the Archaic period in Greece [800–480 BCE] the pipe, especially the phrygian one, was used as the teaching tool for the notes, the intervals and the scales, that is for the theoretical or quasi-theoretical level of the musical art.” From Demetrios E. Lekkas, “Αρχαία ελληνικά μουσικά Θεωρητικά,” in Αγγελόπουλος Λ. κ.ά., ed., *Τέχνες II: Επισκόπηση Ελληνικής Μουσικής και Χορού. Ελληνική Μουσική Πράξη: Αρχαίοι και Μέσοι Χρόνοι*, vol. Β’ (Patras: Hellenic Open University, 2003), 25.

If we consider that there were instances of “under-cutting,” a technique still used by instrument makers to correct the pitch of faulty instruments, we might partially reconsider the relativity of pitch inaccuracy and instability of the ancient aulos; it just seems that the Pythagoreans needed a highly indisputable instrumental source, as a stringed *kithara* for their demonstrations - see J. G. Landels, “Fragments of *Auloi* Found in the Athenian Agora,” *Hesperia: The Journal of the American School of Classical Studies at Athens* 33, no. 4 (1964): 392–400. Cf. Aristoxenus, *Elementa harmonica* 37.10–34, in Barker, *The Science of Harmonics in Classical Greece* (Cambridge: Cambridge University Press, 2007), 56: a report making clear “that the accounts of the relations between *tonoi* retailed by the *harmonikoi* were innocent of explicit theoretical presuppositions and axioms, and that at least some of them were based on a study of the practices of performers on *auloi* and of the structures of the instruments they used.”

<sup>133</sup> Barker, *Greek Musical Writings* II, 132-133: “All voice production is divided into two categories: continuous and discrete....”

speech, which is continuous; singing, which is intervallic or discrete; and poetic recitation, which occupies an intermediate state between the two.<sup>134</sup>

Behind the conclusions of Aristides are the writings of such earlier theorists as Aristoxenus, who in his *Elements* characterizes vocal motion as either continuous (stepwise), resembling speech, or diastematic (intervallic), resembling singing, thus confirming that the voice naturally operates on a continuum until musical pitch-making introduces discreteness.<sup>135</sup> Here Aristoxenus, as Barker notes, is further developing Aristotle's efforts to decide whether and in what sense a visual or sonic *continuum* – a rainbow is his example of the former – can be conceived as having distinct parts.<sup>136</sup> Ptolemy, on the other hand, treated musical tones as discrete entities: fixed pitches derived from precise octave and intervallic ratios, aligning more with the *discretum* of stringed instruments like the kithara, the lyre, and the monochord.<sup>137</sup>

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<sup>134</sup> See Thomas J. Mathiesen, *Aristides Quintilianus: On Music in Three Books* (New York: Garland, 1986), 14–15; also Flora R. Levin, *Greek Reflections on the Nature of Music* (Cambridge UP, 2009), 45 ff.

<sup>135</sup> Aristoxenus, *Elements of Harmony*, trans. H. S. Macran (Oxford: Clarendon Press, 1902), bk. I, chap. 8: “continuous movement (stepwise) ... as in speech; ... diastematic (intervallic).” Armand d’Angour has emphasized that ancient Greek musical theory and notation necessarily operate through an abstraction of pitch into discrete entities, even though actual vocal performance was almost certainly far more fluid and continuously inflected. He stresses that the theoretical representation of melody presupposes stable pitch points derived from instruments and tuning systems, rather than the full variability of the singing voice, whose expressive nuances exceed what can be captured by numerical ratios or notation. In this sense, ancient harmonic theory describes an idealized, systematized model of sound rather than raw vocal production, reflecting a conceptual move from the natural continuum of pitch toward discretized musical structures required for analysis and transmission: Armand d’Angour, *How the Greeks Heard Music: Ancient Melodies and Their Modern Realization* (Oxford: Oxford University Press, 2018), esp. discussion of pitch abstraction, vocal inflection, and the limits of notation in chs. 2–3.

<sup>136</sup> Aristotle, (*Περὶ αἰσθήσεως καὶ αἰσθητῶν/De sensu et sensibilibus*, 445b32–446a4), in Barker, *Science of Harmonics*, 349–50. Barker’s commentary on his translation of Aristides Quintilianus 108.22–24 (“music dismisses an extreme continuity of sound as unusable, and rejects excesses of discontinuity as indeterminate, basing its melody on suitably proportioned distances”) reads: “‘Continuous’ movement is that of speech. Excesses of discontinuity should, correspondingly, be very large intervallic leaps, which give no clear impression of their melodic form, but Aristides may be referring to intervals that do not correspond to properly harmonic ratios [my emphasis].” Barker, *Greek Musical Writings II*, 509.

<sup>137</sup> Ptolemy, *Harmonics*, consistently treats tones as quantitatively measured and distinct—see Claude V. Palisca and Ian Bent, “Theory, Theorists,” *Grove Music Online*, retrieved January 24, 2026, <https://www.oxfordmusiconline.com/grovemusic/view/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000044944>, §4.

Susan Rankin has underscored Greek music theorists' "extreme [awareness] of two ways of thinking about musical sounds, as discrete or continuous -- this latter described by Boethius through analogy with the rainbow."<sup>138</sup> The relevant passage in Boethius, taken here from Calvin Bower's exemplary translation of *Fundamentals of Music*, is:

Just as when a rainbow is observed, the colours are so close to one another that no definite line separates one colour from another – rather it changes from red to yellow, for example, in such a way that continuous mutation into the following colour occurs with no clearly defined median falling between them – so also this may occur often in pitches.<sup>139</sup>

Continuing her analysis of this distinction between discrete and continuous pitches, Rankin notes that

...it was only for the discrete model that Greek theory provided systems rationalized [having ratios, that is] in word and number; such sounds could be heard as a series of individual, discrete pitches. These pitches could be named, and their distance at measured intervals systematized; of course, once they were articulated in language, these sounds could be captured in writing. The Greek system set out in Boethius' *De musica* names each discrete pitch.<sup>140</sup>

Accordingly, Rankin concludes, that "through the use of names, and knowledge of the place of each pitch in a larger framework such as the 'greater perfect system' [...], it was possible to internally compute the intervallic distance between any two specific pitches."

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<sup>138</sup> Rankin, "On the Treatment of Pitch," 106–7.

<sup>139</sup> Bower, *Fundamentals*, 167.

<sup>140</sup> Rankin, "On the Treatment of Pitch," 106-107.

When it came to real music, of course, even this degree of specificity would have been relative to the given genus and *chroa*. Although Boethius demonstrates all three genera (diatonic, chromatic, and enharmonic) and their constituent tetrachords, he explains modes with reference only to the diatonic genus. Atkinson notes that ‘as a result, and perhaps also because its division of tonal space was perceived to be closest to that of the chant repertoire to which it was eventually applied, the diatonic genus was the one taken over from Boethius into the medieval theoretical tradition.’<sup>141</sup>

### **On the Frankish Reception: chant notation and theory**

As we turn now to consider the Frankish reception of ancient intervallic theory and subsequent creation of pitch-specific notations for Latin plainchant favouring sight-reading over memory, it is helpful for us to consider these developments as particular manifestations of what other scholars have described as a “characteristic Frankish pragmatism” and a “Carolingian fashion to the practical.”<sup>142</sup> It is in this conceptual framework that we detect the gradual limitation of diatonicism. Carolingian efforts to render the theory of *harmonics* and the practice of chant compatible with the eight-mode (*Oktoechos*) Byzantine system of modal classification led to circumscription of the meanings of the terms ‘tone’ and ‘semitone.’ With the aid of monochords and organs, they eventually came to be viewed as representing functionally uniform intervals encoded in pitch-specific notations.

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<sup>141</sup> Atkinson, *Critical Nexus*, 12.

<sup>142</sup> For instance Richard L. Crocker, “Hermann’s Major Sixth,” *Journal of the American Musicological Society* 25, no. 1 (1972); Nancy Phillips, “Classical and Late Latin Sources for Ninth-Century Treatises on Music,” in *Music Theory and Its Sources: Antiquity and the Middle Ages*, ed. André Barbera (Notre Dame, IN: University of Notre Dame Press, 1990); Raymond Erickson and Claude V. Palisca, *Musica enchiriadis and Scolica enchiriadis* (New Haven: Yale University Press, 1995); Fiona McAlpine, *Tonal Consciousness and the Medieval West* (Bern: Peter Lang, 2008), 47.

During the reign of Charlemagne (768–814), the Franks initiated a wide-ranging programme of cultural, educational, and religious reform known to modern scholars as the ‘Carolingian Renaissance.’ This included strenuous efforts to remodel Christian liturgical practices along Roman lines through the imposition of the Roman rite and its traditions of plainchant. Carolingian clerics and scholars sought to systematise and facilitate the performance of their newly adopted musical repertoires through dynamic applications of both the ancient Greek musical science of *harmonics* as transmitted by Boethius and the parallel borrowing of the *Octoechos*, an eightfold system of modal classification system originating in the liturgical traditions of Jerusalem.<sup>143</sup>

The religious policy of the Carolingians was highly dependent on literacy, creating an environment that encouraged the development and use of musical notations to supplement the transmission liturgical chant melodies hitherto passed on exclusively by oral means.<sup>144</sup> Reflecting on the earliest efforts to notate chant, Rankin observes that

it was not the intention of early notators of chant melodies to replace precise intervallic memories. And this is why points of view about the notation of pitch were not one-dimensional. [...] nevertheless the fact of invention of the stave, not to speak of Guido d’Arezzo’s own comments on the subject, indicates that some musicians felt the need for more precise indications of

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<sup>143</sup> See Peter Jeffery, “The Earliest Oktōēchoi: The Role of Jerusalem and Palestine in the Beginnings of Modal Ordering,” in *The study of medieval chant: paths and bridges, East and West; in honor of Kenneth Levy* (Woodbridge, Suffolk: Boydell Press, 2001), 147–209; and Stig Simeon R. Frøyshov, “The Early Development of the Liturgical Eight-Mode System in Jerusalem,” *Saint Vladimir’s Theological Quarterly* 51 (2007): 139–178.

The tenth-century Latin theorists who, in common with Guido, equated the eight-mode system with eight had to solve the problem of “seven pitches ... but only four modes” McAlpine, *Tonal Consciousness and the Medieval West*, 58. The Greek echoi (modes) therefore had to conform to the notion of two sets of four scales, authentic and plagal.

<sup>144</sup> For the background see Susan Rankin, “Carolingian Music,” in *Carolingian Culture: Emulation and Innovation*, ed. Rosamond McKitterick (Cambridge: Cambridge University Press, 1994), 274–316.

pitch in practical notations. The insufficiency of conventional notations ('the signs which custom has handed down to us') was remarked on already in the late ninth century by the theorist Hucbald. For this reason the limiting of knowledge about the notation of pitch to the view that the primary function of musical notation was *not* to notate pitch would effectively exchange one set of misunderstandings for another, depriving us of insight into the variety and nuance of ways in which pitch was actually handled, and the ways in which this changed in relation to chronology, geography and function.<sup>145</sup>

Richard Crocker offers a complementary assessment of the practicalities of the situation from the perspective of a Frankish musician who

started with the singing of the chant and worked his way toward theoretical constructions such as the scale, rather than the other way around. He was singer, teacher, theorist, in that order. *Cantus*, not *musica disciplina*, was his starting point; his curriculum was that of the monastic school of the seventh and eighth centuries, not the liberal arts curriculum of an earlier or a later time. The Greater Perfect System itself was not a basic assumption but rather a theoretical abstraction, relatively remote from practical experience.<sup>146</sup>

### **On the *Enchiriadis* treatises and *non-diatonic* diatonicism**

Charles Atkinson and Rebecca Maloy have previously identified many of the problems that arose from the Frankish attempt to integrate ancient Greek harmonics,

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<sup>145</sup> Susan Rankin, "On the Treatment of Pitch," 127.

<sup>146</sup> Crocker, "Hermann's Major Sixth," 29.

Roman chant, and Byzantine modal theory and then adapt them for the daily liturgical needs of the churches and monasteries.<sup>147</sup> One is the interesting question of how chants which did not fit the established tonal system were treated by medieval Latin theorists and scribes. Those tasked with committing to pitch-specific notations the melodies of chants employing pitches that fell outside the diatonic tone system derived from Boethius had no choice but to address the inconsistencies between theory and practice. While ‘non-diatonic’ pitches such as B flat, E flat, F sharp and C sharp posed no practical problem for cantors, they were largely unavailable in prevailing notational systems. Maloy, continuing a line of research previously pursued by Dominique Delalande, Gustav Jacobsthal, Urbanus Bomm, Theodore Karp, John Snyder and Charles Atkinson, has shown that scribal variations in the choice of pitch-levels can often be attributed to the underlying use of pitches not conforming to the octave-based diatonic framework generally assumed within post-Enlightenment traditions of Western musical theory.<sup>148</sup>

A transposition system based on the consonances of the perfect fourth and fifth is expounded in the set of mid- to late-ninth century treatises known as the *Musica* and *Scolica Enchiriadis*.<sup>149</sup> Atkinson is among those who have noted that they contain

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<sup>147</sup> Seminal studies: Atkinson, *The Critical Nexus*; Rebecca Maloy, “Problems of Pitch Level and Modal Structure in Some Gregorian Offertories,” in *The Offertory and Its Verses: Research, Past, Present and Future*, ed. Roman Hankeln (Trondheim: Tapir Academic Press, 2007), 67–88; eadem, “Scolica Enchiriadis and the non-diatonic plainsong tradition,” *Early Music History* 28 (2009): 61–96; and eadem, *Inside the Offertory: Aspects of Chronology and Transmission* (Oxford: Oxford University Press, 2010).

<sup>148</sup> Guido Jacobsthal, *Die chromatische Alteration im liturgischen Gesang der abendländischen Kirche* (Berlin: J. Springer, 1897); Jacques Bomm, *La notation musicale dans le “Musica enchiriadis”* (1929); Dominique Delalande, *Vers la version authentique du Graduel grégorien: Le Graduel des Prêcheurs* (Paris: Cerf, 1949); Theodore Karp, *Aspects of Orality and Formularity in Gregorian Chant* (Evanston, IL: Northwestern University Press, 1998), 181–224 (Karp’s important study places the non-diatonic notes in the context of the later “coniunctae” of the Anonymous Berkeley manuscript); and Judith L. Snyder, “Theinred of Dover on Consonance: A Chapter in the History of Harmony,” *Music Theory Spectrum* 5, no. 1 (1983); Judith L. Snyder, “A Road Not Taken: Theinred of Dover’s Theory of Species,” *Journal of the Royal Musical Association* 115, no. 2 (1990).

<sup>149</sup> Bower, “Transmission of Ancient Music Theory;” Raymond Erickson, “Eriugena, Boethius, and the Neoplatonism of *Musica* and *Scolica enchiriadis*,” in *Musical Humanism and Its Legacy* (1992);

echoes of Byzantine chant theory in both their terminology and their tetrachordal system, equivalent to that called *trochos* (wheel) due to the shape of its graphic illustration of relationships between the eight modes.<sup>150</sup> This tetrachordal system of the *Musica Enchiriadis* is the only documented alternative in medieval Latin theory to Greater Perfect System of Boethius that was later adopted by Hucbald and underlies the Guidonian gamut.<sup>151</sup> It is constructed of consecutive disjunct tetrachords resulting in some augmented octaves (between lower and higher B-flats, Fs and Cs). The resulting pentachordal structure, embodied in its so-called daseian system of pitch notation, produces modal identity at the fifth and not the octave.

The *Enchiriadis* treatises offer a very good example of the clash between a flexible tetrachordal practice grounded in aural consonances and a theory struggling to fit diverse materials. Calvin Bower characterizes its tonal system as an outgrowth of practical cantorial traditions of the later eighth and early ninth centuries that had not yet been systematically reconciled with the music theory inherited from ancient Greece.<sup>152</sup> The possibility of pitch alteration (modulation) is introduced in the *Scolica* through a series of so-called *vitia* (“corruptions”) that make possible the flexible alteration of the semitone’s position in the tetrachord (TST, alternating to STT). This resembles mutation in the later system of hexachordal solmization. These *vitia* were not simply mistakes but a recognized necessity for accommodating certain chants is revealed in the catechism of the treatise, where ‘the *vitia* are customarily referred to as

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Erickson and Palisca, *Musica enchiriadis and Scolica enchiriadis*; Maloy, “Scolica Enchiriadis”; Phillips, *Musica and Scolica enchiriadis*; Gushee, “Questions of Genre,” 398–401; and B. Hebborn, *Die Dasia-Notation* (Bonn: Orpheus, 1995). For connections of the treatises with Byzantine music and music theory see Otto Gombosi, “Studien zur Tonartenlehre des frühen Mittelalters II,” *Acta Musicologica* 11, nos. 1–2 (1939): 128–31; and Lukas Richter, “Antike Überlieferungen in der byzantinischen Musiktheorie,” *Acta Musicologica* 70, no. 2 (1998): 194–98.

<sup>150</sup> Atkinson, *Critical Nexus*, 118ff.

<sup>151</sup> David Hiley, *Western plainchant: a handbook* (Oxford; New York: Clarendon Press; Oxford University Press, 1993), 454.

<sup>152</sup> Bower, “Transmission of Ancient Music Theory,” 153ff.

“*leimmata*,” through which ‘one mode can be changed to another, or the original mode restored, in chants.’<sup>153</sup> at all cases, the ratios of the designations ‘tone’ and ‘semitone’ remain undefined in the *Enchiriadis* set.<sup>154</sup>

In Chapter 6 of the *Scolica enchiriadis*, we read that “*Vitia nimirum sunt, sed sicut barbarismi et soloecismi metris plerumque figuraliter intermiscentur, ita leimmata interdum de industria cantibus inseruntur.*” The passage explicitly frames the *leimmata* not merely as corruptions, but as intentional insertions akin to rhetorical figures in poetry. This nuanced perspective regarding vitia and the insertion of *leimmata* “as a result of conscientiousness” (*de industria*) is discussed in detail by Atkinson.<sup>155</sup>

According to Hoppin’s dated reading such a scale “appears to have been created solely for use in the work itself, rather than taken from actual musical practice.”<sup>156</sup>

Phillips, however, concludes correctly in her 1985 dissertation that the irregular pitch series of *Enchiriadis* might actually correspond to the original contour of ninth-century melodies later modified by the imposition of hexachordal- or octave-based modal theory.<sup>157</sup> More recently Bower and Atkinson have concurred with this assessment.<sup>158</sup> Yet it is also worth considering the apparently irregularly placed semitones of the *Enchiriadis* tradition as witnesses to what Maloy calls “non-diatonic practice.”<sup>159</sup> While retaining Maloy’s appellation to denote dispositions of semitones within a diatonic framework reflecting older cantorial practices, we shall try

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<sup>153</sup> Atkinson, *Critical Nexus*, 129.

<sup>154</sup> Bower, “Transmission of Ancient Music Theory,” 156.

<sup>155</sup> Atkinson, *Critical Nexus*, 212; cf. *Musica enchiriadis*, chap. 6..

<sup>156</sup> Richard H. Hoppin, *Medieval Music* (New York: W. W. Norton, 1978), 188–93.

<sup>157</sup> Nancy Phillips, “*Musica and Scolica enchiriadis: The Literary, Theoretical, and Musical Sources*” (PhD Thesis, New York University, 1986).

<sup>158</sup> Erickson and Palisca, *Musica enchiriadis and Scolica enchiriadis*, xix, 34.

<sup>159</sup> Maloy, *Inside the Offertory*, mainly 218–240. Cf. eadem, “Problems of Pitch Level and Modal Structure,” 67–88; eadem, “*Scolica Enchiriadis*,” 61–96.

demonstrate below that the “non-diatonic” might also be explained as falling within the broader conceptions of diatonicism found in Ptolemy, late medieval East Roman chant theory and, for that matter, Chrysanthos.<sup>160</sup>

*Criticism of the Enchiriadis traditions in Guido’s Micrologus*

Boethius’ treatise was only, as Phillips notes, “the only Latin source used by all the Carolingian theorists from Aurelian to Regino,”<sup>161</sup> but starting in the eleventh century it was typically copied as a set with the writings of Guido d’Arezzo. It is therefore not surprising that the authority of the widely disseminated *Enchiriadis* treatises was challenged and then eclipsed. Maloy notes in particular “the negative reaction they provoke in later writers such as Guido and Hermannus, who decry the system’s lack of octave equivalence” as untenable.<sup>162</sup> Guido disparages its tetrachordal notational system in both the *Micrologus* and in the *Regule*.<sup>163</sup> In the *Micrologus* he writes

For this reason we, like Boethius and the musicians of old, indicate all musical sounds by seven letters. However some people nowadays incautiously employ only four symbols. They indicate every fifth sound always by the same symbol, though it is true beyond a doubt that some notes disagree completely with those a fifth away, and that [in the diatonic gamut] no note agrees

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<sup>160</sup> In Chapter 4 we will see that the *phthorai* in East Roman chant books and treatises offered a way of accomplishing what Atkinson calls “rationalizing non-systemic semitones” that corresponds directly with the *vitia* (again perceived as corruptions) of early Western chant mentioned in the *Enchiriadis* treatises. See Atkinson in *Critical Nexus*, 130.

<sup>161</sup> Phillips, “Classical and Late Latin Sources,” 132.

<sup>162</sup> Maloy, “Scolica Enchiriadis,” 74.

<sup>163</sup> Guido d’Arezzo, critique of *Enchiriadis* notation in *Regule*, vv. 71–75, in Dolores Pesce, ed. and trans., *Guido d’Arezzo’s Regule Rithmice, Prologus in Antiphonarium, and Epistola ad Michaelem* (Ottawa: Institute of Mediaeval Music, 1999), 344–45 and 9–10.

perfectly with its fifth. For no note agrees perfectly with any other except its octave.<sup>164</sup>

Guido here conflates octave duplication, the most perfect of Pythagorean consonances (2/1) and the basis of Boethius' modes, with the regulation of chant practice. Crocker has argued that Guido did not embrace octave species due to influence from the pseudo-Odonian *Dialogus de musica*, a work that “does not rely on the rationale of a scalar construction,” but in deference to “mechanical-acoustical instrumentation, the monochord, on which the pitches were fixed more firmly than on the Greater Perfect System.”<sup>165</sup> Before turning to the monochord, however, we need to trace connections between *Enchiridis* and Guido through the writings of another Benedictine, namely Hucbald. We will see that the conception of modality embodied in the ancient Greek *tonoi* with their three different genera and associated *chroai* that Boethius transmitted to the medieval Latin West was abandoned for a scalar system in which the modes are presented as differing segments or species of a scale.<sup>166</sup>

### **On Hucbaldus: between theory and practice**

Hucbald (or Hucbaldus, ca 840/850-930) of St Amand undertook a hard and puzzling task in his treatise *De musica*: the systematic reconciliation of ancient Greek music theory and contemporary ecclesiastical chant practice using a fully diastematic system of alphabetic musical notation. Hucbald was in some ways following precedents established by anonymous authors of the roughly contemporary *Alia musica* and

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<sup>164</sup> Stefano Mengozzi, “Virtual segments: the hexachordal system in the late Middle Ages,” *The Journal of Musicology* 23, no. 3 (2006): 431.

<sup>165</sup> Crocker, “Hermann’s Major Sixth,” 34.

<sup>166</sup> Atkinson discusses how this occurred in part through ninth-century misreadings and misunderstandings of Boethius and Martianus Capella. See *Critical Nexus*, 76.

*Enchiridis* treatises by presenting “not a speculative treatise after the Boethian tradition but a practical handbook for the education of young monks in the proper performance of psalmody.”<sup>167</sup> In *De musica* Hucbald distinguishes nine species of intervals or *modi*: minor and major 2<sup>nds</sup>, 3<sup>rds</sup> and 6<sup>ths</sup>, 4<sup>th</sup>, 5<sup>th</sup> and octave. Firstly, it is notable that Hucbald omits the tritone for the introduction of a new consonance to singing, the most perfect *diapason* or octave. With this Boethian concept introduced here, it is easier to understand the historical progression to Guido’s strictly octaval scalar species. Secondly and most importantly, although Hucbald provides an explanation of tone and semitone “as found in the liturgical repertory and on musical instruments such as the organ and the crwth,”<sup>168</sup> he explicitly warns his readers not to assume “that these intervals between tones are to be equated with the consonances with which musical *auctoritas* [Boethius] deals, for a consonance is one thing, an interval [*modus*] another.”<sup>169</sup> By stating that the intervals “are never defined in any precise way,” he is apparently referring to contemporary chant practice.<sup>170</sup>

According to James Grier, the medieval conception of pitch space “from at least” 900 CE directly relates to the diatonic gamut. *Musica enchiridis*, Hucbald and later medieval theorists including pseudo-Odo and Guido “defined the available repertory of notes in the gamut as diatonic, with the exception of the space between A and middle C and the same notes an octave higher, which was inhabited by both B natural and B flat.”<sup>171</sup>

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<sup>167</sup> Yves Chartier, “Hucbald of St Amand,” *Grove Music Online* (2001).

<sup>168</sup> *Ibid.*; cf. Babb et al., *Hucbald, Guido, and John on Music*, 16.

<sup>169</sup> Charles M. Atkinson, “The other ‘modus’: on the theory and practice of intervals in the eleventh and twelfth centuries,” in *The Study of Medieval Chant: Paths and Bridges, East and West: In Honor of Kenneth Levy*, ed. Peter Jeffery and Kenneth Levy (Woodbridge, Suffolk: Boydell Press, 2001), 235.

<sup>170</sup> *Ibid.*

<sup>171</sup> James Grier, “Adémar de Chabannes (989–1034) and musical literacy,” *Journal of the American Musicological Society* 66, no. 3 (2013): 610.

As David Hiley observes, Hucbald perceives the received chant repertory as essentially compatible “with the diatonic two-octave scale plus middle B-flat.”<sup>172</sup> To fit the practical needs to situate the finals of chants, he divided the gamut into the standard medieval tetrachords of tone-semitone-tone.<sup>173</sup> Chants not fitting into that framework, and therefore unnotatable with his pitch-letters, are ignored. Thereafter, Hiley notes, “once the idea gained a hold that chants stood in this relationship to a clearly definable pitch-system, and once teachers began to pick out chant melodies on monochords where the notes of the Greek system were marked off, pressure must have been felt to eliminate notes which did not fit that system.”<sup>174</sup>

These first practical treatises (of Italian origin, early 11<sup>th</sup> c.) make extensive use of the monochord, as an interval indicator for chant practice and a partial substitute for a teacher (at least for beginners), and include pseudo-Odo’s *Dialogus de musica* (as Lombard Anonymous manuscript is usually referred to, falsely attributed to Odo of Cluny in the past; the misconception had to do with Odo of Arezzo, as Huglo showed)<sup>175</sup> and Guido d’ Arezzo’s famous *Micrologus*.

### **On *Dialogus* and Aretinus**

In his article on Hermannus Contractus, Richard Crocker calls attention to the pragmatism of Frankish theorists and suggests how it eventually affected in a decisive way the evolution of Western musical notation:

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<sup>172</sup> Hiley, *Western plainchant*, 452.

<sup>173</sup> *De harmonica institutione* [former title of Hucbald’s (*De Musica*), in Martin Gerbert, ed., *Scriptores ecclesiastici de musica sacra potissimum*, 3 vols. (St. Blasien, 1784; repr., Hildesheim: Georg Olms, 1963), 112–14.

<sup>174</sup> Hiley, *Western plainchant*, 452.

<sup>175</sup> For the origins of this treatise, see Michel Huglo. (1969). “L’auteur du ‘Dialogue sur la musique’ attribué à Odon.” *Revue de musicologie* 55(2), 168; and Michel Huglo. (1971). “Der Prolog des Odo zugeschriebenen ‘Dialogus de Musica.’” *Archiv für Musikwissenschaft* 28(2), 134–146.

[they] tended to make that characteristic Frankish response of seeking order in things or imposing it on them. As teachers they were in daily need of ways to communicate general concepts as quickly and reliably as possible. Later on, Guido recommended his methods for their speed and efficiency,<sup>176</sup> and others made similar claims. There was a great deal of chant to be sung; and if the Roman *schola cantorum* was content with rote memorization, the Frankish monasteries clearly were not.<sup>177</sup>

Discussing elsewhere the historical context underlying the development of Latin chant theory, Crocker notes that the *Dialogus* attributed to Odo largely avoids the systematic scalar frameworks, such as species of fourths and fifths that were common in other theoretical writings. Read together, the *Musica enchiridis* and the *Dialogus* form a complementary pair: the former embodies a strongly functional approach centred on relationships between finals, while the latter proffers a method based on measured string intervals. After Hucbald, the *Musica enchiridis*, and the *Dialogus*, Guido and Hermannus emerge as mediators seeking to reconcile prior theorists both with one another and with contemporary musical practice, which by the eleventh century extended well beyond the Gregorian repertory. Building on the monochordal scale of the *Dialogus*, Guido constructed a relatively inflexible system—a strictly diatonic, octave-based seven-tone scale with octave duplication—to replace the tetrachordal steps of the *Enchiridis*.<sup>178</sup>

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<sup>176</sup> *Prologus* in *Micrologus*, in Warren Babb, transl., *Hucbald, Guido, and John on Music: Three Medieval Treatises*, Music Theory Translation Series 3, ed. Claude V. Palisca (New Haven: Yale University Press, 1978), 58.

<sup>177</sup> Crocker, “Hermann’s Major Sixth,” 28.

<sup>178</sup> *Ibid.*, 34.

Modern scholarship has established that staff notation and the method of solmisation attributed to Guido of Arezzo were not the invention of a single man,<sup>179</sup> but the outcome of protracted theoretical speculation over decades across a wide geographic area within Western Europe.<sup>180</sup> Nonetheless he is remembered today for his contribution to the development of a system of precise pitch notation through lines and spaces and for propagating a method of sight-singing. Guido proposed his approaches to these matters in his *Aliae regulae* [*Prologus in Antiphonarium*] of circa 1030.

Regardless of who might have been their creator, one may distinguish the following notational innovations in chant manuscripts copied after Guido:

- a) staff lines representing notes a third apart, the intermediate notes being placed in the space between. The pitch of the lines is indicated by letter-clefs.
- b) lines representing the upper note of a semitone step (F & c, that is) would usually be coloured in the eleventh- and twelfth-century manuscripts.

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<sup>179</sup> Neither the system nor the hand is explained in any of Guido's extant writings, and only later theorists and commentators attribute the practice to Guido. Nevertheless, in view of his known interest in practical and pedagogical methods, his authorship or adoption of the system may be accepted as likely. For a discussion of the disputable attribution of pitch-precise notation to Guido, see Jason Haines, "The origins of the musical staff," *The Musical Quarterly* 91, nos. 3–4 (2008): 328–32 and 344–46; and Michel Huglo, "Toward a scientific palaeography of music," in *The calligraphy of medieval music* (2011), 15–16. Christopher Page, on the other hand, strongly argues for Guido's patronage in Christopher Page, *The Christian West and its singers: the first thousand years* (New Haven: Yale University Press, 2010), 454–58. On Haines' discounting of Guido's originality based on the use of horizontal guidelines for music already found in the *Enchiridion* treatises of the ninth–tenth centuries, James Grier sees the argument as "specious," since although they both use vertical space to indicate pitch and the diatonic division of this space, "the lines in the *Enchiridion* treatises are a second apart, not a third, as emerges from Guido's method, and [...] they support the individual syllables of the sung, literary text, not the neumes themselves." Grier, "Adémar de Chabannes and musical literacy," 611.

<sup>180</sup> We cannot rule out the possibility that Guido's legendary fame in the Middle Ages, and to this day could be, except of course for the importance of the notation system itself, also due to his invitation in c.1028 to Rome by Pope John XIX, who had been informed about Guido's novel teaching methods, as well as the unique new notation of the Antiphoner that Guido and fellow monk Michael had drafted. Showing to the pope how a previously unknown melody could be learnt from notation alone, Guido was commissioned to notate Roman liturgical books in staff notation – an obvious sign of papal approbation.

- c) the addition of a direct or *custos* at the end of a staff, indicating the first note of the next staff to facilitate sight-reading.

Not all these elements were adopted immediately everywhere, as David Hiley and Janka Szendrei write in their survey of plainchant notation for *The New Grove Dictionary of Music and Musicians*. This may be seen at a glance in their detailed list of manuscripts of the 11<sup>th</sup>–13<sup>th</sup> centuries from spanning the European continent including central and northern Italy, central, northern and north-eastern France, Normandy, and England, Low countries, Germany, and Cistercian monasteries in central Europe.<sup>181</sup> Significantly, the majority of these places fall within the boundaries of the Holy Roman Empire. Although the Carolingian emperors of the medieval Latin West had long been succeeded by Germans,<sup>182</sup> the practical tendencies of the Franks found new impetus in the work of Guido.

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<sup>181</sup> Drawing from the abovementioned entry, we witness the impressive dissemination of Guido's codification. Among the earliest centres to adopt the Guidonian reform were:

- central Italy (from Perugia to the Lombard plain, Tuscany, Umbria, the Papal States, the secular churches, Camaldolese, Vallombrosians);
- the scriptoria of north Italy including the plain of Lombardy, with few exceptions (adopted the Guidonian system by the beginning of the 12<sup>th</sup> c.);
- during the 12<sup>th</sup> c. many centres in northern France [Paris included], especially Normandy, and England;
- scriptoria in northeastern France and the area of Messine notation during the 12<sup>th</sup> century, not necessarily applying all three aspects of the system (coloured lines, *custodes* and letter-clefs). From the 13<sup>th</sup> c., however, Lorraine neumes regularly appear on staves of four red or black lines;
- scriptoria in central France developed their own variety of the staff notation, following Guidonian practice strictly are the mss of Nevers;
- the first great houses of the Cistercians (Clairvaux, Morimond and Pontigny) were founded in the area in which the French-Messine hybrid notations were used. Cistercian notation used the staff from the very beginning. Cistercian monasteries in central Europe used staff notation from the time of their foundation in the 12<sup>th</sup> c.;
- in Rhineland down to the Low Countries was one of the first areas to use staff notation, employing it as early as the late 11th century onwards (staff notation was known in St Trond in 1099. Aachen, Liège and Cologne seem to be among the earliest centres that adopted the system, with Utrecht, the Münster area, Mainz and even further south along the Rhine within the area of influence. Later, staff notation spread north-east, following, for example, the path of the Teutonic Knights;
- non-monastic scriptoria using German neumes. Sources with staff notation appear regularly to the east of Mainz or in the south German dioceses only after the mid-13<sup>th</sup> c.

<sup>182</sup> See Kaldellis, *Romanland*, esp. chaps. 1–2.

The Guidonian system changed the whole relationship between writing and music in the greater part of Europe. As Hiley remarks “the pressure to adopt a pitch-specific notation for chant-books was so great, it seems, that no sooner was the ink dry on the first alphabetically notated books, so to speak, than another type of notation was invented, Guido of Arezzo’s staff-notation.”<sup>183</sup>

The main goal of Guido’s musical pedagogy, according to Mengozzi, was the further reduction of intellectual distance between the figures that Aurelian had called *musicus* and *cantor*:

From this perspective, it is not surprising that Guido frequently resorted to monochordal divisions in his explanations of the intervallic relationships between pitches. To understand the monochordal derivation of the diatonic pitches was to Guido (and others before him) no mere abstract or speculative knowledge, but one step in the complex process of merging practical competence and theoretical knowledge.<sup>184</sup>

Page concurs with this assessment in his magisterial account of *The Christian West and Its Singers*, writing that the roots of Guido’s staff

are ultimately Carolingian, not only because the stave is indebted to the tradition of graphic inventiveness that began with the charts devised by ninth-century scribes as they compiled materials about the Liberal Arts, but also because Guido’s notation emerged from his attempt to edit and teach a correct

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<sup>183</sup> Hiley, *Western Plainchant*, 388.

<sup>184</sup> Mengozzi, “Virtual segments,” 429.

version of Roman chant for the Universal Church, a thoroughly Carolingian ideal.<sup>185</sup>

Before turning to consider the role played by the monochord in the consolidation of octave-based conceptions of diatonicism, it is instructive to consider briefly the matter of vocal ornamentation. In our introduction we briefly mentioned that vocal ornamentation was an issue for modern performers of early medieval chant related to that of diatonicism. The connection becomes clearer when one considers the consequences of adopting forms of notation prioritising sight-singing and written over oral transmission. As McGee has shown,<sup>186</sup> details of performance practice encoded in adiaستمatic and early diastematic neumatic notations were gradually marginalized following the adoption of staff notation. So-called “ornamental” neumes were not additions to a more basic melodic structure, but signs that conveyed in their very graphic form information about articulation, inflection, and vocal gesture. Such information belonged to a performative logic that became increasingly difficult to accommodate within a staff notation oriented toward fixed pitch, intervallic regularity, and visual legibility.<sup>187</sup> These features nonetheless remained an integrated part of performance practice, sustained orally even as their notational representation became attenuated.

It is therefore telling that, shortly after Guido’s time, “Gregorian chant came to be called *cantus planus* (‘flat song’),” a designation which, as Kelly observes, “doesn’t

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<sup>185</sup> Page, *Christian West and its singers*, 533.

<sup>186</sup> See Timothy J. McGee, “‘Ornamental’ Neumes and Early Notation,” *Journal of the American Musicological Society* 49, no. 1 (1996): 39–40, 44–46; and McGee, *The Sound of Medieval Song: Ornamentation and Vocal Style According to the Treatises* (Oxford: Clarendon Press, 1998), esp. 1–9, 21–35.

<sup>187</sup> Peter Jeffery, *Re-envisioning Past Musical Cultures: Ethnomusicology in the Study of Gregorian Chant* (Chicago: University of Chicago Press, 1992), 67–74.

sound like a music with a lot of elegant performance nuance.”<sup>188</sup> The emergence of square notation in the twelfth century marks a further step in this process. While not implying the disappearance of ornamented or inflected performance as such, the increasingly vertical and pitch-rationalized framework associated with organum and notated polyphony constrained the kinds of vocal nuance that notation could readily encode, a point already suggested by Huglo and subsequently nuanced by later performance-practice scholarship.<sup>189</sup>

Kelly characterizes the staff, accordingly, as both a remarkable technological achievement and, by virtue of its practical efficiency, a blunt instrument that permitted a decline in certain kinds of specialized expertise.<sup>190</sup> This raises the question of whether intervallic perception itself might also be affected by such a reorientation. We favour a positive answer. Polyphony, as an architectural art based on consonant relations, presupposes stability and repeatability of intervallic structures; as in conventional architecture, its foundations must be secure. In this sense, the increasing precision of pitch representation and the relative stabilization of intervals may be understood as a necessary counterpart to the emergence of complex polyphonic forms. The history of notation thus reflects a dynamic of loss and gain: a narrowing of certain melodic and performative possibilities, alongside the opening of new structural and harmonic ones.

Two further authors merit brief mention for their roles in the development of medieval theory and notation. The Benedictine monk Hermannus Contractus (1013–

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<sup>188</sup> Ibid.

<sup>189</sup> Michel Huglo, “Notated performance practices in Parisian chant manuscripts of the thirteenth century,” in *Plainsong in the age of polyphony*, ed. Thomas Forrest Kelly (Cambridge: Cambridge University Press, 1992), 38; Leo Treitler, “Reading and singing: On the genesis of occidental music-writing,” *Early Music History* 4 (1984): 135–208, esp. 198–203.

<sup>190</sup> Ibid.

1054) developed a notational system that—unlike earlier practices—explicitly designated *intervallic relations* between successive notes, though entirely in relative terms. He indicated intervals by using the following letters: ‘s’ (*semitonus*) for the semitone; ‘t’ (*tonus*) for the tone; ‘ts’ for the minor 3rd; ‘tt’ for the major 3rd; ‘d’ (*diatessaron*) for the perfect 4th; ‘D’ (*diapente*) for the perfect 5th; ‘Ds’ for the minor 6th; ‘Dt’ for the major 6th; and ‘e’ (*equaliter*) for the unison. While this system distinguishes intervallic *types*, it does not clarify the *actual sizes* of those intervals; apart from the unison and the perfect consonances, no precise intervallic magnitude is specified.

The importance of Adémar de Chabannes (c. 989–1034) for the history of pitch notation is known primarily through the work of James Grier. Adémar—a French monk, historian, and composer active in Aquitaine—constitutes an exceptional case as a near contemporary of Guido of Arezzo who undertook a comparable reform of notation, largely independently. According to Grier, Adémar was the first to employ *heighted neumes* systematically in order to convey fixed pitch and precise intervallic information. He was also among the earliest scribes to use the *custos* consistently. Moreover, by assigning unequivocal pitch values to liquescent neumes, Adémar effectively clarified Guido’s otherwise ambiguous description of liquescence as involving sliding or indeterminate pitch.<sup>191</sup>

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<sup>191</sup> James Grier, *The musical world of a medieval monk: Adémar de Chabannes in eleventh-century Aquitaine* (Cambridge; New York: Cambridge University Press, 2006), 76.

### **On the monochord and its new use**

Having repeatedly mentioned above the importance of the monochord, we will now confront directly how Guido in his *Micrologus* and the *Dialogus de musica* attributed to Odo<sup>192</sup> advocate its use to facilitate sight-singing and function as a substitute for a teacher.

The monochord, first mentioned in Greece in the 5<sup>th</sup> century BCE, and said to have been an invention of Pythagoras allowing for the safe demonstration of the principles of harmonics. We know that at least from about 300 BCE on, Greek writings used the monochord “as a device to provide both visual and aural representation of the mathematical ratios of the intervals.”<sup>193</sup> Centuries later Boethius employed the instrument in the same way. For Boethius, according to Atkinson, the division of the monochord was crucial to his argument in *De Institutione musica*, “since it provided the means by which the mathematical theory of consonances and systems could be demonstrated precisely and translated into actual sound.”<sup>194</sup> Atkinson emphasizes to that this “translation” was intended for demonstration and measurement, not for prescribing the exact intervals to be sung by the human voice.<sup>195</sup> Thus the monochord functioned primarily as a didactic instrument—a rational, one-dimensional tool designed to illustrate harmonic ratios under controlled conditions.<sup>196</sup> As Claude Palisca and others have noted, its purpose was never to replicate the flexibility of real

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<sup>192</sup> For the origins of this treatise, see Michel Huglo, “L’auteur du ‘Dialogue sur la musique’ attribué à Odon,” *Revue de musicologie* 55, no. 2 (1969): 119–171; and Michel Huglo, “Der Prolog des Odo zugeschriebenen ‘Dialogus de Musica’,” *Archiv für Musikwissenschaft* 28, no. 2 (1971): 134–146.

<sup>193</sup> Cecil Adkins, “The technique of the monochord,” *Acta Musicologica* 39, nos. 1–2 (1967), 43.

<sup>194</sup> Atkinson, *Critical Nexus*, 16.

<sup>195</sup> *Ibid.*, 122.

<sup>196</sup> Mathiesen, *Apollo’s Lyre*, 165–66.

musical performance, but to provide a visual and acoustic analogue to theoretical systems.<sup>197</sup>

The *Micrologus* and the *Dialogus* innovated by recommending the instrument as useful not only for measuring intervals within the science of *harmonics*, but also for its application to the melodies of chant performance. Written in Italy during the first half of the eleventh century, the two treatises were widely disseminated. They are found in more extant manuscripts than any other Latin musical treatise with the exception of Boethius.<sup>198</sup> Bower notes that

Both begin with a monochord division, that is, with the assumption that the Pythagorean ratios determine the intervallic structure of the pitch collection; both derive a collection that is, at its core, identical with the ancient system; and both signify notes on the monochord only with letters that articulate the underlying principle of octave periodicity (when justifying the principle of octave periodicity Guido cites Boethius and criticizes *Musica enchiriadis*).<sup>199</sup>

The “student” in the early-eleventh-century *Dialogus* is astounded that a properly marked monochord can teach melodies better than a person.<sup>200</sup> Guido also boasted that

Some [students], trained by imitating the [steps of the mono]chord, with the practice of our notation, were within the space of a month singing so securely

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<sup>197</sup> Claude V. Palisca, “Boethius and the Development of Musical Thought,” in *Boethius: His Life, Thought and Influence*, ed. Margaret Gibson (Oxford: Blackwell, 1981), 148–49.

<sup>198</sup> M. Bernhard, *Das musikalische Fachschriftum im lateinischen Mittelalter* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1990), 72–73.

<sup>199</sup> Bower, “Transmission of Ancient Music Theory,” 162.

<sup>200</sup> Quote from Sarah Fuller, “Interpreting Hucbald on Mode,” *Journal of Music Theory* 52, no. 1 (2008): 23.

at first sight chants they had not seen or heard, that it was the greatest wonder to many people.<sup>201</sup>

Although figures like Guido d' Arezzo repurposed the monochord for rudimentary pedagogy, yet even then it remained a schematic aid rather than a direct guide for vocal execution.<sup>202</sup> According to Adkins:

[the monochord] not only fulfilled the basic functions allotted to it by the Greeks, but it also served as the principal method of expounding details of music theory -- that is, it was employed frequently in explanation of the mathematical manner of determining intervals and scales, and also *as a pitch-producing device for the teaching of singing* [my emphasis]. The Renaissance and later periods utilized the instrument to a great extent as a practical means of experimenting with scalar variants, and to a lesser extent as a pitch-producing medium for the tuning of keyboard instruments.<sup>203</sup>

By the end of the Middle Ages this “venerated tool of speculative *canonics* – the monochord – [had come to be] used in a highly practical way by teachers: as a musical instrument to establish pitches and scales for singers.”<sup>204</sup> Music theory was thus gradually reoriented towards practices as the music theorist became a pedagogue teaching the elements of music to the would-be performer or composer and

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<sup>201</sup> *Prologus* in *Micrologus*, in Babb and Palisca, *Hucbald, Guido, and John on music*, 58.

<sup>202</sup> Anna Maria Busse Berger, *Medieval Music and the Art of Memory* (Berkeley: University of California Press, 2005), 28–29.

<sup>203</sup> Adkins, “The Technique of the Monochord,” 43.

<sup>204</sup> Gushee, “Questions of genre,” 388.

establishing rules to discipline their practice. “This is by no means to say that “speculative” knowledge of music was in complete disrepute,” reports Gushee,

...such knowledge was valued, but mainly to the extent that it could be of value to *musica practica*. The true *musicus* of the later Middle Ages was now the *cantor peritus et perfectus* – one who not only knew, but could do, to turn Guido’s aphorism on its head.<sup>205</sup>

The implication here is that a monochord could function better than a teacher. Yet Guido was very careful to affirm the importance of a teacher’s guidance. A teacher remained indispensable for the serious study of music:

To find an unknown melody, most blessed brother, the first and common procedure is this. You sound on the monochord the letters belonging to each neume, and by listening you will be able to learn the melody as if from hearing it sung by a teacher. But this procedure is childish, good indeed for beginners, but very bad for pupils who have made some progress. For I have seen many keen-witted philosophers who had sought out not merely Italian, but French, German, and even Greek teachers for the study of this art, but who, because they relied on this procedure alone, could never become, I will not say skilled musicians, but even choristers, nor could they duplicate the performance of our choir boys.<sup>206</sup>

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<sup>205</sup> Ibid., 408; cf. Robert W. Wason, “Musica practica: music theory as pedagogy,” in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), 48.

<sup>206</sup> Oliver Strunk, *Source readings in music history from classical antiquity through the romantic era* (New York: W.W. Norton, 1950), 123. Compare also Guido’s remark in *Micrologus*, “But such things as these are shown better by conferring (colloquendo) than by writing,” ed. J. Smits van Waesberghe (Nijmegen: American Institute of Musicology, 1955), 167. Crocker reinforces this: ‘the passing on of precept in the person of the teacher was at that time more reliable than any graphic alternative for preserving the totality of a piece of chant. It was not the case that alternatives were altogether lacking;

It was in this spirit of practicality and pragmatism that Guido's method was adopted throughout most of Europe: one that would allow cantors to read a completely unknown musical text without any outside assistance at all, because "to sing correctly by themselves [...] and without a master"<sup>207</sup> was a pedagogical desideratum. By the late fourteenth century this spirit was so pervasive that Ciconia was able to claim that singers could learn unknown melodies "either [through] the hand, like the Guidonists, or [through] the monochord, which, like a good teacher, never misleads."<sup>208</sup>

A simple, and perhaps unavoidable, question follows. It is unlikely that highly trained professional musicians constituted the majority of cantors in Guido's time; rather, most were probably practitioners of modest training, concerned primarily with functional correctness. In such a context, Guido's pedagogical devices—especially the monochord—may easily have been received not as provisional aids to musical understanding, but as authoritative determinants of intervallic structure. For cantors whose engagement with music remained largely utilitarian, monochord-derived intervals could thus come to be treated as the end of chanting rather than as a means of cultivating musical taste and judgment in performance. A cautious comparison with contemporary parish-level practice, where similar dynamics between pedagogical tools and musical understanding can still be observed, lends plausibility to this interpretation.

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only that alternatives were inadequate—that is, not as good as personal instruction.' in Crocker, "Hermann's Major Sixth," 28.

<sup>207</sup> Strunk et al., *Source readings*, 212.

<sup>208</sup> From Stefano Mengozzi, "Si quis manus non habeat": charting non-hexachordal musical practices in the age of solmisation," *Early Music History* 26 (2007): 193.

### On “correcting” chant after Guido

Proceeding further into the Latin Middle Ages, we consider now briefly the case of Johannes Cotto or Affligemensis (*fl* c.1100) as a music theorist among the generations of music theorists after Guido who had been formed by his system. His *De Musica* includes chapters on singing and correcting chant demonstrating a preoccupation with rooting out incorrect melodic versions of chants. In the one bearing the title “How the ignorance of fools often corrupts the chant,” he claims to not be sure whether the fact that certain chants “cannot be sung in their proper course results from the fault of singers or whether they were thus issued by composers in the first place.”<sup>209</sup> Evidently finding the singers at fault, he observes that “we do know most assuredly that a chant is oftentimes distorted by the ignorance of men, so that we could now enumerate many corrupted ones.” Johannes’ solution for a ‘corrupted’ chant is either transposition or emendation so that it can be sung to the monochord, the inflexibility of which we have already made apparent.

Laura Weber’s dissertation on the *Tractatus de musica* of Dominican theorist Hieronymus de Moravia (d after 1271), one of the sources of which is Johannes Cotto, casts further light on his perception of certain chants as corrupt. For Weber, *De musica* expresses “an important feature of Dominican musical thought in the 13<sup>th</sup> century: the desire for uniformity in practice across the entire order which was a

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<sup>209</sup> Material in this paragraph drawn from Atkinson, *Critical Nexus*, 242. Johannes is one of those theorists who tend to find in his corrections “diatonic equivalents for microtones or dieses that were part of the earlier singing tradition,” in the words of David G. Hughes, “Evidence for the Traditional View of the Transmission of Gregorian Chant,” *Journal of the American Musicological Society* 40, no. 3 (1987): 400; as we shall see through the notion of broader diatonicism that we propose, these microtones could in fact be of diatonic character, just not of strictly monochord-measured proportions. Johannes is not a single case. For instance, see Rebecca Maloy, “The Roles of Notation in Frutolf of Michelsberg’s Tonary,” *The Journal of Musicology* 19, no. 4 (2002): 641–693 on the early 12<sup>th</sup> c. treatise and lengthy tonary attributed to the scribe, prior Frutolf of Michelsberg Abbey in Bamberg, Germany (d. 1103). Both a theoretical work and practical performance guide, the tonary contains chant passages of practical or theoretical difficulties for which the notation serves to clarify the scribe’s preferred solutions. Traditional versions of melodies are emended by Frutolf to present readings more compatible with modal theory.

significant factor in the liturgical reforms undertaken by the order during the mid-13<sup>th</sup> century.”<sup>210</sup> At the same time Hieronymus himself, closely connected to the music theorists in contemporary Paris, complicates any straightforward equation of notational divergence with “corruption.” In his *Tractatus de musica*, Jerome explicitly describes and names conventional vocal ornaments and melodic expansions of plainchant—such as *reverberatio* (an appoggiatura-like gesture), *flores harmonici* (trill-type ornaments), and interpolated passing notes (*nota mediata*)—thereby documenting a regulated layer of performance practice that exceeds what is strictly written.<sup>211</sup>

A similar mentality underpinned the twelfth-century Cistercian reform of chant, a movement Marcel Pérès notably described as a turning point “when the frame of reference ceased being a tradition passed on orally by a living authority, and became a system of logic transmitted in writing.”<sup>212</sup> This rational approach to reform—seeking authentic roots in a systematized logic—has been illuminated in detail by Claire Maître. In her critical study *La réforme cistercienne du plain-chant: étude d’un traité théorique* (1995), Maître demonstrates how Cistercian theorists, particularly through Guido d’ Eu’s *Regule de arte musica*, sought to purge the liturgy of ornamental accretions and restore a coherent modal system. She shows that the Cistercians “systematically emended existing melodies to eliminate superfluous figures,” ensuring each chant’s mode was unmistakable, with every scale-degree

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<sup>210</sup> Laura Weber, *Intellectual currents in thirteenth century Paris: a translation and commentary on Jerome of Moravia’s Tractatus de musica*. PhD Thesis (Yale University, 2009), 40–41.

<sup>211</sup> *Ibid.*, 166-170 and 210-212.

<sup>212</sup> Material for the Cistercians drawn from Marcel Pérès’ liner notes in the CD album *Chant cistercien (monodies du XIIIe siècle)—Ensemble Organum/Marcel* (Harmonia mundi, 1992). On the reforms of the Cistercians as a major force in the dissemination of literacy in general, and staff notation in medieval Europe, see Page, *Christian West and its singers*, 502.

retaining its hierarchical role and the melodic compass strictly bounded.<sup>213</sup> Maître situates this reform within the broader Cistercian effort to renew monastic life through clarity and primitive purity.<sup>214</sup> The resulting chant repertory, reworked to conform to theoretical modal frameworks, exemplifies the order's commitment to liturgical austerity and logical clarity—reflecting the same mindset that drove their architectural and spiritual disciplines.

### **On Just Intonation**

Although it would have been possible to discuss additional medieval theorists, we shall bring the central section of this chapter to a close by addressing the transformation of diatonicism in the Renaissance. The first music theorist to assert the primacy of triad as a means of structuring harmony was the Venetian composer and theorist Gioseffo Zarlino (1517–90), “easily the most influential personality in the history of musical theory from Aristoxenus to Rameau.”<sup>215</sup> Zarlino departed from the Pythagorean diatonic system as passed on by Boethius with his exposition of just intonation (henceforth JI). With intervals based on Ptolemy's aforementioned tense diatonic tetrachord, JI was praised by the Italian theorist for its purity, evinced by its relatively small superparticulars.<sup>216</sup> Given its Ptolemaic roots, however, why is the JI attributed to Zarlino?

Before we answer this question, it is necessary for us to acknowledge that the number of possible “just” or “pure” intonations is as infinite as the harmonic series. This is

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<sup>213</sup> Claire Maître, *La réforme cistercienne du plain-chant: étude d'un traité théorique*, *Studia et Documenta* 6 (Brecht: Abdij Nazareth, 1995), esp. 120–200.

<sup>214</sup> Eadem, “The Regule de arte musica,” *Music & Letters* 63, nos. 3–4 (1982): 341.

<sup>215</sup> Strunk et al., *Source readings*, 228.

<sup>216</sup> *Ibid.*, 228–61.

because JI is achieved through the tuning of musical intervals as whole number ratios of frequencies. It is then a question of where one places the numerical limit to keep these intonations simpler (i.e. smaller integers) or more composite. If, for example, the main tuning principle is to use the smallest possible numbers, then the foundation of “justness” lies at the 3-limit, which entails tuning by fifths and fourths. This is none other than the diatonic genus of Eratosthenes, the ditonic diatonic Pythagorean.

To be more specific: the 3-limit tuning system consists of intervals whose frequency ratios involve only the prime factors 2 and 3. That is, all pitch relationships are built using combinations of these primes: for example,  $2/1$  (octave),  $3/2$  (perfect fifth), and  $4/3$  (perfect fourth), with 4 simply being  $2^2$ . As a result, the tuning lacks prime factor 5, which is necessary for generating justly tuned major thirds ( $5/4$ ) and sixths ( $5/3$ ). Consequently, in such a system, scale degrees corresponding to the third, sixth, and seventh (e.g., E, A, and B in a C-based scale) sound significantly too sharp when compared to JI, making them not only difficult to sing accurately, but also unsatisfactory in harmonic resonance.

What Ptolemy did, was to “soften” these degrees, while remaining in the realm of JI: he tempered these steps by  $81/80$ , a Didymean comma that is.<sup>217</sup> To be more precise, the whole ptolemaic construct we are about to describe is initially designated in the writings of Ptolemy as the diatonic genus *according to Didymus*; it is only a form of it, with the intervals in reversed order, which Ptolemy presents as his; otherwise he uses none other than the Didymean ratios.

The emerging mutation widens the prime factors used by adding one, resulting in a new JI limit, 5 instead of the previous 3. The resulting tetrachord consists of a major

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<sup>217</sup> The syntonic or widely known as the Didymean comma, alternatively known through the history of music theory as the diatonic comma, as well, or the chromatic diesis, or the Ptolemaic comma.

tone (9/8), a lesser tone (10/9, here is the first instance of the integer 5), and a just diatonic semitone (16/15, with the use of integer 5 as well), and is called Ptolemy's "(in)tense" diatonic tetrachord. Whereas the diatonic of the Pythagorean Eratosthenes, with its preference for the perfection of fifths (and fourths), is unconcerned with the harmonic resonance of the thirds and sixths, the Didymean (and Ptolemaic) mutations provide just thirds and sixths as well. The major and minor (thirds of 5/4 and 6/5; sixths of 8/5 and 5/3) of the latter are smoother and more easily tuned by the voice than Pythagorean thirds and sixths. Zarlino therefore established the Ptolemaic tense diatonic in his *Istituzioni armoniche*<sup>218</sup> as the only tuning suitable for performing vocal polyphony.<sup>219</sup>

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<sup>218</sup> Gioseffo Zarlino's the *Harmonic Institutions*, is one of the most important treatises on musical education. Aristotelian in spirit, it is divided in two parts, the theoretical ("contemplative" on the matter of intervals and consonances) and the practical (on counterpoint and its form). Gioseffo Zarlino, *Istituzioni armoniche*, partially translated in Strunk et al., *Source Readings*, 229-261

<sup>219</sup> Followed in this opinion by many including Vincenzo Galilei, Lodovico Zacconi, and Nicola Vicentino. See Gioseffo Zarlino, *Le istituzioni harmoniche*, ed. Claude V. Palisca (Rome: American Institute of Musicology, 1983), 81-95; Claude V. Palisca, *Humanism in Italian Renaissance Musical Thought* (New Haven: Yale University Press, 1985), 234-36; Vincenzo Galilei, *Dialogo della musica antica et della moderna* (Florence: Giunti, 1581), trans. Claude V. Palisca in *Music Theory in the Renaissance* (New York: Norton, 1968), 210-15; Franchinus Gaffurius, *Practica musicae* (Milan: 1496), trans. Irwin Young (Madison: University of Wisconsin Press, 1968), 132-40; Lodovico Zacconi, *Prattica di musica* (Venice: Bartolomeo Carampello, 1592); Nicola Vicentino, *L'antica musica ridotta alla moderna prattica* (Rome: Antonio Barre, 1555), facsimile ed. and trans. by Claude V. Palisca (New Haven: Yale University Press, 1996). Cf. also the views of the 18<sup>th</sup>-century composer Giuseppe Tartini in Dr. Crotch, "On the Derivation of the Scale, Tuning, Temperament, the Monochord, etc.," *The Musical Times* October 1, 1861), 115.

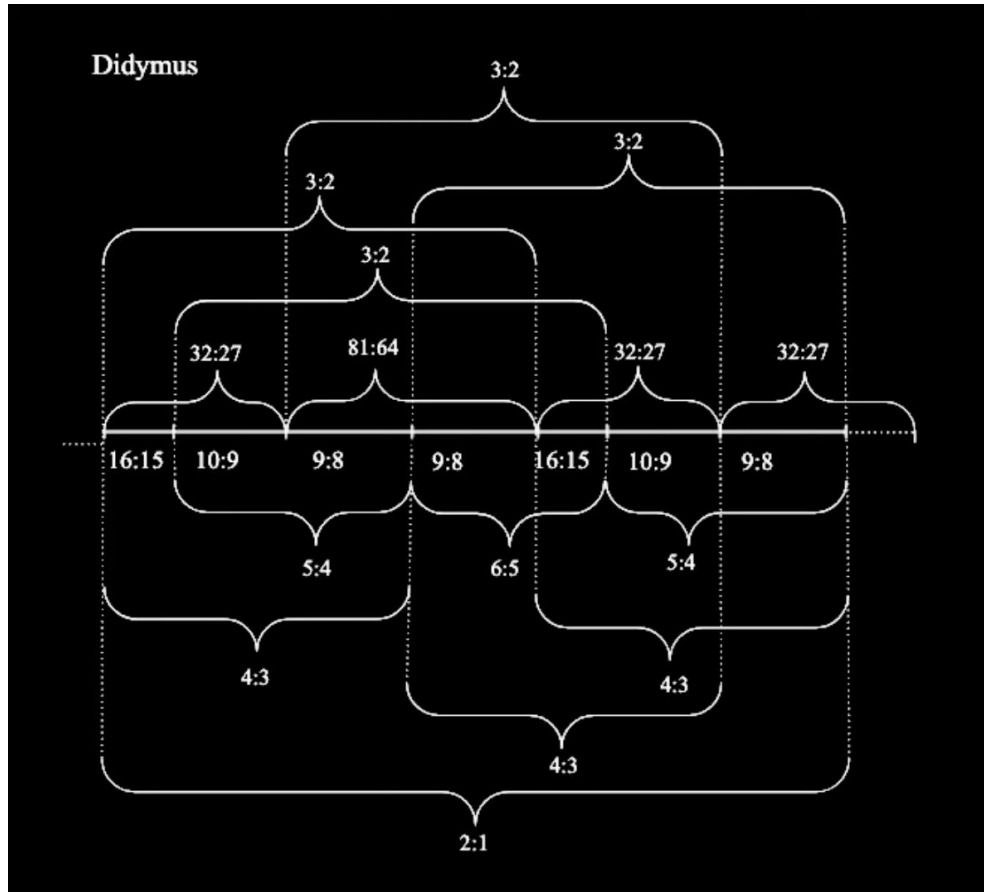


Fig.2.1. Illustration of the JI, the standard Zarlinian tuning derived from Ptolemaic tense diatonic and Didymean intervallic principles. *Screenshot from Socratic Swansongs, Eight Preludes for Piano and Sax in Ancient Greek Attunements (Harmonia): Just Intonation Microtonal (2023), 02:15.*

## Conclusions

This chapter has traced how interval theory in the medieval Latin West developed from a primarily speculative discipline into a practical and increasingly prescriptive system for chant. Beginning with Boethius, the Western tradition inherited Greek harmonics mainly as *philosophical and mathematical doctrine*, not as a descriptive theory of living performance. Boethius' careful distinction between theory and musical practice—especially his awareness of continuous vs. discrete pitch—shows that late antique harmonics was not designed to regulate the voice in liturgical singing. However, in the Carolingian and post-Carolingian world, the needs of pedagogy, liturgical uniformity, and institutional reform required a very different kind of musical knowledge: one that could support rapid training, standardization, and written transmission.

The chapter has shown that this practical demand altered the meaning and function of theory. From the ninth century onward, Frankish and later theorists increasingly treated theoretical categories—tone, semitone, octave, and mode—not simply as analytical tools, but as *normative structures*. This shift is visible in the growing effort to align chant with a fixed pitch system derived from the monochord and organized through octave equivalence. As a result, the inherited Greek framework was not merely transmitted: it was effectively *reinterpreted* so that scalar systematisation could function as a disciplinary guide for chant practice.

A key point in this development is the contrast between two competing tendencies within early Western theory. On the one hand, treatises such as the *Musica enchiriadis* preserve traces of a more flexible tonal logic, including tetrachordal thinking and mechanisms for relocating semitones (the so-called *vitia* or *leimmata*).

Even if partially schematic, this tradition suggests that Western chant practice could tolerate pitch patterns that did not conform neatly to a rigid octave-based scale. On the other hand, later authorities—especially Guido of Arezzo and the pedagogical tradition he shaped—rejected such systems as theoretically incoherent and replaced them with a diatonic, octave-structured gamut that could be taught, written, and corrected with far greater clarity.

The adoption of staff notation and related pedagogical tools marks the decisive culmination of this process. What began as an attempt to support memory and improve teaching increasingly became a mechanism for controlling and normalizing sound. The monochord, originally a scientific device for demonstrating interval ratios, was repurposed as a reference instrument for chant training; notation moved from indicating contour toward increasingly explicit pitch placement; and the ability to sight-sing became an institutional ideal. In this framework, melodic details that resisted pitch discretization—especially those linked to vocal nuance, ornamentation, and flexible intonation—became less accessible to notation and more vulnerable to being reclassified as error, corruption, or local deviation.

The chapter's final sections showed that this prescriptive tendency did not stop at transmission but extended to *reform*. The corrective mentality seen in writers such as Johannes Cotto (and later, in movements such as the Cistercian reforms) illustrates how the notated and systematised diatonic framework became a benchmark against which older chant traditions could be judged and altered. Even where oral practice may have preserved nuance beyond what was written, the intellectual authority of written pitch systems increasingly shaped what could count as correct musical knowledge. In the Western case, this development also anticipates later harmonic

priorities: as polyphony becomes structurally central, stable and repeatable intervallic frameworks acquire even greater importance, further reinforcing discretized pitch and regulated tuning logic.

In short, the Western reception of ancient harmonics produced not only a transmission of Greek theory but a transformation of its role. Through a series of related developments –Carolingian liturgical reforms, pedagogical priorities, broader use of the monochord, and the rise of staff notation – Western chant theory gradually moved toward a conception of pitch that was increasingly fixed, measurable, and enforceable. This reorientation explains why later Western theoretical discourse tends to collapse older flexibility into a limited diatonic framework, and why traces of alternative pitch behaviour survive only indirectly, often framed as “irregularity” or “corruption.”

The survey of Western theoretical traditions from Boethius to the Carolingian reformers has therefore shown that the gradual convergence of speculative harmonics, pedagogical pragmatism, and notational technology led to increasingly prescriptive conceptions of pitch and interval. In this context, the theoretical discretization of sound—originally an abstract tool for philosophical inquiry—came to function as a normative framework against which chant practice itself was measured, corrected, and eventually constrained. The result was not merely a clarification of musical structure, but a fundamental reorientation of the relationship between theory and performance, in which notation and scalar systematisation increasingly dictated melodic possibility. If this development explains the historical trajectory of Western chant theory, it also highlights the methodological difficulty faced by any attempt to reconstruct earlier or parallel traditions whose transmission remained predominantly oral and whose intervallic logic was not fixed through comparable prescriptive systems.

The following chapter therefore turns to the Byzantine theoretical tradition, and in particular to the nineteenth-century synthesis of Chrysanthos of Madytos, not as a direct witness to medieval practice, but as a historically situated reference framework. Read critically and comparatively, Chrysanthos' tuning system offers a coherent point of orientation for evaluating intervallic structure in Byzantine chant without importing the prescriptive assumptions that shaped Western medieval theory.

## Chapter 4

## THE CHRYSANTHINE TUNING SYSTEM AS HISTORICAL REFERENCE

**Preamble**

Chapter 3 showed that the question of “intervals” in medieval chant is never just a technical matter. In both the Western and Eastern Roman traditions, notation can transmit the *melodic logic* of chant, but it does not fully transmit its *actual sound*. Even when notation becomes more detailed, it still assumes that singers already possess oral, embodied knowledge of how the chant should be performed.

Medieval Latin theorists gradually tried to standardise chant by fixing it within increasingly prescriptive pitch systems. In the Eastern Roman tradition, however, Middle Byzantine notation communicated modal identity mainly through signs indicating successions of intervals within a melody and the quality of their vocal performance, rather than by giving exact pitch and interval sizes. This gap between what is written and what is performed becomes most visible when the sources explicitly indicate moments of “alteration” or “corruption”: in Latin chant through categories such as *vitia* and *absoniae*, and in Byzantine chant through *phthorai*, modulatory signatures, and later through theoretical discussions of the musical genera.

This chapter takes that shared problem as its point of departure and turns to the dissertation’s central question: how can a historically responsible reference tuning for

medieval Byzantine chant be proposed in the absence of direct acoustic evidence? Reconstruction requires a defensible scale model, yet Byzantine sources prior to the nineteenth century do not provide fixed, measurable interval sizes, operating instead through melodic formulas characteristic of particular modes and tonal regions. For this reason, the New Method reform—and especially the systematisation undertaken by Chrysanthos of Madytos—becomes methodologically decisive, since it offers one of the earliest comprehensive attempts to codify Byzantine modal practice within a ratio-based intervallic framework.

Since Chrysanthos' explicit ratios cannot be treated as a direct witness of medieval practice, we propose that the Chrysanthine tuning system should be treated as a historically plausible reference model—a “least-wrong” framework through which medieval melodic phenomena may be tested in performance. Read comparatively within an Eastern Mediterranean modal ecology (Zalzal, al-Farabi, Ottoman traditions, Persian fretting systems), Chrysanthos' intervals—his major tone (9/8), minor tone (12/11), and minimum tone (88/81)—can be understood as a codification of an older and regionally shared intervallic logic. The chapter therefore seeks both to clarify a medieval definition of chromaticism beyond rigid augmented-second ideologies and to establish the Chrysanthine system as the most coherent historically grounded reference tuning currently available for reconstructive performance practice of specific troparia in the Second Modes. Given the necessarily extensive scope of this chapter, we offer here an outline of its structure:

**Section I — Preliminaries on the nature of chromaticism in medieval Byzantine chant:**

- The function of medieval modal signatures that in later centuries determine intervals.

- The phthorai as controlled disruption or reconfiguration of the diatonic frame, implying alteration and transposition long before they imply a fixed chromatic genus.
- Medieval Byzantine “chromaticism” understood as deviation from the normative diatonic disposition (in terms comparable to the Western notion of *vitia/absonia*), and not necessarily a specific scalar genus.

**Section II — On the invention of a new chromatic definition in the nineteenth century:**

- The redefinition of chroma as, in the writings of the early nineteenth century, any re-arrangement of the diatonic scale. We suggest that this approach may illuminate medieval realities more effectively than more rigid definitions.

**Section III — On Chrysanthos’ tuning as a reference: methodological and comparative framework:**

- A necessary methodological and conceptual defence of using Chrysanthos as a framework for reconstructing the performance earlier layers of the Byzantine musical tradition. Using comparative Near Eastern evidence and perceptual theory, we argue that “chromaticism” can emerge from diatonic interval structures. Consequently the “soft chromatic” in Byzantine chant may be structurally diatonic but perceptually chromatic.

**Section IV — Corrective interventions: On Chourmouzos and the canonisation of “soft” chromaticism:**

- The fourth part analyses the critical corrective step that made the soft chroma viable as a coherent octave species: the interventions of Chourmouzos Chartophylax. This section is central for the thesis because it supports a claim of great methodological importance: the New Method was never a closed system but a working framework explicitly open to further refinement (by contrast with the position encountered later in Section IX).

**Section V — On organology and the acoustic archaeology of neutral intervals:**

- Develops a sustained argument from organology (with main reference to the *ney* reed flute) to support the thesis that Chrysanthos’ intervals align with stable acoustic possibilities.

**Section VI — On neutral thirds as structural constants: Arabic, Ottoman, and Persian evidence:**

- Broadening to the comparative modal sphere we examine Zalzal’s *wuṣṭā*, al-Farabi’s multiple placements, Ottoman *tanbur* fretting, and Persian modal structures. The emphasis here is on the enduring presence of “middle thirds” in the 340–355 cent region. This comparative evidence functions as the strongest historical defence of the Chrysanthine neutral third ( $\approx 347$  cents): it is not uniquely Byzantine, but pan-regional.

**Section VII — Application to Byzantine chant reconstruction and performance practice:**

- How can Chrysanthos’ tuning be used as a practical reference model for reconstructing medieval Byzantine chant? Clarification of what the system can and cannot claim historically, showing why it remains structurally useful for modal analysis.

**Section VIII — On observational error theory:**

- The chapter’s final theoretical section introduces observational error theory and Bayesian-like logic as a justification for preferring Chrysanthos over later “corrections” when the corrections are less historically grounded.

**Section IX — On the 1881 Patriarchal Committee: ideology and arithmetic bias:**

- Evaluation of the Patriarchal Committee’s attempt to “correct” Chrysanthos. Its reliance on repeated comma-subtractions as mathematically arbitrary and historically unmoored, producing ratios neither perceptually distinctive nor supported by comparable Eastern traditions in contrast to structurally coherent Chrysanthine ratios confirmed across neighbouring cultures.

## Section I — Preliminaries on the nature of chromaticism in medieval Byzantine Chant

Because Middle Byzantine notation provides no direct interval measurements, the chapter begins with those notational devices that explicitly signal alteration—modal signatures and *phthorai*—since these constitute the primary medieval witnesses to what later theory would label as indicators of chromaticism.

### *On the indications of modal signatures*

As Strunk notes, a Byzantine modal signature (*martyria*) is a conventionalised sign designed to indicate to the singer both the modality of the melody to follow and the step of the system from which its initial tone is to be reckoned. In addition to initial signatures, Byzantine notations also employ medial signatures (MeSi).<sup>220</sup> Raasted argues that MeSi were used in Palaeobyzantine and Middle Byzantine manuscripts to prepare and support modal changes within a melody and were often placed at textual “turning points,” where musical articulation follows the structure of the text.<sup>221</sup> In the NM, however, the relationship between signatures and intervallic instruction is comparatively explicit: the diatonic and chromatic classifications of the Second-mode family are distinguished by different signature conventions:<sup>222</sup>

- for the diatonic Second Mode, the *martyriai* are those of *legetos* (a symbol depicting a λΓ from λέγετος):

<sup>220</sup> Oliver Strunk, “Intonations and Signatures of the Byzantine Modes.” *The Musical Quarterly*, Vol. 31, No. 3 (Jul., 1945), pp. 339-355, 340.

<sup>221</sup> Raasted, *Intonation Formulas*, 96.

<sup>222</sup> There are instances of question, but the general consensus is the one described here. Significant exceptions in NM are the exegeseis of the Second authentic mode in kalophonic octoechal mathemata, where it was transcribed in both chromatic and diatonic *martyriai*. See for instance the patriarchal musical editions of *Mousike Pandekte* (1851) or the long series *Tameion Anthologias*.



Fig.4.1. The standard NM martyria of the diatonic second mode (Legetos)

- for the chromatic Second Modes (authentic and plagal), the signatures use a byzantine version of the beta letter:

1	2
ω	α δ λ α δ
υ	Β Β Β β β

Tab.4.1. Characters in minuscule codices: in col. 1 the pure forms, used in the vetustissimi; in col. 2 altered minuscules, cursive and uncial forms - from Groningen, *Greek Palaeography*, 34<sup>223</sup>



Fig.4.2. First Mode martyria in MB notation (left) and in Chrysanthos' treatises (right)



Fig.4.3. Second Mode martyria in MB notation (left) and in Chrysanthos' treatises (right)

<sup>223</sup> Bernhard Abraham van Groningen, *Short Manual of Greek Palaeography*, 4th printing (Leiden: A. W. Sijthoff, 1967), 34.

In the Middle Byzantine phase, however, the same graphic distinctions cannot be assumed to carry the same intervallic implications. In particular, the minuscule beta functions as the standard Second-mode signature, without thereby encoding a specific chromatic scale. Conversely, legetos-type medial signatures appear in certain 14<sup>th</sup>-c. manuscripts primarily in extended kalophonic and papadic contexts and in association with particular patterns of melodic motion,<sup>224</sup> rather than as typical indicators that “this Second-mode chant is diatonic.” The methodological consequence is crucial for the present chapter: medieval signatures can identify modal location and facilitate local shifts, but they cannot be read straightforwardly as fixed intervallic labels in the later Chrysanthine sense.

A related ambiguity concerns the sign *nenano*: a sign originating in the palaeobyzantine tradition as a *phthora* (literally “corruption”)—a sign “corrupting” the melody towards what Chrysanthine theory calls the chromatic genus.



Fig.4.4. Martyria (signature) of *Nenano* in NM

Yet in medieval sources the same graphic element may appear as an initial or medial signature rather than a *phthora* in the later technical sense. This difference of function is one of the central points on which interpretations of medieval chromaticism turn.

<sup>224</sup> The *melos* of the *Heirmologion* consists of relatively simple, syllabic chant used for model hymns (*heirmoi*); the *Sticherarion* includes more florid but metrically regular melodies for *stichera* (for more detail, see Chapter 5); the *Papadike* transmits both theoretical content and ornate didactic pieces used in chant training; *kalophonic* compositions, by contrast, feature highly elaborate, melismatic reworkings of earlier chant, often used in solo performance and rich in embellishment. Many thanks to Arvanitis, who brought to our attention that the oldest dated *Papadike* (dating from 1336, Ms Atheniensis NLG 2458) contains the medial signature of *Legetos* only 4-5 times, but generally it constitutes a manuscript containing limited medial signatures; *legetos* signatures get gradually more frequent in later mss.

*Phthorai* (“Corruptions”): Modulation and Alteration Signs before “chromatic genera”

Graphically derived from the Greek letter φ, phthorai are often described as modulatory signs. In medieval usage they are better understood as indicators of *modulation*—a controlled “corruption” of what is currently being sung and a reorientation of melodic syntax. This conceptual frame appears already in the stands at the head of a theoretical tradition resumed in the fifteenth century with the treatises by Gabriel the Hieromonk and Manouel Chrysaphes. The *Hagiopolites* mentions that two of the phthorai – Nenano and Nana – function normally as a pair of modes in addition to the usual eight of the Octoechos system. The same treatise also calls them non-echoi. From this difficult expression we are led to understand that their melodic formulas were peculiar enough to form “new” modes requiring integration into the eight-week modal cycle of the church of the Holy City of Jerusalem:

φθοραὶ δὲ ὠνομασθήσαν, ὅτι ἐκ τῶν ἰδίων ἤχων υπᾶρχονται, τελειοῦνται δὲ εἰς ἑτέρων ἤχων φθογγὰς αἱ θέσεις αὐτῶν καὶ τὰ αποτελέσματα. [They were called Phthorai (i.e. destroyers), because they begin from their own Echoi, but the theses of their cadences and formulas are on notes (phthongoi) from other Echoi.]<sup>225</sup>

*Nana* and *nenano* therefore occupy an anomalous position in the Hagiopolitan Octoechos classification system: they are treated both as phthorai and, in certain formulations, as quasi-modes integrated alongside the standard octoechos. The

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<sup>225</sup> Raasted, *Hagiopolites*, 42.

Hagiopolites explains that phthorai were so called because they begin “from their own echoi,” yet their melodic formulas and cadential theseis results resolve on the pitch-material of other modes. In this sense, a medieval phthora does not automatically signal, as in later periods, the introduction of “chromaticism” as a fixed genus. According to the Hagiopolites, it could mark instead a shift of melodic grammar and tonal orientation within the modal system.

The Hagiopolites also sets its extended Octoechos within a wider Constantinopolitan environment. The same treatise reports an alternative system of sixteen echoi “sung in the Asma,”<sup>226</sup> including mesoi and additional phthorai,<sup>227</sup> indicating that medieval practice could accommodate more tonal categories than the an eight-mode liturgical and pedagogical framework of modes might suggest. These observations are significant because they establish, at the level of medieval theory itself, that

<sup>226</sup> The *Asma* is a repertory of mainly melismatic chants setting texts representing both the *Ecclesiastikos* tradition of the Constantinopolitan rite of the Great Church of Hagia Sophia and the *Hagiopolites*, the rite of the Holy City of Jerusalem. The *Asma* constituted only the proto-kalophonic stratum of the repertory; other components of the tradition were transmitted through the *Asmatikon* and the *Psaltikon*. The manner in which the *Ekklesiastikos* and *Hagiopolites* traditions interacted between the 8<sup>th</sup> and 14<sup>th</sup> centuries represents a highly complex historical process, one that is only now beginning to be investigated in a more systematic and comprehensive manner. For an inventory of manuscripts (all copied in Southern Italy) containing the *Asma* repertory, see Bartolomeo Di Salvo, “Gli asmata nella musica bizantina,” *Bollettino della badia greca di grottaferrata* XIII, XIV (1959–60): 45–50, 127–45; 45–78. A tentative exploration of the liturgical questions is Stig Simeon R. Frøyskov, “The Early History of the Hagiopolitan Daily Office in Constantinople: New Perspectives on the Formative Period of the Byzantine Rite,” *Dumbarton Oaks Papers* 74 (2020): 351–82.

<sup>227</sup> «Οἱ μὲν οὖν τέσσαρες πρώτοι οὐκ ἐξ ἄλλων τινων ἀλλ'ἐξ αὐτῶν γίνονται. οἱ δὲ τέσσαρες δευτέροι, ἤγουν οἱ πλάγιοι, ὁ μὲν πλάγιος πρῶτος ἐκ τῆς ὑποροῆς τοῦ πρώτου γέγονε. καὶ ἀπὸ τῆς ὑποροῆς τοῦ πληρώματος τοῦ δευτέρου γέγονεν ὁ πλάγιος δευτέρου· ὡς ἐπὶ τὸ πλεῖστον δὲ καὶ τὰ πληρώματα τοῦ δευτέρου [εἰς τὸν πλάγιον δευτέρου] τελειοῖ. ὁ βαρὺς ὁμοίως καὶ ἀπὸ τοῦ τρίτου· καὶ γὰρ εἰς τὸ ἄσμα ἢ ὑποβολὴ τοῦ βαρέως τρίτος ψάλλεται ἅμα τοῦ τέλους αὐτοῦ. καὶ ἀπὸ τοῦ τετάρτου γέγονεν ὁ πλάγιος τέταρτος. καὶ ἀπὸ τῶν τεσσάρων πλαγίων ἐγεννήθησαν τέσσαρες μέσοι· καὶ ἀπ'αὐτῶν αἱ τέσσαρες φθοραί. καὶ ἀνεβιβάσθησαν ἤχοι ἰς', οἵτινες ψάλλονται εἰς τὸ ἄσμα, οἱ δὲ δέκα ὡς προείπομεν εἰς τὸν Ἀγιοπολίτην.» [“The four Echoi which come first are generated from themselves, not from others. As to the four which come next, i.e. the Plagal ones, Plagios Prōtos is derived from Prōtos, and Plagios Deuterios from Deuterios – normally Deuterios melodies end [in Plagios Deuterios]. Similarly, Barys from Tritos, for in the *Asma*, Hypobole of Barys is sung as Tritos together with its ending”. From the four Plagioi originate the four Mesoi, and from these the four Phthorai. This makes up the sixteen Echoi which are sung in the *Asma* – as already mentioned, there are sung only ten in the *Hagiopolites*.”] (Raasted, *Hagiopolites*, 14).

modulatory signs and “extra-modal” motion can be structurally embedded without implying the presence of a single, stable chromatic scale.

*Nana and nenano: two paradigms of transformation*

Tillyard frames the problem of “chromaticism” in Byzantine chant historically and functionally.<sup>228</sup> He proposes that clear signs of change become apparent in the 13<sup>th</sup> c., when a chromatic sub-mode identified by the intonation formula *nenano* becomes increasingly used. Crucially, however, he does not treat *nenano* as a full echos within the formal modal structure; rather, he sees it as effecting chromatic modulation within one of the established diatonic modes. Tillyard also remarks that in the Neo-Byzantine (Chrysanthine) system *nenano* later assumes a different status, effectively replacing the diatonic identity of *Plagal Second*. The methodological implication is straightforward: the later prominence of *nenano* within the Chrysanthine system cannot be assumed to describe its medieval function.

Wolfram, writing more recently from a more systematising perspective, shifts attention from *nenano* as a primarily modulatory procedure toward the question of what tonal and intervallic content such transformations might entail. In her account, the introduction of *nana*<sup>229</sup> indicates modulation into the *triphōnos* region G–c.<sup>230</sup>

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<sup>228</sup> Tillyard, *Handbook*, 30–6; cf. Tillyard, “The Modes in Byzantine Music,” 140.

<sup>229</sup> The name “*nana*” is taken from the syllables (written in ligatures “*λλ*”) sung during the intonation which precedes a melody composed in this mode. According to Chrsyanthus the “*nana*” intonation is the standard for the third authentic mode.

<sup>230</sup> Gerda Wolfram, “Die *Phthorai* der paläobyzantinischen Notationen,” in *Palaeobyzantine Notations: A Reconsideration of the Source Material*, ed. Jørgen Raasted and Christian Troelsgård (Hernen: A. A. Bredius Foundation, 1995), 122. Available online: <https://archive.org/details/palaeobyzantine-notations/Palaeobyzantine%20Notations%20I/>; Ioannis Zannos, *Ichos und Makam. Vergleichende Untersuchungen zum Tonsystem der griechisch-orthodoxen Kirchenmusik und der türkischen Kunstmusik*. (Bonn, Orpheus Verlag, 1994), 112.

while Nenano<sup>231</sup> is more complex: it produces chromatic alterations in different tonal areas and tends to culminate in the Plagal Second.<sup>232</sup> On the basis of Byzantine theoretical treatises and musical examples, Wolfram proposes for nenano a chromatic tetrachord E–F–G♯–A (or alternatively D–E ♭ –F♯–G). At the same time, she stresses that Chrysanthos’ division into diatonic/chromatic/enharmonic genera is only relative within the Byzantine modal system, and she further concludes that Middle Byzantine manuscripts with diastematic notation provide no evidence for a fully articulated “modulation system”; in that repertory, nana and nenano often appear not as phthorai but as initial or medial signatures. This combination of claims sharpens the central interpretive difficulty: the same signs may be read either as functional markers of transformation or as signatures of a fixed chromatic genus, and the medieval notational evidence does not force a single conclusion.

In his treatise, Manuel Chrysaphes articulates an understanding how phthorai were used in his own era.<sup>233</sup> In his wording, “A phthora is the unexpected corruption of the melody of the echos being sung and the creation of another melody, together with a brief, partial transposition from the echos being sung to another.”<sup>234</sup> This allows notators to indicate the exact place, where a transposition (*μεταβολή κατὰ τόνον*) would take place.

It is not entirely clear to what extent Chrysaphes was relaying longstanding practice in Byzantine ecclesiastical chant or providing tools for the technical innovations of late Byzantine composers. Chrysaphes wrote his treatise according to Wolfram, under the

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<sup>231</sup> Because of its additional status as one of the two extra modes in the system of *Hagiopolites*, nenano has been subject of much attention in Byzantine and post-Byzantine music theory. Papadikai such as the manuscript EBE 899 and other late Byzantine manuscripts associate nenano and nana with a corruption of intervals, see Eustathios Makris, “The Chromatic Scales of the Deuterios Modes in Theory and Practice,” *Plainsong and Medieval Music* 14 (2005), 3.

<sup>232</sup> Wolfram, “Die Phthorai,” 121-125.

<sup>233</sup> Conomos, *The Treatise of Manuel Chrysaphes*, 55-65; cf. Wolfram. “Fragen.” 581-582.

<sup>234</sup> Conomos, *The Treatise of Manuel Chrysaphes*, 48.

influence of Pachymeres and Bryennius, the classicising music theorists of the fourteenth century. Some of the modulatory techniques he describes appear rooted in orally transmitted performance practices employed for the realisation of older chants recorded in Palaeobyzantine and Middle Byzantine notations. While Chrysaphes gives only examples of kalophonic compositions from the fourteenth and fifteenth centuries,<sup>235</sup> the examples of phthorai given by Raasted and Wolfram that we cited above feature chromatic alterations occurring as a result of systemic transpositions.<sup>236</sup> The *vitia* or *absonia* in the Latin sources that we discussed in Chapter 3 are similar instances of chromaticism, with chromatic alterations placing semitones where tones normally occurred.

The tension between models of chromaticism relating to temporary alterations of intervals and those rooted in broader conceptions of diatonicism becomes particularly consequential when phthorai and medial signs are interpreted as evidence for chromatic scales with augmented seconds. As we shall see below, Arvanitis sees the former model as representing a particular interpretive tendency in modern scholarship. Wolfram's investigations—despite the value of her descriptive work—rest on the assumption of a broadly diatonic tonal system interrupted by local alterations and temporary transitions to scales with augmented seconds. This leads her to conclude that medieval phthorai entail specifically “chromatic” (augmented-second) pitch structures.<sup>237</sup> Nevertheless, Wolfram remains cognisant of the dangers of over-systematisation: the medieval notational evidence does not behave like a

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<sup>235</sup> Other usual phthorai are thematismos, thema haploun, henarxis - according to the Papadikai of the Messina mss for instance.

<sup>236</sup> Cf. Gerda Wolfram and Christian Troelsgård, eds., *Der Traktat des Akakios Chalkeopulos zum Byzantinischen Kirchengesang* (Turnhout: Brepols, 2021).

<sup>237</sup> See Ioannis Arvanitis, “Phthora and Chromaticism in Early and Late Byzantine Chant,” unpublished paper presented at the meeting of the international research group *Cantus Planus*, within the 17th International Congress of the International Musicological Society, Leuven, Belgium, August 1–8, 2002.

stable scale-signature system and “phthorism” may simply mean any deviation from the diatonic scale without genus transposition.<sup>238</sup> Such a phthoric definition of chromaticism will occupy us soon in Section II.

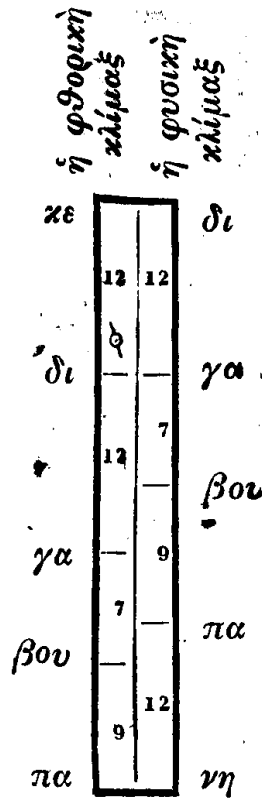


Fig.4.5. Rearranged diatonic as *corrupted*: comparison of the “natural” diatonic scale (right) with the rearranged-diatonic *phthoric* (left) not explicitly associated with chromaticism - from Chrysanthos,

*Θεωρητικόν Μέγα*, 173

*Consequence in modern scholarship: The continuity narrative of the “Greek School”*

<sup>238</sup> Lekkas has contributed to the study of the phthorai in recent publications, by suggesting that according to mathematics, the primal use of the phthorai (nenano and nana) seems to be primarily corrective; he holds that the notational signs of nenano and nana were probably invented to correct impure fourths to pure ones, notwithstanding the intervallic impact of such a modification. He sees the corruption in changing the order or size of intervals to achieve pure fourths or fifths in positions that would not normally have such pure frameworks. See Lekkas relevant articles on the soft diatonic and soft chromatic scales, published in the *Polyphonia* journal.

Late twentieth-century Greek musicology has met these ambiguities over the nature of chromaticism in pre-modern repertoires of Byzantine chant with a powerful narrative of historical continuity between the Greek Orthodox chant of today and its forbears.<sup>239</sup> A group of mainly Greek scholars steeped in the received traditions of Byzantine chanting constituting an unofficial “Greek School” of musicological inquiry has contested the premise of Western European and North American scholars, especially those associated with the MMB, that medieval Byzantine chant was fundamentally diatonic. They have projected chromatic tetrachords with augmented seconds back into the medieval Byzantine repertory, resting their arguments on their interpretations of terms such as *phthora*, the modulation signs *nana* and *nenano*, and the assumption—acquired through a selective reading of Chrysanthos—that the Second Modes are primarily “chromatic.”

Among the pioneering representatives of this traditionalist “Greek School,” Simon Karas, Gregorios Stathis, Georgios Amargianakis made significant contributions to the debates over continuity in chromatic theory and practice. Karas gained notoriety for his extreme assertions of continuity, stating for example that the “living tradition of Greek Orthodox chanting ‘through its notation...and through its teaching and its continuous practice in divine worship appears to have been maintained through the ages spotless and basically pure from every foreign effect and influence.’”<sup>240</sup> Reading Karas more closely, as Lingas has done, reveals that maintained a more moderate position, namely that “textual evidence of notated manuscripts and theoretical

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<sup>239</sup> Lingas coins the term “Greek School” in “*Performance practice and the politics of transcribing Byzantine chant.*” *Acta Musicae Byzantinae* 6, 56-76, 2003. The musicological disputes he describes were not limited to chromaticism but encompassed wider issues of continuity between medieval and modern times in Byzantine chant relating to the shape of musical repertoires and the cantorial practices governing the realisation of their notations.

<sup>240</sup> Lingas, “*Performance practice,*” 66.

treatises” must be read “in the light of the received performing tradition.”<sup>241</sup> Furthermore, according to his pupil Arvanitis, it was Karas who introduced ideas about chroma in NM, which “opposed not only the teachings and transcriptions of the Three Teachers, but also to the musical praxis of practically all the singers (including even performances of himself and his pupils!).”<sup>242</sup>

Stathis and Amargianakis engaged directly with the scholars of the MMB by studying and publishing in Copenhagen. These interactions laid the foundations for the gradual (but still incomplete) convergence between scholars holding differing views regarding historical continuity in Byzantine chant. From the side of the MMB, Raasted did much to advance the dialogue. As Lingas notes, “Raasted was particularly energetic in his attempts to assure that the exchange of ideas was not entirely one-sided, immersing himself in the received tradition in a search for common ground with the Greek traditionalists led by Karas and Stathis.”<sup>243</sup>

Such flexibility has not always been reciprocated. Through the decades Stathis has maintained a relatively hardline view of unbroken continuity in Byzantine chant, including the perpetual presence of tense chromatic intervals in the Second Modes.<sup>244</sup>

Amargianakis likewise argued for the centrality of “chromatic modes,” particularly in relation to the repertoires of the Second and Second Plagal Modes. Such claims, however, remain methodologically fragile unless the term chromatic is defined consistently, since the word is used with incompatible meanings across Western tonal theory, Aristoxenian genus theory, and later psaltic theory.

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<sup>241</sup> Ibid.

<sup>242</sup> Ioannis Arvanitis. “On the Second Modes: History, Practice and Theory” (unpublished notes), n.d.

<sup>243</sup> Lingas, “*Performance practice*,” 75.

<sup>244</sup> For instance, see Stathis, “Ἡ Ἐξήγησις τῆς Ψαλτικῆς Τέχνης” [“The Exegesis of the Psaltic Art”], *Θεολογία* 58 (1987): 337–371.

The sorts of issues that arise may be seen in *An Analysis of Stichera in the Deuterios Modes*, the publication by Amargianakis that emerged from his studies at the MMB.<sup>245</sup> Objecting to a wholesale diatonic reading of pre-modern Byzantine chant, he argued instead for the historical use of chromatic scalar systems of featuring the tense chromatic interval of an augmented second (Fig. 4.6).

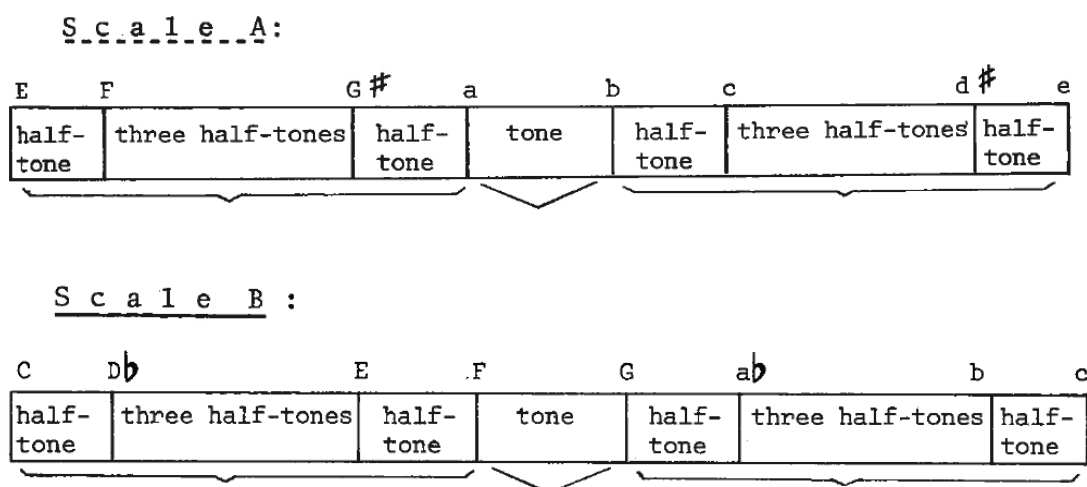


Fig.4.6. Chromatic scales proposed by Amargianakis in *An Analysis of Stichera in the Deuterios Modes*

Appendix A, 101-102

When this model is applied uniformly, including the chants of the medieval Heirmologion and Sticherarion, transcription repeatedly produces intervallic contradictions—most notably the emergence of impure leaps, such as augmented fourths—which Amargianakis himself recognizes as problematic. These contradictions arise systematically, not as isolated anomalies, indicating that the

<sup>245</sup> George Amargianakis, *An Analysis of Stichera in the Deuterios Modes*, 2 vols., *Cahiers de l'Institut du Moyen-Âge Grec et Latin* 22–23 (Copenhagen: Université de Copenhague, 1977); idem, “The Interpretation of the Old Sticherarion”, in *Byzantine Chant: Tradition and Reform. Acts of a Meeting held at the Danish Institute at Athens in 1993*, ed. Christian Troelsgård (Athens: Danish Institute at Athens, 1997), 24-25.; idem, “The Chromatic Modes.”

reconstructed chromatic scales cannot be consistently reconciled with the melodic evidence. By treating chromaticism as a single, scale-defining intervallic genus, Amargianakis is forced either to accept forbidden intervals or to invoke ad hoc melodic exceptions, revealing that the analytical framework itself is inadequate for the diversity of chromatic grammar encountered in the sources.<sup>246</sup>

More recently, Eustathios Makris has offered a more nuanced version of the argument for allocating the Second Modes to the chromatic genus in pre-modern times. Explicitly rejecting the view that chromaticism in the Second Modes should be understood as a purely post-Byzantine phenomenon caused by Ottoman musical influence, Makris maintains that the available evidence, although though limited, does not allow us to exclude the existence of pervasive chromaticism already in the kalophonic chant of the late Byzantine period (14<sup>th</sup>-15<sup>th</sup> c.).<sup>247</sup>

### *Ioannis Arvanitis: Critique of Chromatic Interpretation*

Against this background, Ioannis Arvanitis (born 1961)<sup>248</sup> stands out as an exception, combining palaeographical competence with a performance-oriented critique of

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<sup>246</sup> Amargianakis discusses the problem of prohibited or “impure” intervals throughout his analysis of the chromatic modes, with particularly explicit treatment in the discussion of reconstructed scales and their application to melodic examples in *The Chromatic Modes*, 12–15.

<sup>247</sup> Makris, “The Chromatic Scales,” 10.

<sup>248</sup> Ioannis Arvanitis is a Associate Professor of Eastern Orthodox Church Music at the Ionian University of Corfu, Greece. He received his PhD in Music (about rhythm in medieval Byzantine chant) at the Department of *Music Studies* of the same university (2010). Formerly, a researcher in Music at the University of Athens, and a librarian at the National Library of Greece. He received his BSc in Physics from the University of Athens; and a Teacher’s Diploma of Byzantine Music from the Skalkottas Conservatory under the supervision of late Archon Lycourgos Angelopoulos. He also studied Byzantine music at the Conservatory of Halkis, as well as Byzantine and folk music under Simon Karas at Society for the Dissemination of National Music. Arvanitis has been an instructor of Byzantine music at the Ionian University of Corfu and offered lectures for the Irish World Music Centre at the University of Limerick. An accomplished performer on various Greek folk instruments (tambura, oud and laouto), he has taught at the Experimental Music Gymnasium and Lyceum of Pallini, the School of the Society for the Dissemination of National Music and the Philippos Nakas Conservatory. Since 2001, Arvanitis has been a frequent collaborator with Cappella Romana, recording

interpretive overreach. As an experienced exegete (transcriber from MBN into modern notations, both staff and that of the NM), Arvanitis maintains that medieval Byzantine chant was originally organised as an essentially diatonic system, with modal tonics regulated—“in principle”—by Pythagorean intervallic relations.<sup>249</sup> Although Pythagorean intervals cannot always be sustained with acoustic precision in sung performance (the voice frequently “slips” towards JI tendencies), he argues that this does not negate the underlying diatonic structure: rather, it produces a historically traceable softening from a theoretical “hard diatonic” model to a “soft diatonic” practical realisation involving major and minor tones. Importantly, he argues that such dual intervallic behaviour (tense/soft) is not exclusively modern but is already discernible in the transcriptions of the Three Teachers, implying continuity of practice rather than rupture.<sup>250</sup>

On this basis, Arvanitis interprets Byzantine chromaticism not as external “oriental” influence, but as an internally generated historical transformation, especially in the Second and Plagal Second modes, where diatonic softening may lead further into augmented seconds and thus to what Byzantine chant theory designates as

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a series of CDs with the ensemble, and frequently providing it with editions of medieval Byzantine chant. Other groups that have performed his transcriptions include his own ensemble Hagiopolites, as well as the Greek Byzantine Choir (Lycourgos Angelopoulos, dir.) and the Romeiko Ensemble (Dr Yiorgos Bilalis, dir.). He has sung with Marcel Pérès and his *Ensemble Organum* and is a member of the International Musicological Society’s Cantus Planus Study Group, publishing on topics from the 10<sup>th</sup> to the 20<sup>th</sup> cc. The composer also of new Byzantine chants, Arvanitis designed a font with Byzantine musical characters for his 1997 publication *The Akathist Hymn*. (from <https://cappellarecords.com/artist/ioannis-Arvanitis/> with some necessary updates and adjustments by us.)

<sup>249</sup> Sub-chapter 4.15 of Arvanitis’ doctoral dissertation (“Modes and intervals of the stichera and heirmoi”) is explanatory on this intervallic subject: “The question of the nature of intervals is among the thorniest, a point of intense disagreement between Greek and Western scholars. Our own research has shown that the intervals for the heirmoi and stichera in the period under consideration are diatonic, that is major tones and semitones, as more or less described by Western scholars, such as Oliver Strunk. [our translation],” from Arvanitis, *Ο ρυθμός των εκκλησιαστικών μελών μέσα από τη παλαιολογική έρευνα και την εξήγηση της παλαιάς σημειογραφίας [The Rhythm of the Ecclesiastic Chants through the Paleographic Research and the Transcription of the Old Notation]*. PhD Thesis 2010, Corfu: Ionian University (2011), 135.

<sup>250</sup> Ioannis Arvanitis, “A Personal Profile,” in *Anáil Dé / The Breath of God: Music, Ritual and Spirituality*, ed. Helen Phelan (Limerick: Irish World Music Centre, University of Limerick, 2001), reproduced by permission in <https://www.ivanmoody.co.uk/arvanitis.htm>

“chromatic.” These premises are directly reflected in his editorial decisions: repertoires which the New Method assigns to the soft chromatic genus may nevertheless be rendered diatonically in staff notation for reasons of melodic structure and performance necessity (particularly the intervallic purity of leaps). Lingas similarly notes (in his editorial comments on the forthcoming Holy Saturday *Tetraodion*) that Arvanitis’s reconstruction treats these chants as diatonic, employing diatonic *martyriai*, and proposes the use of Pythagorean tunings rather than the “soft diatonic” intervals of the New Method.<sup>251</sup>

Arvanitis’ views on the subject of chromaticism and diatonicism in the medieval repertoires of the Byzantine rite are of particular importance to us because they relate not only to problems of analysis, but also to performance practice. This is the reason why we dedicate enough space in the present chapter to make his ideas accessible. In his 2002 unpublished paper “Phthora and Chromaticism in Early and Late Byzantine Chant,” which he kindly shared with us,<sup>252</sup> he elaborates on the chromatic problem:

The main arguments of the western or Greek scholars in favour of chromatic scales are the following:

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<sup>251</sup> From Alexander Lingas, “Notes,” in Ioannis Arvanitis and Alexander Lingas, eds., *Kassiani* (attr.), *Tetraodion for Holy Saturday* (Portland, OR: Cappella Romana, forthcoming), the paragraph *The Modes and Their Tunings* reads: “The New Method assigns kanons in the Second Plagal Mode to the soft chromatic genus, but Dr Arvanitis has presented the medieval Holy Saturday tetraodion as a sequence of diatonic chants. He therefore renders them in the neumes of the New Method with diatonic *martyriai* (a term that literally means “witnesses,” referring in contemporary neumatic notation to composite signs combining elements of the modern and medieval solmisation systems). Furthermore, we suggest that the Holy Saturday odes be sung using Pythagorean tunings (i.e. with very high major thirds), rather than the “soft diatonic” intervals (with major thirds lower than those of just intonation) of the New Method.”

<sup>252</sup> Arvanitis, “Phthora and Chromaticism.”

i) The *Martyria*, the signature of the medial Second (mesos Deuterios), i.e. of a mode<sup>253</sup> that lies two steps lower than the tonic of the second mode, which is similar in form to the martyria of the authentic Second and to that of the plagal Second. Since the martyria of authentic and plagal (on B and E respectively) indicate a semitone above the note they are placed (*B-C* and *E-F*), it was supposed that the signature of the medial mesos deuterios should also indicate such a semitone between G and a. The form of the chants themselves dictated a G-sharp against an a-flat. This results, of course, to a scale with augmented seconds, i.e. to a chromatic scale: *E F G# A B c d# e*. This is, more or less, the modern scale of the Second Modes.<sup>254</sup>

ii) The presence of the sign *Phthora* in Palaeobyzantine Mss. This sign was used to make some combinations of signs more precise in the frame of the otherwise adiaستمatic Palaeobyzantine notations.<sup>255</sup> It was supposed that this sign should also indicate at least a more or less *local* transition to a chromatic scale while the main scale of the chant remained diatonic.<sup>256</sup>

In our private correspondence,<sup>257</sup> Arvanitis mentioned that this paper is, more or less, a direct refutation of the positions presented by Wolfram in her study “Die Phthorai

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<sup>253</sup> Original footnote by Arvanitis: “One must be careful in using the word *mode* (gr. Echos) or when reading the treatises, as this word can have multiple meanings: from a single note to the scale whose tonic is this note or the *Apechema* (intonation) or a phrase cadencing on this note or the melodic type of a whole piece. These meanings can be used for the classification of a certain piece to a mode, resulting sometimes to modal ambiguity.”

<sup>254</sup> Original footnote by Arvanitis: “See Amargianakis, Karas, Raasted, Stathis. The intervals are so *grosso modo*. No distinction is made here of the so called ‘soft’ and ‘hard’ chromatic variants of the now sung chromatic variants. This could be of some relevance only in my argumentation on the meaning of the Mesos Deuterios martyria and could possibly solve a problem, but in fact it does not.”

<sup>255</sup> Arvanitis: “See Floros [sic].”

<sup>256</sup> Arvanitis: “See Wolfram [sic].”

<sup>257</sup> In June 2025.

der palaeobyzantinischen Notationen.”<sup>258</sup> Referring especially to Examples 5, 6, and 7 (where Gis = G#, Es = E b, Fis = F#; in example 6, “as” likely indicates A b), he observes that Wolfram uses both chromatic tetrachords from E and D for the same piece, evaluating such a choice as “completely unreasonable:”

[...]it’s not just the scale E F G# A B C D# E, which is what most proponents of the chromatic interpretation have generally claimed. Rather, she seems to be attempting to justify a chromatic scale beginning on D E b F# G A B b C# D. This she appears to conceive as some form of heptatonic structure, relating it to the *Hemiphthoron* (ἡμίφθορον) that occurs on D (high Pa). In an effort to perhaps also justify a chromatic structure beginning from di (G), she even includes a A b at one point.

But if we closely examine the examples, they make no musical sense. Such intervallic confusion is absent both from the chromatic transcriptions of the Three Teachers and from the older compositions (*palaiā mele*), which show no evidence of accommodating such modulations -- nor is it found in *kalophonic* pieces, let alone in the simpler *sticheraric* repertory.

Arvanitis’s intervention is significant because it challenges the widespread tendency—both in modern ecclesiastical pedagogy and in scholarship—to equate the chromatic identity of the Second-mode family with the systematic presence of augmented seconds. He argues that the two main scholarly arguments for medieval chromatic scales often proceed by theoretical inference rather than by musical

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<sup>258</sup> Cited earlier in the present chapter.

evidence. For Arvanitis, both claims risk imposing later intervallic taxonomies on repertoires whose melodic syntax does not necessarily require them.

In his direct refutation of Wolfram's readings of Palaeobyzantine chants, Arvanitis insists that the deployment of incompatible chromatic frameworks within the same chant (e.g., chromatic tetrachords beginning on both E and D) results in intervallic inconsistency that is musically implausible and unsupported by the tradition of transcription: such "intervallic confusion," he observes, is absent from the chromatic transcriptions of the Three Teachers as well as from older repertoires (*palaia mele*), and it is difficult to justify even for kalophonic composition, let alone for the sticheraric idiom. At the same time, Arvanitis's broader model—an underlying hard diatonic ("in principle" Pythagorean) framework that may be softened in vocal realisation—opens a productive analytical problem for the present study. In the remainder of this chapter, and more generally throughout this thesis, attention will be directed to a selected corpus of medieval Second Modes' melodies whose intervallic behaviour suggests that—without requiring augmented-second chromaticism—they may plausibly admit a soft diatonic realisation in performance. Tested in the case studies that follow, this perspective provides a methodological bridge to the nineteenth century, when Chrysanthos and the introduction of the reformed New Method codify a new theoretical definition of chroma and modal genus.

## Section II — On the invention of a new chromatic definition in the nineteenth century<sup>259</sup>

Chrysanthos of Madytos, a Greek poet, chanter, and Archimandrite, was born in Madytos (present Türkiye) and eventually became an Archbishop of Dyrrachion (present Durrës, Albania). In 1832 he published his *Θεωρητικόν μέγα τῆς μουσικῆς* [*Great theory of music*], edited by Panagiotes G. Pelopides and printed in Trieste), a sequel of sorts to his *Εἰσαγωγή εἰς τὸ θεωρητικόν και πρακτικόν τῆς ἐκκλησιαστικῆς μουσικῆς* (Introduction to the theory and practice of ecclesiastical music) of 1821.

The system of Chrysanthos and his colleagues Chourmouziος Chartophylax and Gregorios the Protopsaltes,<sup>260</sup> dubbed the New Method (NM), was promulgated by order of the Ecumenical Patriarchate of Constantinople (or “Great Church of

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<sup>259</sup> The term *invention* in the title of this section does not imply that chromatic practice—or even chromatic conceptuality—was newly created in the early 19<sup>th</sup> c. Rather, what becomes historically distinctive in the Chrysanthine period is the written articulation (implicitly by Chrysanthos, more explicitly by Georgios the Lesbian as we will see below in this chapter section) of a redefined notion of *chroma*: one in which chromaticism may be understood as *any* re-arrangement of the intervallic quantities of the Chrysanthine diatonic scale, and not necessarily as the introduction of interval sizes that depart from diatonic norms. In other words, the novelty examined here lies primarily in the *codification and terminological fixation* of the concept, not in the sudden appearance of the musical phenomenon itself. We encountered in the previous chapter a parallel logic in the medieval Latin West, where any deviation from the diatonic scale similarly constitutes chromaticism.)

<sup>260</sup> Gregorios Protopsaltes (Γρηγόριος Πρωτοψάλτης, ca. 1778–1821) is presented in the secondary literature as one of the principal musical authorities of the Ecumenical Patriarchate at the turn of the 19<sup>th</sup> c., serving as Protopsaltes during the transitional period surrounding the introduction of the New Method of Byzantine notation (1814). Scholarly accounts emphasize that his authority derived primarily from patriarchal performance practice and pedagogical transmission rather than from theoretical systematization. His involvement in the reform is therefore understood as ensuring continuity of received chant practice during the notational transition, rather than as contributing to its theoretical formulation.

Georgios Chourmouziος Chartophylax (Χουρμούζιος Χαρτοφύλαξ, ca. 1770–after 1840), Chartophylax of the Great Church, is consistently described as the principal notational transcriber of the New Method. Modern scholarship stresses the unprecedented scope of his work in converting the pre-1814 repertory into the new analytical notation, a process that effectively reshaped the transmission of Byzantine chant in the 19<sup>th</sup> c. His contribution is characterized as practical and archival in nature, grounded in deep familiarity with earlier notational strata and patriarchal usage, rather than in independent theoretical speculation. Together, Gregorios and Chourmouziος are treated as complementary figures whose authority lay in practice, memory, and transmission, in contrast to the theoretical role assumed by Chrysanthos of Madytos. See Wellesz, *History* and Lingas, “Byzantine Chant.”

Christ”)<sup>261</sup> in order to to simplify and standardise notation and, crucially, to codify modal and intervallic doctrine in a manner that medieval sources had not done. To many cantors of the early nineteenth century, MBN had become a numbingly complex array of notational symbols and interpretive techniques. In this environment, Chrysanthos’ *Introduction* and *Great Theory* set out a theoretical and pedagogical system that— notwithstanding occasional modifications, clarifications, and debates over the years — is still in use today in churches throughout the world where services are sung to the received corpus of Byzantine melodies.

The monumental character of the NM reform was such, that the modern era of Byzantine chant that followed its introduction has been variously called (post-) Chrysanthine, Neo-Byzantine, and, somewhat disparagingly by Wellesz, “Neo-Greek.”<sup>262</sup> As Wolfram has shown, the *Great Theory* selectively incorporates concepts from earlier Byzantine sources while reshaping modal logic to serve new pedagogical and liturgical needs.<sup>263</sup> For example, the *trochos* (wheel) functions not as a chart of scales, but as a mnemonic tool for understanding functional relationships between tones. The *echoi* themselves are defined not as pitch collections, but as *klimakes*—ordered paths of ascent or descent, grounded in melodic behaviour rather than abstract scale structure.<sup>264</sup>

In spite of periodic attacks upon its authority, the treatises of Chrysanthos remain to this day influential teaching tools. In them Chrysanthos systematized the ordering of

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<sup>261</sup> The Ecumenical Patriarchate of Constantinople (Greek: Οἰκουμηνικὸν Πατριαρχεῖον Κωνσταντινουπόλεως; Latin: Patriarchatus Oecumenicus Constantinopolitanus) is the “first among equals” among the autocephalous churches that together compose the canonical Eastern Orthodox Church.

<sup>262</sup> Egon Wellesz, “Origins of Byzantine Music,” *Bulletin of the American Musicological Society*, no. 25 (1947): 26, where he distinguishes early chant from “late Byzantine and Neo-Greek melodies.”

<sup>263</sup> Gerda Wolfram, “Byzantine Theoretical Treatises on Music in Comparison with the *Theoreticon Mega tes Mousikes* by Chrysanthos of Madytos,” *Epistēmēs Metron Logos* 5 (2021): 107–110.

<sup>264</sup> *Ibid.*, 109–110.

the eight modes into three species: diatonic, chromatic and enharmonic. Within each of these three categories, the intervallic progression of the degrees was fixed according to elaborate mathematical calculations. He also introduced new processes of modulation and chromatic alteration. Finally, and unlike their medieval predecessors, the reformed music theory treatises of Chrysanthos define the size of each interval in every echos by presenting them in detailed *canonia* tables.

Chrysanthos presents (§13) the three genera of music early in his *Θεωρητικόν*. After defining the term “genus in music” as “a particular division of the tetrachord” in §217,<sup>265</sup> he goes on to borrow the relevant terminology from the ancient Greek mathematical theory of music. Quoting Aristoxenus and Aristides Quintilianus in a footnote, he writes

§13. The Ancient Greeks handed over to us three genera: the diatonic, the chromatic and the enharmonic. The diatonic is the most natural of the three, the oldest and the easiest. The chromatic is more artful, more recent and more difficult.\*

\* [footnote text] “Every melos occurring in the hermosmenon is either diatonic, chromatic or enharmonic. First and earliest should be considered the diatonic, because it is the one human nature meets first. Second is the chromatic. Third and most recent is the enharmonic because this is the last that hearing gets used to, indeed, after much effort.” Aristoxenos, *Harmonic Elements*, I; “The most natural of the three genera is the diatonic because it may be sung by everybody, even by the uneducated. Most artful is the chromatic because it is sung by the educated only. Most precise is the

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<sup>265</sup> Our translation of “Γένος εἰς τὴν μουσικὴν εἶναι ποιά διαίρεσις τετραχόρδου;” slightly more precise than the one found in Chrysanthos, *Great theory*, 111.

enharmonic because it may only be transmitted among the most distinguished in music and is impossible to the many.” Aristeides, [*De Musica*,] 19.<sup>266</sup>

Chrysanthos postulates as his model chant scale a diatonic tetrachord. Extended to a full octave, as we shall see in detail below, it contains two identical tetrachords disjunct by a major tone. He expresses its steps in arithmetical ratios identical to those of Zalzal and Farabi discussed above in Chapter 2 of present thesis. Lekkas concludes from this that “Chrysanthos knew Farabi’s treatise.”<sup>267</sup> Whether or not this was a case of borrowing from Arab theory, it seems to have been uncontroversial in its own time.<sup>268</sup> Frank Desby, who seems to have been the first modern researcher to seek an origin for Chrysanthos’ ratios, remarks only that his aim was to approach natural tuning.<sup>269</sup> At all events, we will argue that the tuning system of Chrysanthos for the diatonic and chromatic genera is best understood as a systematic reference model—a coherent framework against which historical and comparative evidence may be assessed.

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<sup>266</sup> Chrysanthos, *Great Theory*, 36. For Aristoxenus, see *El. Harm.* I, 19, ll. 18-29; for Aristides Quintilianus, see I, cap. 9, ll. 10-15.

<sup>267</sup> Lekkas, “Byzantine Church Chant and Islamic Art Music on the English Recorder: Theory and Practice”. *Epistēmēs Metron Logos*, no. 5, Jan. 2022, doi:10.12681/eml.28941. Al-Farabi’s *The Great book of Music* is translated into French in Rodolphe d’Erlanger into French (originally published in 1930–35; reprint 2001)

<sup>268</sup> Unlike the NM’s reformed notation, which the Patriarchal Protopsaltes Constantinos refused to employ.

<sup>269</sup> Desby, *The Modes*, 95.



In the following sections §.217–228 of the *Great Theory*, Chrysanthos mentions the Ancient Greek *Systema Teleion* whose tetrachords contain the intervals of tonos (9/8) and leimma (27/13) (§.220). But the diatonic genus

is for us, the one that fills in the diapason system with seven tones, three major, two minor and two minimum (§217). [...] It follows that we find the ratio between two tones by observing the relations of these fractions and by multiplying the numerator of the first by the denominator of the second and again the numerator of the second by the denominator of the first. For example, pa:bou=2/3: 11/18 = 36/33 = 12/11. And again, ke:zo=8/9 : 22/27 = 216/198 = 108/99 = 12/11 (§226).

Having already noted above that Chrysanthos constructs his diatonic scale through the repetition of a tetrachord disjunct by one major tone, we turn now to his calculation of its component intervals. He lays out the ratios of this tetrachord from  $\alpha$  to  $\delta$ , beginning from the sequence's end:  $\delta$  (1/1),  $\alpha$  (9/8),  $\beta$  (27/22),  $\gamma$  (4/3). The proportions refer to a string tuned to the pitch of  $\delta$  (the solmization syllable *Di*, as below in the following illustration of a fretted string instrument (*tambouras*) from *The Great Theory*:<sup>271</sup>

The ratios to the entire string of the various lengths of the string, whereupon the frets of the tones are made and where from is emitted every note, are expressed numerically thus:

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<sup>271</sup> §65, p. 28.

1  $\frac{8}{9}$   $\frac{22}{27}$   $\frac{3}{4}$   $\frac{2}{3}$   $\frac{11}{18}$   $\frac{9}{16}$   $\frac{1}{2}$   
 Di ke zo ne pa bou ga di

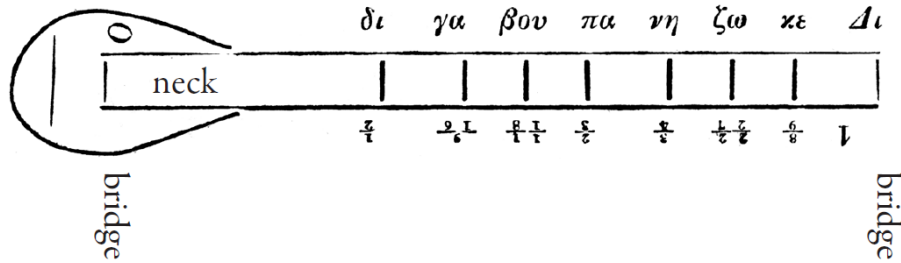


Fig.4.8. Instructions on how to tune a tambouras according to Chrysanthos -

from Chrysanthos, *Great Theory*, §65

§226: If one wants to know how the intervals of the scale of our diatonic genus on the diapason system are represented with numbers, we say that this is what we found the closer to truth possible:

1x8/9x22/27x3/4x2/3x11/18x9/16x1/2

di ke zo ne pa bou ga Di.<sup>272</sup>

Constantinides considers Chrysanthos' tuning to be both a *chroa* of Ptolemy's smooth diatonic and a "chroa expression" [sic] of Didymus' *diatonon*.<sup>273</sup> Chrysanthos himself on the other hand makes no such reference to these ancient authors when presenting this sequence of intervals as a model for the diatonic genus of ecclesiastical chant.

We have previously observed that Chrysanthos was not the first theorist to proffer a corrective mutation of ancient diatonic scales allowing for more perfect fourths in a

<sup>272</sup> Chrysanthos, *Great Theory*, 114.

<sup>273</sup> Antonis Constantinides, *Θεώρηση και προσδιορισμός των «λεπτών» διαστημάτων της μιας φωνής*, Μελέται 17 (Αθήνα: Ίδρυμα Βυζαντινής Μουσικολογίας, 2011), 286.

row. Karas seems to be the earliest to have traced a connection between Ptolemy and Chrysanthos through Zalzal, having read d’Erlanger consequently referring to the zulzulian [sic] *wusta* of the oud when discussing the minor tone.<sup>274</sup> Lekkas has also linked Chrysanthos’ tuning to Zalzal, and consequently Ptolemy:

The first to record this [Chrysanthine] diatonic structure with complete accuracy was Mansūr Zalzal, or Zulzul (d. 791), at the court of the Abbasid caliphs in Baghdad in the 8<sup>th</sup> c. AD. This was followed by at least a century and a half of official obscurity, until al-Farabi (878–951) adopted and incorporated the corresponding ratios into his diatonic system.<sup>275</sup>

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<sup>274</sup> Simon Karas cites D’Erlanger’s *La Musique Arabe* included in the bibliography of his multivolume *Method of Greek Music (Μέθοδος της Ελληνικής Μουσικής Τόμος Α’, ι)*. He refers explicitly to Zalzal in his later *Αρμονικά: Έκ συμφωνιῶν, κατ’ ἄρμονικὰς μεσότητας, τὰ μελωδικὰ διαστήματα· Ανακοίνωσις εἰς τὸ Μουσικολογικὸν Συνέδριον τῶν Δελφῶν τῆς 28–30 Ὀκτωβρίου 1988* (Αθήνα, 1989), 14: «...Οὗτος ὁ ἐλάσσων [σημ.: 54/49], τὸν ὁποῖον καὶ ὁ Farabī ἀναφέρει ὡς δεσμὸν τοῦ Zulzul (Ζουλζούλ), εἶναι συστατικὸν πάντων τῶν ἤχων (μακαμίων) τοῦ μαλακοῦ διατόνου καὶ βασικὸν διάστημα τῶν ἤχων λεγέτου Βου (σεγκιάχ μακάμ), βαρέος διατονικοῦ Ζω (Αράκ ἢ Ἰράκ μακ.) καὶ τῆς ἑπταφωνίας τοῦ Ζω (ἐβίτζ μακ.)». [my translation: “...This minor tone [note: 54/49], which al-Farabī also mentions as the *wusta* of Zulzul, is a constituent of all the modes (maqamat) of the soft diatonic [genus], and a fundamental interval of the modes Legetos Vu (Segah maqam), [Varys=]Grave diatonic Zo (Arak or ‘Iraq maqam), and heptaphonic of Zo (Ενῆc maqam)”].

<sup>275</sup> Lekkas, «Ἡ διατονικὴ βάση.» 18.

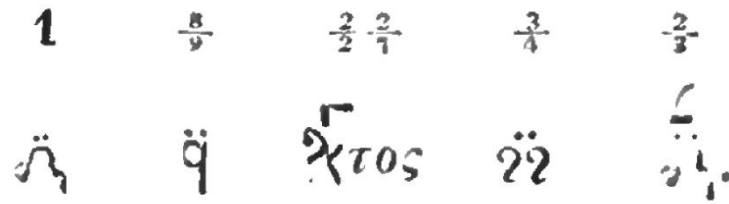


Fig.4.9. Succession of ratios with reference to the tonic (left) for the diatonic steps ne (C) to di (G) -  
from Chrysanthos' *Great Theory*, §76

For the sake of comparison, Figure 4.10 offers a visual representation by Demetrios Lekkas comparing the Spondeiac/Zalzalian/Chrysanthine scale with two other scales that this thesis has already identified as being of historical importance : the ditonic diatonic Pythagorean major and the JI diatonic (*bilydian*).<sup>276</sup>

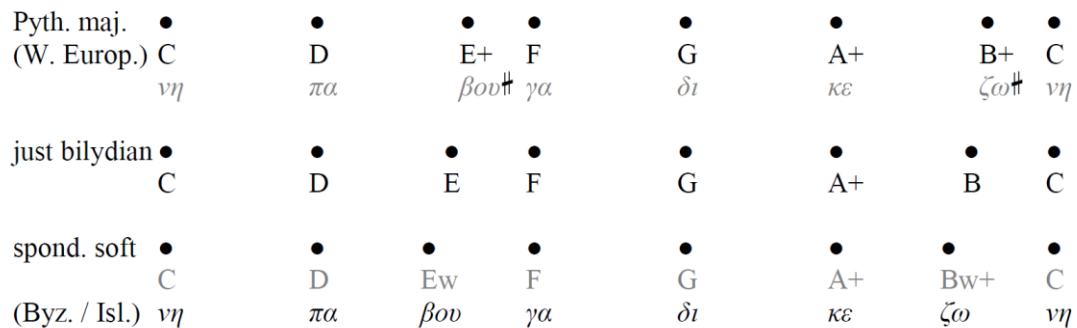


Fig.4.10. Visual comparison of historically important scales advanced by music theorists: the ditonic diatonic Pythagorean major scale, the JI diatonic (“bilydian” mode) scale, and the Spondeiac/Zalzalian/Chrysanthine scale – authored and kindly shared by D. Lekkas

<sup>276</sup> Lekkas employs specific symbols and terms for accuracy of intervallic charge. Terms assigned to symbols employed in this figure: “#”: super, “+”: plus / acute, “w”: w / admedial, “w+”: w plus / acute admedial, “-”: minus / grave, “#”: spondeiac sharp / half-sharp.

Chrysanthos has been criticized severely for his error of basing the calculation of his commas on the quotients of his ratios. While his ratios remained unchallenged, it soon became evident to his successors that his commas needed revision.<sup>277</sup> According to Arvanitis:

the use of these commas, either as given by Chrysanthos or as divisions of the octave in 68 or 66 acoustically equal parts, should be discarded. Nevertheless, the ratios given by Chrysanthos can still be used and be transformed to correctly calculated commas through the logarithmic method [...]. If we divide by definition the major tone in 12 (acoustically equal) commas, then the ratios used by Chrysanthos give in a tetrachord 12-9-8.5, which can be approximated by 12-9-9, in an octave of 72 commas as usually.<sup>278</sup>

Interestingly, several Cypriot cantors active during the first half of the twentieth century also embraced the approximation 12-9-9: Stylianos Chourmouzios, followed by Oikonomos Charambous and Theodoulos Callinicos.<sup>279</sup> Stylianos Chourmouzios, in a chant treatise generally following Chrysanthos, proposed that the sequence of 12-9-9 commas (approximations of 12.23460 | 9.03820 | 8.60990) should be adopted

<sup>277</sup> Ioannis Arvanitis, “On Chrysanthos’ Diatonic Scale,” online article: <http://analogion.com/site/pdf/Chrysanthos-Intervals-Arvanitis-2005.doc>.

<sup>278</sup> Additionally to Arvanitis, see also Beyhom, “Theory and Practice of Psaltiki, 630, ft.5; for a more detailed study, see the relevant online studies of Papademetriou: Panagiotes D. Papademetriou, “Η διατονική κλίμακα τοῦ Χρυσάνθου” [The diatonic scale of Chrysanthos] (online PDF, current online ed. 12 March 2014; first online ed. 12 August 2005), <http://psaltiki.gr/articles/papadimitriou/004-xrusan0os-diatonikh-papadimitriou.pdf>; and Panagiotes D. Papademetriou, “Οἱ Κλίμακες καὶ Συγκερασμοὶ τοῦ Χρυσάνθου ἐκ Μαδύτων” [The Scales and Temperaments of Chrysanthos of Madytos], in «Μέθοδος Δημιουργίας Κλιμάκων» (online PDF, draft ed. 0.9, 15 March 2014), <http://psaltiki.gr/articles/papadimitriou/016g-Chrysanthos-Scales-Temperament-Papadimitriou-v0p9.pdf>.

<sup>279</sup> Stylianos Chourmouzios, *Ὁ Λαμασκηνός, ἤτοι Θεωρητικὸν πλήρες τῆς Βυζαντινῆς Μουσικῆς* [Damascene, or a complete theoretical treatise of Byzantine music] (Nicosia, 1934), 19-21; cf. Oikonomos Charalambous, *Βυζαντινῆς Μουσικῆς Χορδὴ* [The string of Byzantine Music] (Paphos, 1940), 40-41, 61; Theodoulos Callinicos, *Mega Theōrētikon Ekklesiastikēs Vyzantinēs Mousikēs* [Great theoretical treatise of ecclesiastical Byzantine music] (Nicosia, 1977), 47.

instead of the less accurate Chrysanthine 12-10-8 as a better approximation within the 72-comma system. This made him the first to reveal that the minor and minimum tones are very close in size.<sup>280</sup>

*The partially rearranged diatonic scale: casus modulationis*

In ancient Greek harmonic theory and its medieval descendants, chromatic genera feature intervals narrower or wider than those of diatonic genera.<sup>281</sup> Chrysanthos tries to respect these precedents with mixed success, revealing the difficulty of defining chroma in the received tradition of Greek ecclesiastical chant. He presents two basic chromatic scales in *The Great Theory* (§240, reproduced here as Figure 4.11). The expected narrower and wider sizes appear only in chromatic Scale B shown on the right side of Figure 4.11. An example of a tense chromatic scale, it includes intervals of 3, 7, 12 and 18 commas. Scale A, on the other hand, includes only intervals of 12 and 7 commas in constant alternation.<sup>282</sup> Obviously diatonic, they appear in a different

<sup>280</sup> Lekkas, based upon advanced mathematical theory, favours the temperament of the byzantine diatonic scale in 53 mercator's (or holdrian) commas (research to be published), where the major tone is the size of 9 commas, the minor of  $6\frac{2}{3}$ , and the minimum of  $6\frac{1}{3}$ . This makes instantly apparent visually as well the proximity of the intervals and the truth of an approximative  $1-\frac{3}{4}-\frac{3}{4}$  construction. This 9-9 seems also to be the standard tuning of Mode 1 for Greek contemporary folk instrumentalists (our private interview with Panos Demetracopoulos, famous Greek kanun virtuoso on 20.2.2024).

<sup>281</sup> According to the standard bibliography on the matter, briefly put in the chromatic genus, the largest interval was called a Greek: τριμιτόνιον ἀσύνθετον, Latin: triemitonium incompositum—translated as “incomposite” (or “noncomposite”) “trihemitone” (See Boethius, *De institutione musica*, 43; Hagel, *Ancient Greek Music*, 105, 266, 267; Flora R. Levin, *The manual of harmonics of Nicomachus the Pythagorean: translation and commentary* (Grand Rapids: Phanes Press, 1994), 125, 174; Barker, *Greek Musical Writings II*, 261, 267, prefers a descriptive translation, “an individuated interval of three semitones;” Strunk et al., *Source readings*, 36, 37 uses “trisemitone”), the modern term being “minor third” -- leaving a *pyknon* of roughly a whole tone to be divided into two semitones. There is a larger number of variations in the tuning of the chromatic than in the enharmonic. Up to the beginning of the 4<sup>th</sup> c. BCE the chromatic *pyknon* spanned a major whole tone with a 9/8 ratio, and this was divided by Gaudentius into ascending semitone intervals of 256/243 and 2187/2048; see Chalmers, *Divisions of the tetrachord*, 8. Ptolemy defined two different tunings of the chromatic genus: the “soft” chromatic with a smaller *pyknon* and the tense chromatic with a larger one. The unequal semitones dividing the *pykna* were in ratios of 28:27 and 15/14 for the soft chromatic and 22/21 and 12/11 for the intense. The larger remaining interval was 6/5 in the soft chromatic and 7/6 in the intense (Chalmers, *Divisions*, 9).

<sup>282</sup> Chrysanthos, *Great Theory*, 121.

order than those of the diatonic scale he expounded earlier in *Great Theory*.<sup>283</sup> Another anomaly of Scale A is that it does not contain the 68 commas that Chrysanthos established as his standard octave species (it only contains 64).

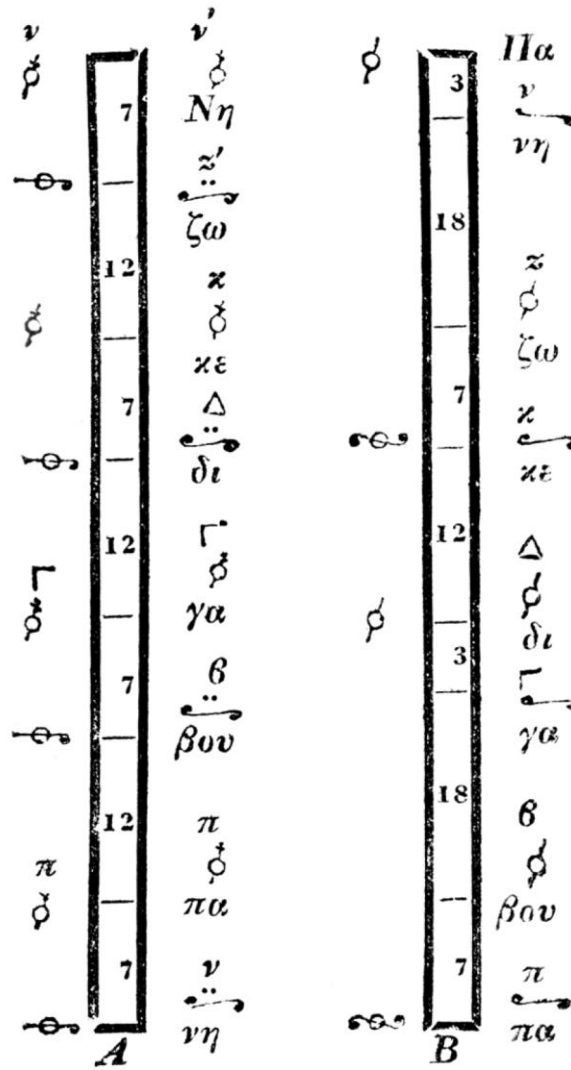


Fig.4.11. Chrysanthine canonia (intervallic tables)

for the Second Mode scales A (soft chromatic) and B (tense chromatic)

Chrysanthos explains at length the intervals of Scale B, but offers no comparable exposition of Scale A:

<sup>283</sup> Ibid., 38.

§.248. Among the eight notes of the chromatic scale B, four, the pa, di, ke and Pa are immovable, that means that they are the same with those in the diatonic scale, their pitch not differing from them in lowness or height. The remaining four move into flats and sharps. The martyria of each appears at the scale B.”

The chromatic genus, according to Chrysanthos, is derived from the diatonic genus through the *alteration* of certain pitches, either by the application of a single sharp or flat to one pitch, or by multiple alterations applied to several pitches. For him, contrary to what is asserted in harmonic theory and theoretical treatises as the Patriarchal Committee of 1883<sup>284</sup> (see Section IX of present chapter), the existence of intervals larger than the major tone is not a necessary condition for the formation of the chromatic genus. What is required instead is the alteration of pitches of the diatonic scale in such a way that the quality produced by the diatonic genus is “coloured” in such a way as to generate a “quality possessing a different ethos.”

Regarding this ethical quality, Chrysanthos writes:

Chroma in music is what has the power to paint the quality created by the notes of the diatonic scale and produce the quality of a different ethos. This is what the dieses and the hypheses can do. Just one hyphesis is able to paint the series of notes in a tetrachord and make it seem as something completely different. The change becomes even greater with two hypheses (§241 in *Great Theory*, 120).

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<sup>284</sup> Στοιχειώδης διδασκαλία τῆς ἐκκλησιαστικῆς μουσικῆς ἐκπονηθεῖσα ἐπὶ τῇ βάσει τοῦ Ψαλτηρίου τῆς Μουσικῆς ἐπιτροπῆς τοῦ Οἰκουμενικοῦ Πατριαρχείου ἐν Κωνσταντινουπόλει ἐν 1883 [= *Elementary instruction in ecclesiastical music, composed on the basis of the Psalterion, by the Musical Committee of the Ecumenical Patriarchate in Constantinople, 1883*] (Constantinople: Patriarchal Printing House, 1888).

Chrysanthos is suggesting here that such qualitative changes of ethos arise from *any* alteration of the diatonic scale, regardless of whether it produces intervals larger than a major tone. This principle is clearly illustrated in the Second Mode. With the application of a single flat to the pitch *Ke*, the diatonic tetrachord *Di–Ni* becomes chromatically altered and appears entirely different. It imparts the ethos of the Second Mode and produces a chromatic genus including any intervals larger than the major tone in its scale.

### *Georgios the Lesbian's Contribution*

An important witness clarifying what Chrysanthos and his contemporaries understood to be chromatic is found in the work of a composer, writer, and editor who promoted a competing notational scheme: namely Georgios of Lesbos, inventor of the so-called *Lesbian Music System*.<sup>285</sup> Well-grounded in music theory, he published a long series of books commencing in 1840 with a theoretical treatise entitled (apparently after Chrysanthos) *Introduction to the Theory and Practice of the Musical Art of the Lesbian System*. While the musically conservative Ecumenical Patriarchate condemned his notational system at around the same time that it denounced the introduction of ecclesiastical polyphony into worship at the diaspora churches of Vienna,<sup>286</sup> Georgios represented a strong local chant tradition that given the frequent

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<sup>285</sup> Georgios the Lesbian, *Εἰσαγωγή εἰς τὸ θεωρητικὸν καὶ πρακτικὸν τῆς μουσικῆς τέχνης τοῦ Λεσβίου συστήματος / συντεθεῖσα πρὸς χρῆσιν τῶν σπουδαζόντων αὐτὴν παρὰ Γεωργίου Λεσβίου τοῦ εὑρετοῦ τῆς μεθόδου* [Introduction to the theoretical and practical aspects of the musical art of the Lesbian system, composed for the use of those studying it by Georgios the Lesbian, the inventor of the method,] (1840), Athens: Printing House of L. Papadopoulos and I. Leonidis.

<sup>286</sup> Demetrios Balageorgos, “Ἐκκλησιαστικὴ μουσικὴ στὴν Κωνσταντινούπολη” (*Ecclesiastical music in Constantinople*), *Ἐγκυκλοπαίδεια Μεῖζονος Ἑλληνισμοῦ – Κωνσταντινούπολη* (2008). URL: <<http://www.ehw.gr/l.aspx?id=11048>>

exchange of cantors between Lesbos and Constantinople, appears to have been well-connected to that of the Ecumenical Patriarchate itself.<sup>287</sup>

What is striking about Georgios's treatise of 1840 and makes it useful for our present discussion, is that he offers a clear definition, with examples, of the nature of chroma that eschews the strict measurement of intervals customary in Greek music theory.

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<sup>287</sup> The influences and effects received by the island of Lesbos from the nearby large urban centers of Asia Minor's coasts were significant geopolitically, historically and culturally. The music of Lesbos was greatly influenced by the musical practices that were consolidated in the large urban centers of Asia Minor (Smyrna, Ayvali, Aydini) and to a certain extent Constantinople itself. Since the 18th c., Lesbos has been closely linked to these centers, both economically - within a wider network of product circulation, promoted by the monoculture of the olive tree on the island - and in wider social practices and activities.

## ΚΕΦΑΛΑΙΟΝ ΔΕΚΑΤΟΝ ΠΡΩΤΟΝ.

### ΠΕΡΙ ΤΩΝ ΓΕΝΩΝ ΤΗΣ ΜΟΥΣΙΚΗΣ.

#### § 1.

- Ερ. Τί ἐννοοῦμεν μὲ τὴν λέξιν, γένος;
- Απ. Ἰδιότητα μέλους.
- Ερ. Πόσα καὶ ποῖα εἶναι τὰ γένη τῆς Μουσικῆς;
- Απ. Τρία· τὸ διατονικόν (α), τὸ χρωματικόν, καὶ τὸ ἐνερμόνιον.
- Ερ. Ποῖον εἶναι τὸ διατονικόν;
- Απ. Ἐκεῖνο, τὸ ὁποῖον μεταχειρίζεται τὴν πρωτότυπον διατονικὴν ὀκτάχορδον κλίμακκα.
- Ερ. Ποῖον εἶναι τὸ χρωματικόν;
- Απ. Ἐκεῖνο, τὸ ὁποῖον ρθερίζει τὰ τονικὰ διαστήματα τῆς πρωτοτύπου διατονικῆς κλίμακκος (β).

(β) Γνώμη κοινὴ καὶ βεβαία εἶναι (καθὼς ἡ φυσικὴ τὸ διδάσκει) ὅτι καὶ εἰς τὴν Μουσικὴν ὑπάρχει χρωματισμός· ὅθεν χρωματίζονται λέγεται καθεὶ τί, τὸ ὅτιον ἡμπορεῖ νὰ προξενήσῃ τὴν παραμιαν διαφρετικὴν ἰδέαν εἰς τὴν ἀλοὴν διὰ τῆς Μουσικῆς.

- Απ. Διάφορος ποικιλία τῆς μελωδίας. (α)
- Ερ. Πόθεν παράγεται ὁ χρωματισμός εἰς τὴν Μουσικὴν;
- Απ. Ἀπὸ τὴν διάφρον ἀλλοίωσιν τῶν τονικῶν διαστημάτων τῆς κλίμακκος.
- Ερ. Ὅποιον παράδειγμα ἔχομεν ἐπὶ τούτῳ;
- Απ. Ἰδοὺ μεταβάλλομεν τὴν διατονικὴν κλίμακκα εἰς χρωματικὴν, ὅταν κάμωμεν τὸν ζε̄ ὕφειν, ἢ τὸν Γᾱ δίειν, ἢ τὸν Γᾱ δίειν, καὶ τὸν ζε̄ ὕφειν.

Fig.4.12. A section of the eleventh chapter in Georgios the Lesbian's *Introduction*

In Chapter 11 of his Introduction (entitled “About the genera of music,” see Figure 4.12), he presents the following dialogue between master and student:<sup>288</sup>

§1

[...]

- *How many are the genera of Music?*
- *They are three; the diatonic, the chromatic and the enharmonic.*
- *Which one is the diatonic?*
- *It is that, which uses the original diatonic eight-stringed scale.*
- *Which one is the chromatic?*
- *It is that, which corrupts the tonal intervals of the original diatonic Scale.\**

\*footnote insertion: *It is a common and certain view (as nature itself has taught) that chromaticism also exists in music; hence, chromatic is commonly called anything that is capable of imparting even the slightest differentiating idea to the hearing through music.* [end of footnote] [...]

§2

- *What does chroma mean in Music?*
- *A different variety of the melody.*
- *How is chromaticism produced in Music?*
- *Through the corruption of the tonal intervals of the Scale.*
- *Which example do we have about it?*
- *Behold; we modify the diatonic scale into a chromatic, when we flatten ζε, or when we sharpen Γα; or we sharpen Γα, and flatten ζε.*<sup>289</sup>

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<sup>288</sup> Our translation and highlighting.

[In a later version edited by Stavrakēs Anagnostēs,<sup>290</sup> the very last passage reads “we modify the diatonic scale into a chromatic, when we flatten Zo, or when we sharpen Ga; or we flatten Ga, and sharpen Ke.”]

Georgios the Lesbian here detaches chromaticism from the mathematical proportions. He effectively considers chroa<sup>291</sup> and chroma to be synonymous, considering even one recurring flat or sharp of a specific note to constitute a chromatic alteration. Furthermore, he views any such modification upon the diatonic as a manifestation of chromaticism. Although music theorists after Chrysanthos have not exploited these insights, they point the way toward the formation of alternative approaches to what we call and how we perform the “chromatic” in the medieval and the received repertoires of Christian plainchant. This is because Georgios helps us to reconstruct the conceptual world of a nineteenth-century cantor, particularly with regard to how tonal material was understood and manipulated in performance, as well as how it was subsequently codified when a theorist, composer, or redactor was called upon to record compositions or their *exegeseis*.

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<sup>289</sup> In his notational system, the Lesbian uses a solmization scheme differing from that of the NM. Without elaborating further, let us only note that in the Lesbian system ζε stands for the Chrysanthine zo.

<sup>290</sup> Stavros Ioakeimoglou (1804 Mandamados, Lesbos – 1891). Poet and composer, editor of chant books and seemingly a chant theory expert. Important musical personality of the nineteenth century, better known as Stavrakēs Anagnostēs or Anagnostou (Σταυράκης Αναγνώστης; he changed his surname to the office of reader or lector he held – Reader=Αναγνώστης); co-editor of chant books in the Lesbian System, and of the -undetected as of yet in a complete form- second (?) edition of the *Introduction to the Lesbian System of notation* by Georgios the Lesbian; co-editor also of *Euterpe* (an 1830 anthology of external, ottoman music) together with important Constantinopolitan editor and composer, Theodoros Phocaeus. See Takes Kalogeropoulos, *Τὸ Λεξικὸ τῆς Ἑλληνικῆς Μουσικῆς*, Vol. 1, Athens: Εκδόσεις Γιαλλελή (1998), 131. See also Σταυράκη Α. Αναγνώστου του Λεσβίου, *Ἡ Λεσβιαὺς Ὡδὴ*, Ἱστορικὸν Ἐγκώμιον, Smyrne, 1850.

<sup>291</sup> Chroa (hue) in Chrysanthos is the setting of an accidental on a single note, while remaining on the initial mode. This principle is debunked by the Lesbian. According to the Greek theory, within the basic forms the intervals of the chromatic and diatonic genera were varied further by three and two hues, respectively. See Cleonides, “Harmonic introduction”, trans. Oliver Strunk, in Oliver Strunk (ed.), *Source readings in music history*, vol. 1, *Antiquity and the Middle Ages* (New York, NY: W. W. Norton, 1965), 39–40; Mathiesen et al. “Greece”.

Georgios has not reinvented chroma, but presents in clear wording a view that Chrysanthos implies mainly through tables (the canonia reproduced above). It is now methodologically productive to ask: what if this kind of thinking extends further back in time? Might the Lesbian provide a missing link toward a more adequate understanding of the so-called “chromatic” *phthorai* in medieval repertoires? The Lesbian’s conception of chromaticism corresponds to the standard of the medieval conception of a phthora, according to which any deviations from the original diatonic scale through semitonal dispositions constitute a sort of chromaticism.<sup>292</sup>

One may recall that, ten centuries before Chrysanthos, irregularly placed semitones in the *Enchiriadis* treatises documented what Maloy has recognised as “non-diatonic” practice.<sup>293</sup> Further back in time, Baccheius Geron (possibly third or fourth century CE.), defines *metabole* as “an alteration of the substratum, or the transposition of something similar into a dissimilar place.”<sup>294</sup> Such irregularities disappeared in Latin writings after the *Enchiriadis* treatises conforming to more the prescriptive theories of gamut and octave species. If dispositions of semitones are able to disturb the basic diatonic structure, then *mutatis mutandis* the non-diatonic tradition in Western Roman and Frankish medieval chant could be the equivalent to the Chrysanthine chromatic Scale A.

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<sup>292</sup> Atkinson, *Critical Nexus*, 130.

<sup>293</sup> Maloy’s studies: “Problems of pitch;” “*Scolica Enchiriadis*;” and *Inside the offertory*.<sup>294</sup> Andrew Barker, “Baccheius Geron. 3<sup>rd</sup>-4<sup>th</sup> Cent. CE,” *Oxford Research Encyclopedia of Classics*. Oxford University Press (2015), 12.

<sup>294</sup> Andrew Barker, “Baccheius Geron. 3<sup>rd</sup>-4<sup>th</sup> Cent. CE,” *Oxford Research Encyclopedia of Classics*. Oxford University Press (2015), 12.

### Section III — On Chrysanthos' tuning as a reference: methodological and comparative framework

This section proceeds from the premise established above: that “chromaticism” in chant traditions does not necessarily require non-diatonic interval sizes, but may arise from the internal reconfiguration of diatonic material. In the absence of direct evidence for medieval Byzantine intonation, the methodological question is therefore one of reference: how can one find a tuning model that most plausibly represents such “quasi-chromatic” diatony in a controlled and historically meaningful way?

Inspired by Peter Jeffery's ethnomusicological perspectives on the study of medieval chant, we approach the tuning ratios of Chrysanthos of Madytos as the written crystallisation of an oral tradition with roots in Arab music theory of the ninth and tenth centuries CE.<sup>295</sup> We aim to show in the present chapter, that the neutral third (32/27) and minimum tone (12/11) central to Chrysanthos' system are attested across Persian, Ottoman, and Byzantine practice,<sup>296</sup> indicating a long-standing perceptual and modal logic that transcends any single notation system.

Consequently, we argue that the tuning system of Chrysanthos, and especially his diatonic and so-called “soft chromatic” structures grounded in acoustically consistent intervals while satisfying the small integer ratio principle, provides such a defensible frame of reference.<sup>297</sup> His three basic interval types – major tone (9/8), minor tone (12/11), and minimum tone (88/81) – constitute a rational structure that enables

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<sup>295</sup> Jeffery, *Re-envisioning Past Musical Cultures*,” 6–12; Erlanger, *La musique arabe II*, 72–73; George Sawa, “Survival of Some Aspects of Medieval Arabic Performance Practice,” *Asian Music* 35, no. 2 (2004): 7–13.

<sup>296</sup> Amine Beyhom, *The lost art of maqam*, *NEMO-Online* (2019), 11–19; Kioumars Poorhaydari, “Empirical Evaluation of Intervals and Fretting Systems in Persian Art Music,” *Analytical Approaches to World Music* 11, no. 2 (2023): 8–10; Walter Feldman, *Music of the Ottoman Court: Makam, Composition and the Early Ottoman Instrumental Repertoire* (Berlin: VWB, 1996), 132.

<sup>297</sup> Skoulios, “Modern Theory and Notation,” 23; Chalmers, *Divisions*, 46.

expressive asymmetry within each tetrachord. This is particularly evident in his (so-called “soft” by later theorists revisiting Ancient Greek terminology) chromatic genus, where no interval exceeds a whole tone, yet perceptual phenomena such as the illusion of an augmented second emerge naturally. Our aim is not to achieve a definitive reconstruction of medieval practice. Instead, we seek a rational and performable working model, strengthened not only through comparative study of parallel phenomena in the intervallic frameworks of Arab, Persian, and Ottoman musics emphasizing neutral thirds such as  $11/9$  or  $27/22$ , but also through attention to perceptions of chromatic effects emerging from the use of diatonic intervals.

Recent empirical studies confirm that neutral intervals (particularly between 140–150 cents)<sup>298</sup> are not only common in Persian and Arabic traditions, but exercise also structural roles in their music for fretted instruments and voices. Poorhaydari’s evaluation of Persian fretting systems (e.g., for the *tār* and *setār*) shows that neutral-second values clustering around the mid-point between minor and major seconds—approximately 145–150 cents, including ratios close to  $12/11$  ( $\approx 150.6$  c)—are among the most stable and frequently encountered in practice, despite ongoing variation resulting from oral transmission and performer discretion.<sup>299</sup> Similarly, Markos Skoulios notes that Chrysanthos reintroduced the  $12/11$  interval into Byzantine theory to align it with the neutral tones observed in Arab and Ottoman instruments such as the *ney* and *tanbur*.<sup>300</sup> Thus, what may seem like an idiosyncratic innovation of the

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<sup>298</sup> Cents are a unit of measurement used in music to describe the difference in pitch between two notes. One cent is equal to 1/100th of a semitone (ET). More details in ft. at the beginning of Chapter 2.

<sup>299</sup> Poorhaydari, “Empirical Evaluation,” 15-17; idem, “Examination of neutral intervals and parent scales in Persian art music: a step toward the standardization of the musical system,” *Music Theory and Analysis* 9, no. 1 (2022), 42-43.

<sup>300</sup> Markos Skoulios, “Modern Theory and Notation of Byzantine Chant: A Near Eastern Musicological Perspective,” *NEMO-Online* 1, no. 1 (2012): 22–23.

nineteenth century instead reflects a deeper cross-cultural continuity, grounded in the shared auditory grammars of the Eastern Mediterranean.

*Alexander Lingas*

In formulating our own approach to the reconstruction of tuning in medieval Byzantine chant, we have adopted an approach that aligns closely with the performance-practice methodology articulated by Lingas in both his scholarly writings and practical work with his vocal ensemble, Cappella Romana. Lingas' reconstructions of medieval Byzantine services routinely draw on later witnesses (most notably the Chrysanthine "New Method") as historically mediated but valuable conduits for earlier performance traditions.<sup>301</sup> Likewise, this study treats Chrysanthos' 1832 fractional intervals not as isolated innovations, but as codifications of an intervallic logic traceable at least to Arab theorists of the ninth and tenth centuries such as Farabi and Zalzal.<sup>302</sup> In both cases, the later sources are not used uncritically, but as a point of entry into a broader historical continuum illuminated by comparative evidence from related traditions. Lingas has emphasised that notation alone cannot recover the full sonic reality of medieval chant, and that performance reconstructions necessarily combine textual, archaeological, and ethnomusicological evidence with informed artistic judgement.<sup>303</sup> This principle underlies the present work's integration of theoretical treatises, documented oral traditions, and modal parallels across the Eastern Mediterranean in order to propose an historically grounded, performable tuning system that reflects the acoustic and cognitive conditions within which medieval Byzantine chant was sung.

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<sup>301</sup> Alexander Lingas, "Medieval Byzantine chant and the sound of Orthodoxy," in *Byzantine Orthodoxies*, ed. Andrew Louth and Augustine Casiday (Aldershot: Ashgate, 2006), 136–137; Alexander Lingas, *Good Friday in Jerusalem* (Portland: Cappella Romana, 2015), CD booklet, 4–6.

<sup>302</sup> Erlanger, *La musique arabe* II, 72–73; George Sawa, "Survival," 7–13.

<sup>303</sup> Lingas, "Performance Practice" 57–58; see also Alexander Lingas, interview by Steven E. Ritter, "Bringing Byzantium to Light: A Conversation with Alexander Lingas of Cappella Romana," *Fanfare Magazine* (12 October 2010), reposted on *Byzantine Blog*, 15 October 2010, <https://mybyzantine.wordpress.com/2010/10/15/bringing-byzantium-to-light-a-conversation-with-alexander-lingas-of-cappella-romana/>.

*A Chromatic Sound for Diatonic Intervals: The case of Demetrios Lekkas*

The work of Demetrios Lekkas challenges prevailing polarities in the modern study of Byzantine modal systems. He aligns directly neither with the pro-chroma camp, which defines chromaticism narrowly through the presence of augmented seconds, nor with the contra-chroma stance, which sees chromatic modes as post-medieval corruptions or innovations. Instead, Lekkas formulates a distinct and original approach: chromatic colour can arise from diatonic systems themselves, not as imported anomalies but as acoustical or structural effects arising internally within diatony.

His 1995 doctoral dissertation “Η μαθηματική θεωρία της μουσικής” [The Mathematical Theory of Music] proposes a first-principles, mathematically grounded reconstruction of modal interval theory, which undermines rigid categorical divisions like diatonic vs. chromatic. Modes are understood here not as static scales, but as dynamic systems of internal tension, where colour results from the unequal distribution of scalar energy. Crucially, Lekkas suggests that certain chromatic impressions may be the result of an acoustic illusion generated by the human cochlea itself, thus placing psychoacoustic perception at the core of modal theory. By allowing a more diverse approach to some chromatic cases however, he does not deny the existence of augmented-second tetrachordal structures (usually described as “hard” chromatic).

He develops this line of thinking in greater analytical depth in two published studies. In “Η διατονική βάση της βυζαντινής μουσικής: συστημική δομική προσέγγιση” [The diatonic basis of byzantine music: systemic structural approach], Lekkas presents a comprehensive argument for the fundamentally diatonic architecture of Byzantine

modal theory—even in the most chromatically coloured modes. His approach rejects the necessity of importing foreign or non-diatonic genera (such as the ancient *chrōma*) to explain modal nuance. Instead, chromatic expression arises from the specific partitioning of the diatonic tetrachord, particularly through unequal divisions of tone and semitone that challenge symmetrical expectations.

In his later article, “Βυζαντινό ‘μαλακό χρώμα:’ συστημική δομική προσέγγιση” [Byzantine ‘soft chroma:’ systemic structural approach], he further develops this argument by treating soft colour as a kind of “internal colouring” within diatony that does not rely on structural insertion of augmented seconds. He contends that the expressive affect of certain modes, especially in their ascending and descending pathways, results from acoustical illusions reinforced by the ear’s expectations of resolution within asymmetric tetrachordal divisions. This effect, he proposes, is intimately related to the morphology of the cochlea and human pitch perception, arguing that some Byzantine chromaticism may be better understood as a perceptual consequence of our auditory physiology, rather than a reflection of distinct scalar structures.

In the beginning of this study he also comments on the subject of the soft colour, that

[t]he critical nature of the issue lies in a sometimes irreconcilable division of opinion between, on the one hand, local Greek cantors and theorists, who took for granted that the current rendition of Byzantine chant must necessarily preserve faithfully its medieval and perhaps even ancient paradigms, and, on the other hand, certain Western European scholars -- foremost among them the eminent Austro-Hungarian Byzantinist Egon Wellesz (1885–1974) -- who rejected any such notion, considering the chant as we know it today to be a

*neo-Greek* phenomenon, specifically influenced by Ottoman musical idioms. The focus of the disagreement centred on the so-called “chromatic” modes. Wellesz, for example, in his classic monograph, makes no mention whatsoever of the possibility -- or even the opinion -- that the second and plagal second modes might have been chromatic [that is, include an augmented second in their tetrachords]. As a result, the view that these modes were originally diatonic in Byzantium and only later, so to speak, “turned Turkish,” circulated widely in the West. Even today one can find online discussions in which the chromatic character of the second modes is rejected; sometimes even ridiculed. As was perhaps to be expected, for Greeks and other Rums, *chrōma* became a matter of honour, and at the same time something like a touchstone for the overall Greekness not only of the chant but of Byzantium and the *Greek race* itself. For some, Byzantine music found in Wellesz, so to speak, its own *Fallmerayer*.<sup>304</sup>

<sup>304</sup> Ibid., 139-140. Our translation of the following original text:

Το ζήτημα του μαλακού χρώματος ήταν και είναι φλέγον για μεγάλο μέρος της ελληνικής θεωρητικής φιλολογίας της βυζαντινής μουσικής των τελευταίων διακοσίων ετών. Ως προς τη γενική μαθηματική προτύπωση, πυθαγορικής ασφαλώς προέλευσης, αρκεί να αναφέρει κανείς τους: Αρχιεπίσκοπο Χρύσανθο, Πατριαρχική Μουσική Επιτροπή του 1881, Ανδρέα Τσικνόπουλο, Μισαήλ Μισαηλίδη, Κωνσταντίνο Ψάχο, Σίμωνα Καρά και Σταύρο Βραχάμη, Σπύρο Περιστέρη κ.ά. Παράλληλα, και πολύ περισσότερο, στην ίδια φιλολογία επικρατεί μια πρακτική προτύπωση αριστοξενικής έμπνευσης με συγκεκριμένα δωδεκατημόρια του τόνου / 72α της οκτάβας.

Η κρίσιμη φύση του ερωτήματος άπτεται μιας κάποτε αγεφύρωτης διχογνωμίας ανάμεσα αφενός στους εδώ ψάλτες και θεωρητικούς, που λάμβαναν αυτονοήτως ως δεδομένο ότι η τωρινή απόδοση της υμνωδίας δεν μπορεί παρά να διατηρεί πιστά τα μεσαιωνικά και, ίσως, τα αρχαία πρότυπά της, και αφετέρου σε ορισμένους Δυτικούς Ευρωπαίους, με κορυφαίο πόλο τον μεγάλο διαμετρήματος αυστρουύγγο μελετητή της βυζαντινής μουσικής Έγκον Βέλλες (1885-1974), που απέρριπταν κάθε τέτοια ιδέα, θεωρώντας την ψαλτική όπως την γνωρίζουμε «νεοελληνική», και δη οθωμανότροπη. Στους «χρωματικούς» ήχους επικεντρώθηκε η εστία της διαφωνίας. Ο Βέλλες, π.χ., στο κλασικό σύγγραμμά του, ούτε καν μνειά δεν κάνει για το ενδεχόμενο, ή την άποψη τουλάχιστον, ότι μπορεί και να ήταν οι ήχοι β' και πλάγιος β' «χρωματικοί». Έτσι, στη Δύση κυκλοφόρησε ευρέως η θέση πως στο Βυζάντιο ήταν διατονικοί και μετά, τρόπον τινά, «τούρκεψαν». Ακόμα και σήμερα βρίσκεται κανείς στο διαδίκτυο αλληλογραφίες, όπου η «χρωματικότητα» των δύο β' ήχων αποκρούεται, έως και λοιδορείται. Όπως ήταν αναμενόμενο, για τους Έλληνες και λοιπούς Ρωμιούς, το «χρώμα» κατέστη ζήτημα τιμής, και συνάμα κάτι σαν λυδία λίθος για την καθόλου ελληνικότητα όχι

Lekkas' importance is reflected in the breadth of his bibliography on musical intervals, spanning from ancient Greek theoretical sources to Byzantine chant and contemporary modal questions. His contributions cover topics such as tetrachordal divisions, tuning systems, acoustic psycho-phenomena, and modal archaeology. His work seems to have been rarely cited yet, not because of any deficiency in content, but because it stands apart from academic convention, both in its style and in its level of formal rigour. He does not write within the traditional discourses of historical or analytical musicology, but brings instead a mathematical and acoustical framework to bear on philological problems; and does so with the intent, at least *in principio*, to provide solutions and not merely theorize. His methodology is not speculative but constructive: it attempts to reframe modal logic from first principles and to describe the emergent structures of musical perception in analytically verifiable terms.

Lekkas redefines chroma not on the basis of augmented-second tetrachordal structures, but as a condition emergent from scalar asymmetry, tension, and psychoacoustic reception. In doing so, he sidesteps entrenched polemics and provides a third interpretive option; one that is both modern in method and deeply traditional in intuition, consciously employing Chrysanthos' soft chromatic intervals, and unconsciously reaffirming the Lesbian's re-definition of chroma. For a discipline too often trapped in binary debates over intervals, his work models a path toward conceptual synthesis rather than ideological division.

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μόνο της ψαλτικής αλλά και του Βυζαντίου και αυτού του *Γένους*. Για μερικούς, μάλιστα, η βυζαντινή μουσική απέκτησε με τον Βέλλες, ούτως ειπείν, τον δικό της *Φάλμεραϊερ*.

*Amine Beyhom*

The late Amine Beyhom (1960-2022) was a native of Lebanon and a musicologist who served as director of the Centre de Recherches sur les Musiques Arabes et Apparentées and was founding member of the FOREDOFICO foundation, which promotes music and arts in Lebanon). Situating Byzantine chant within a broader Eastern Mediterranean modal continuum encompassing also Arab and Ottoman traditions, he argued that understanding Byzantine scales requires attention to this shared environment. Beyhom’s central concern was the long-standing tension between normative theoretical systems and empirical melodic behaviour as observed in the living chant traditions of the Eastern Mediterranean.<sup>305</sup>

Beyhom admitted that defenses of Byzantine chant against Western “Byzantinism” (such as those mounted, for example, by Stathis) could be a healthy corrective. Yet he also warned that “Re-Byzantinism” becomes problematic when it claims Byzantine chant is historically “pure” and isolated, denying any meaningful interaction with neighbouring Arabic–Persian musical cultures.<sup>306</sup> For Beyhom, this insistence on purity, sometimes resting on the notion of the sharp civilizational break coinciding

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<sup>305</sup> Amine Beyhom, *Théories et pratiques de l'échelle dans le chant byzantin arabe: Une approche comparative et analytique proposant une solution inédite pour le système théorique de Chrysanthos le Madyte* (Broummana, Lebanon: Amine Beyhom, 2015), esp. 15–34.

<sup>306</sup> In idem, “Theory and Practice of Psaltiki: Why do they not coincide?,” in «...έν έπιγνώσει ύμνοϋντάς Σε...» Προϋποθέσεις και Δεξιότητες για την Έρα Ψαλμωδία στην Όρθόδοξη Λατρεία (“...έν έπιγνώσει ύμνοϋντάς Σε...” [= *Chanting consciously in praise to Thee*]: *Prerequisites and skills for sacred chanting in Orthodox worship*), 3ο Διεθνές Μουσικολογικό και Έεροψαλμικό Συνέδριο (Volos, 30 May–2 June 2018) (Volos: Έκδοτική Δημητριάδος, 2020), 656-657, the author uses the term *Byzantinism* to describe the discourse produced by European nations in the 19<sup>th</sup>–20<sup>th</sup> c. about Byzantium, which unfolds in two phases: an initial period of disparagement of Byzantium, followed by a period of integration, in which Byzantium becomes incorporated into a European historical narrative (largely because of its presumed continuity with Ancient Greece). Building on this, Beyhom defines *Re-Byzantinism* as the predominant 20<sup>th</sup> c. trend whereby Western Byzantinological discourse is internalized locally, prompting Byzantine theoreticians to formulate revised, “scientific,” and Western-compatible models of chant theory—exemplified by attempts to force-fit Byzantine chant into frameworks such as Pythagoreanism—with the long-term consequence that theoretical reform increasingly shapes and redirects performance practice.

with the Ottoman conquest of Constantinople in 1453, is not historically credible. Since chant shares demonstrable theoretical and melodic traits with maqam traditions, exceptionalist narratives ultimately reproduce from within the ideological patterns of Western Orientalism.<sup>307</sup>

Accordingly, Beyhom argued that Chrysanthos' theoretical system should not be understood as a rigid or exhaustive prescription of musical reality, but as a conceptual framework that coexists with significant pitch flexibility in practice. He emphasized that Byzantine and Arab-Byzantine chant traditions make systematic use of non-equal and neutral intervals that cannot be adequately accounted for by equalized or overly simplified theoretical grids.<sup>308</sup> Through comparative discussion of Arab maqam theory, Byzantine modal terminology, and modern pitch measurements from Lebanese chant performance, Beyhom shows that modal coherence is maintained not through fixed scalar steps, but through functional pitch relationships, melodic trajectories, and stable focal tones.

A key contribution is his critique of attempts to “correct” Chrysanthos' system (see Section IX about the Patriarchal Committee, at the end of present chapter) by imposing later equalized minute divisions or by forcing theoretical symmetry where none is required by musical practice.<sup>309</sup> Such corrective approaches risk obscuring the very musical realities they aim to clarify. He advocated instead a re-reading of Chrysanthos in the comparative light of Near Eastern modal practice, where tuning systems serve as flexible reference frameworks rather than as precise acoustic

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<sup>307</sup> Ibid., 661.

<sup>308</sup> See for instance Amine Beyhom, “Byzantine Chant Theory and Practice in the Light of Ancient Greek Music Theory and Occidentism,” *Series Musicologica Balcanica* 1, no. 1 (2020): 56–85, <https://doi.org/10.26262/smb.v1i1.7629>.

<sup>309</sup> Idem, “Theory and Practice of Psaltiki.”

prescriptions.<sup>310</sup> Discrepancies between theory and practice would no longer automatically appear to be errors, but indicators of a musical culture in which perception, melodic function, and oral transmission take precedence over mathematical exactitude.

His work reinforces the view that historical Byzantine tuning cannot be reconstructed through theory alone and that performance-oriented analysis is essential. For this reason, he supported a methodological stance in which historically informed “working tunings” are evaluated by their ability to sustain modal behaviour and perceptual stability, rather than by claims of absolute correctness.

In sum, we find that Chrysanthos’ tuning system offers a coherent ratio-based structure capable of modelling the *quasi-chromatic* effects that may arise within diatonic material. Its plausibility is strengthened by comparative evidence from Arabic, Persian, and Ottoman intervallic traditions, as well as by the perceptual insights of writers such as Lekkas and the performance-oriented methodological stance articulated by Lingas. Yet this reference model also reveals an internal tension: Chrysanthos’ own theoretical presentation of the soft chromatic genus does not consistently satisfy the structural demands of the octave, fourth, and fifth. For this reason, the following section turns to the corrective interventions of Chourmouzius and later theorists, who sought to regularise and canonise “soft chromaticism” by rearranging Chrysanthine intervallic material into a form more compatible with modal practice and harmonic integrity.

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<sup>310</sup> Idem, *Théories et pratiques*, esp. 201–245.

#### Section IV — Corrective Interventions: on Chourmouzi<sup>311</sup> and the canonisation of “soft” chromaticism

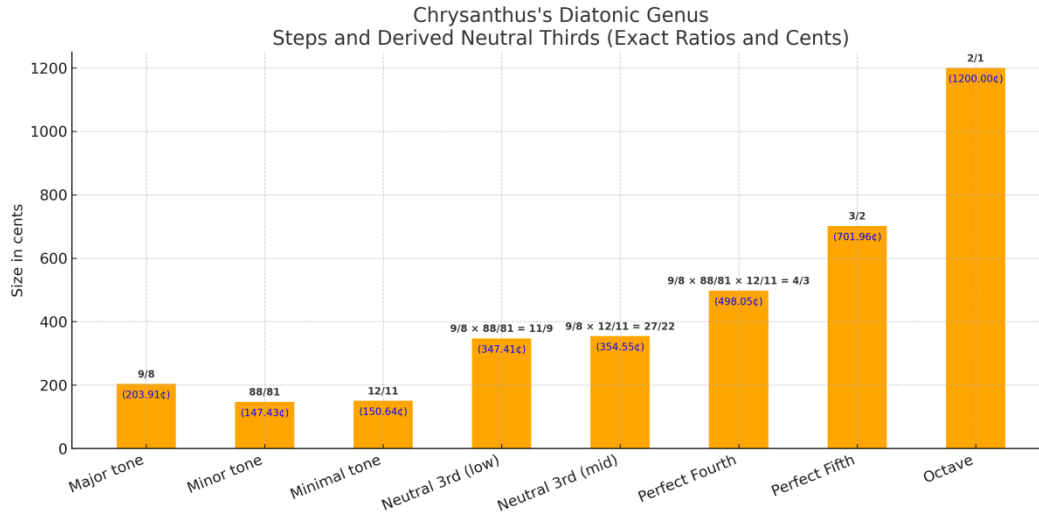
We have already seen that Chrysanthos constructs his modal system using three rational intervals: the major tone (9/8), the minor tone (88/81), and the minimum tone (12/11). These were not chosen arbitrarily, but derive from ancient tuning traditions, including Pythagorean arithmetic, Aristoxenian scalar division, the Ptolemaic homalon, and medieval Arabic theorists like Farabi and Safi al-Din.<sup>311</sup> Chrysanthos’ primary diatonic tetrachord for his diatonic scale (ne-ne’) is structured as 9/8x12/11x88/81. In terms of approximate cents, this yields intervals of

- Μείζων τόνος (major tone) =  $9/8 \approx 203.91$ cents
- Ελάσσων τόνος (minor tone) =  $12/11 \approx 150.64$ cents
- Ελάχιστος τόνος (minimum tone) =  $88/81 \approx 143.50$ cents

producing an overall span of a perfect fourth (498 cents).

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<sup>311</sup> Chrysanthos, *Great Theory*, §§217–228; cf. Skoulios, “Modern Theory and Notation,” 22–23, who documents the Byzantine revival of rational tuning via 12/11 and 88/81 to realign chant with earlier Arab and Greek concepts; also Poorhaydari, “Empirical Evaluation,” 4–7, for statistical measurements confirming the usage of 12/11 and 88/81 intervals on Persian fretted instruments.



Tab.4.2. Chrysanthine intervals in ratios and cents

For his Scale A for the Second Mode (Figure 4.13), the one we conventionally call “soft” chroma, Chrysanthos uses an impure tetrachord of exclusively the minimum and major tones structured as  $88/81 \times 9/8 \times 88/81$ . He states in §244 of his *Great Theory* that, “the chromatic scale ne [pa flat] bou ga di [ke flat] zo’ ne’ does not form tetrachords, but trichords which are absolutely similar and conjunct to each other.” But the division of intervals he proposes cannot simultaneously satisfy the *diphonia homoia* (“similar thirds”) principle, and the structural necessity of a tetrachord. It not only produces a diminished octave of 64 commas (instead of 68 contained in a perfect octave according to the approximative system of Chrysanthos), but also impure fourths and fifths:

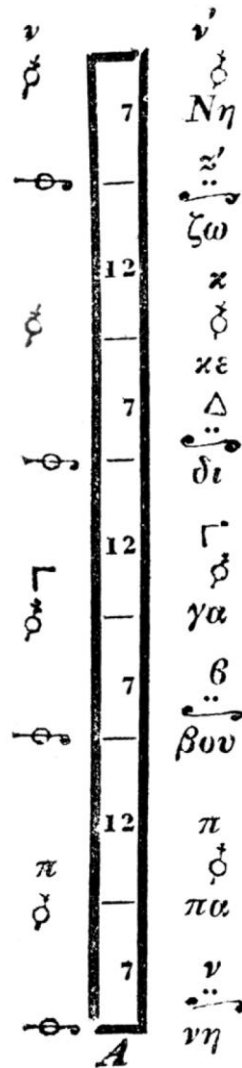


Fig.4.13. Chrysanthine canonion (intervallic table) of Scale A for the chromatic Second Mode – from Chrysanthus' *Great Theory*, 121

His fellow reformer Chourmouzius quickly identified this intervallic peculiarity as a flaw, discussing it in his manuscript treatise *Introduction to the theoretical and practical aspects of ecclesiastical music* (Εἰσαγωγή εἰς τὸ Θεωρητικὸν καὶ Πρακτικὸν τῆς Ἐκκλησιαστικῆς Μουσικῆς).<sup>312</sup> He addressed the issue by proposing an alternative

<sup>312</sup> Found in Ms Cod. Atheniensis 1916 (National Library of Greece), as well as at least two other autographs of Chourmouzius (one from the Lycourgos Angelopoulos collection, and the other from the

scalar division expressed as 9–12–7–12–9–12–7 (summing a total of 68 commas), in contrast to the unbroken sequence of 7–12–7–12–7–12 characteristic of the strict symmetric “diphonic” schema. These alternative distributions restored consonant perfection to the octave and its constituent fourths and fifths. His proposal to replace two of the minimal tones with minor ones was consistent with both the laws of acoustics and those of scale construction. The system that emerges from the intervention of Chourmouzius is not a direct reproduction of the Chrysanthine diatonic, but a practical rearrangement of its intervallic components.

Chourmouzius explains his reasoning in a special “Commentary” to this intervallic puzzle:

#### Commentary

The scale of the Second Mode according to these intervals, because it does not form a perfect octave and because four commas are lacking from the sixty-eight commas of the [normal] diapason, aroused the curiosity of the teacher Chourmouzius Chartophylax, and led him to a more exact investigation into the nature of this mode. And indeed, having already examined with precision the allegedly equal trichords of this scale by means of the pitch-measurer, with the utmost care, he ascertained that this scale, proceeding from the base *Ne*

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Miltiades Pappas collection, which will concern us immediately next), included in the digital versatile disc accompanying the edition Georgios Chourmouzius Chartophylax, *Introduction to the theoretical and practical aspects of ecclesiastical music (Eisagogē eis to Theōrētikōn kai Praktikōn tēs Ekklesiastikēs Mousikēs)*, ed. Georgios N. Constantinou (Mount Athos: Holy Great Monastery of Vatopaidi, 2014); see also Chourmouzius Chartophylax (2002). *Εισαγωγή εις το θεωρητικόν και πρακτικόν της εκκλησιαστικής μουσικής [Introduction to the theoretical and practical aspects of ecclesiastical music]*, introduction and critical edition by Emmanouil St. Giannopoulos. Thessaloniki: University Studio Press.

toward the acute, takes the first trichord *ne pa vu* as consisting of a minor tone and a major tone; the second, *vu ga di*, as consisting of a minimal tone and a major tone; the third, *di ke zo'*, as consisting of a minor tone and a major tone; and the final tone, *zo' ne'*, as a minimal tone. In this way, the sixty-eight intervals of the diapason are completely fulfilled.

If, however, the said scale were to begin from *vu* or from *di*, again proceeding from the grave toward the acute, the stated ordering of the trichords would not be altered. [...] These things were ascertained by the aforementioned Chartophylax, one of the inventors of this system; and if anyone else, at some later time, should wish to say something further or more subtle, with reasoned argument, he will recognize great gratitude owed to him for the benefit that would thereby accrue to our music-loving compatriots.<sup>313</sup>

Chourmouzos' correction of Chrysanthos operates according to a logic comparable to Zalzal's correction of Ptolemy: both seek to re-establish acoustically pure fourths at the level of the tetrachord, even at the cost of modifying an inherited theoretical

<sup>313</sup> Our translation of the original Greek from a manuscript in the collection of Ms Miltiades Pappas included (in .pdf form) on the accompanying digital disc to Georgios Chourmouzos Chartophylax, *Introduction*, 84-86:

**Σχόλιον.**

Ἡ κλίμαξ τοῦ δευτέρου ἤχου κατὰ τὰ διαστήματα ταῦτα, ἐπειδὴ δὲν ἀντιφωνεῖ, ἀλλὰ λείπονται τέσσαρα διαστήματα ἐκ τῶν ἐξήκοντα ὀκτῶ τῆς διαπασῶν, διήγειρε τὴν περιέργειαν τοῦ διδασκάλου Χουρμουζίου Χαρτοφύλακος εἰς ἀκριβεστέραν ἔρευναν τῆς φύσεως τοῦ ἤχου τούτου. Καὶ δὴ ἐξετάσας ἀκριβῶς ἤδη τὰ ὅμοια δῆθεν τρίχορδα τῆς κλίμακος ταύτης διὰ τοῦ φθογομέτρου μετὰ προσοχῆς ἄκρας ἐξηγνίασεν ὅτι ἡ κλίμαξ αὕτη, ὀδεύουσα ἀπὸ τὴν βάσιν τοῦ Νη ἐπὶ τὸ ὄξύ, τὸ πρῶτον τρίχορδον Νη Πα Βου λαμβάνει εἰς τόνον ἐλάσσονα καὶ τόνον μείζονα, τὸ δεύτερον Βου Γα Δι εἰς τόνον ἐλάχιστον καὶ τόνον μείζονα, τὸ τρίτον Δι Κε Ζω' εἰς τόνον ἐλάσσονα καὶ τόνον μείζονα, τὸν δὲ τελευταῖον τόνον Ζω'-Νη' εἰς τόνον ἐλάχιστον. Καὶ οὕτω πληροῦνται ἐντελῶς τὰ ἐξήκοντα ὀκτῶ διαστήματα τῆς διαπασῶν. Εἰ ὅμως ἡ ῥηθείσα κλίμαξ ἤθελε νὰ ἀρχίσῃ ἀπὸ τοῦ Βου ἢ ἀπὸ τοῦ Δι, ὀδεύουσα πάλιν ἀπὸ τοῦ βαρέος ἐπὶ τὸ ὄξύ, ἡ εἰρημένη τάξις τῶν τριχορδῶν δὲν μεταβάλλεται. [...] Αὐτὰ ἐξηγνίασεν ὁ ῥηθείς χαρτοφύλαξ, εἰς τῶν ἐφευρετῶν τοῦ συστήματος τούτου· καὶ ἐὰν ἄλλος τις εἰς τὸ μετέπειτα ἤθελεν εἰπεῖν τι περισσότερον ἢ περιεργότερον μετὰ λόγου, θέλει γνωρίσει μεγίστην εἰς αὐτὸν τὴν χάριν διὰ τὴν γενησομένην ὠφέλειαν εἰς τοὺς φιλομούσους ὁμογενεῖς.

framework. Chourmouziος himself frames his intervention modestly, leaving open the possibility of future correction and refinement. Such formulations underline a central truth of nineteenth-century chant theory: far from being a closed mathematical system, it was consciously presented as an evolving framework, continuously negotiated between theoretical models and the subtleties of lived musical experience.

Chourmouziος evidently relayed his unpublished arguments to his erstwhile student and collaborator Theodoros Papa Paraschou Phocaeus<sup>314</sup> (1790-1851), a composer, editor, publisher, teacher, and theorist of ecclesiastical and secular music in Constantinople. Phocaeus published his own pedagogical manual for the teaching of chant in 1842 bearing the title *Κρηπίς τοῦ θεωρητικοῦ καὶ πρακτικοῦ τῆς ἐκκλησιαστικῆς μουσικῆς* [*Crepis=Foundation of the theoretical and practical [instruction] of ecclesiastical music*].<sup>315</sup> Arranged in the dialogical form of *erotapokriseis* (questions-and-answers), it revisits the contents of the well-known 1821 *Introduction* of Chrysanthos with additional elements, some evidently drawn

<sup>314</sup> According to Manolis Hatzigiakoumis, Theodoros was a student of Georgios the Cretan, as well as of Gregorios the Protosaltēs and Chourmouziος Chartophylax, at the Third Patriarchal Music School (1815–1821). He served as a chanter at St Demetrios in Tatavla, as a second cantor to Chourmouziος. See

<https://www.e-kere.gr/%CE%B2%CE%B9%CE%BF%CE%B3%CF%81%CE%B1%CF%86%CE%B9%CE%BA%CE%AC/%CE%98%CE%95%CE%9F%CE%94%CE%A9%CE%A1%CE%9F%CE%A3-%CE%A6%CE%A9%CE%9A%CE%91%CE%95%CE%A5%CE%A3>

<sup>315</sup> Theodoros Papa Paraschos Phocaeus, *Κρηπίς τοῦ θεωρητικοῦ καὶ πρακτικοῦ τῆς ἐκκλησιαστικῆς μουσικῆς. Συνταχθεῖσα, πρὸς χρῆσιν τῶν σπουδαζόντων αὐτήν, κατὰ τὴν νέαν μέθοδον, παρὰ τῶν τριῶν ἐνδόξων Μουσικοδιδασκάλων, Κυρίου Χρυσάνθου Μητροπολίτου Προύσης, Κυρίου Γρηγορίου Πρωτοψάλτου τῆς τοῦ Χριστοῦ Μεγάλης Ἐκκλησίας, καὶ Κυρίου Χουρμουζίου Χαρτοφύλακος. Ἐκδεδομένη πρότερον μὲν διηγηματικῶς παρὰ Παναγιώτου Πελοπίδου· νῦν δὲ αὖθις εἰς τύπον ἐκδοθεῖσα κατ' ἐρωταπόκρισιν, μετὰ προσθήκης πολλῶν ἑτέρων ἀναγκασιούτων τὰ μάλιστα εἰς φιλολογικὴν γνῶσιν, παρὰ Θεοδώρου Παπᾶ Παράσχου Φωκαέως, ἐπιστασία τοῦ ἰδίου καὶ ἀναλώμασιν αὐτοῦ τε καὶ τῶν φιλομουσῶν συνδρομητῶν.* [*Crepis=Foundation of the theoretical and practical instruction of ecclesiastical music. Compiled for the use of those studying it, according to the New Method, by the three illustrious Teachers of Music: Lord Chrysanthos, Metropolitan of Prussa; Lord Gregorios, Protosaltis of the Great Church of Christ; and Lord Chourmouziος, Chartophylax. Previously published in narrative form by Panagiotis Pelopides; now again issued in print in question-and-answer form, with the addition of many other matters, especially those necessary for philological knowledge, by Theodoros Papa Paraschos of Phocaea, under his own supervision and at his own expense as well as that of the music-loving subscribers*]. Constantinople: Patriarchal Printing House, 1842).

from the unpublished *Introduction* of Chourmouzos.<sup>316</sup> Among the latter is the alternative scalar division of 9–12–7–12–9–12–7 (totalling 68 commas). Phocaeus defended this adjustment with the observation that “the intervals of this scale thus stand almost close to the truth” (*eggūs tēs alētheias schedon*), thereby acknowledging the tension between mathematical constructs and the auditory realities of chant practice. Furthermore, Phocaeus published an illustration of Chourmouzos’ correction in the form of a *canonion* (Figure 4.14). Featuring a perfect octave, fifth, and fourth from its tonic, it also produces perfect tetrachords and pentachords from the notes *ne*, *vu* and *di* respectively. This can be rendered in staff notation, as below in Chapter 5, to a “C” mode with four quarter-tone flats in its signature (reversed flats used on D, E, A and B).

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<sup>316</sup> Georgios Hadzitheodorou notes about the *Crepis*, that it “follows closely the *Great Theoretical Treatise* of Chrysanthos, and especially the *Introduction* [...]. Since, however, it employs the popular method of question and answer of that period, and since the author himself took systematic care for its dissemination, it prevailed for many years and constituted almost the sole instructional book of theory and practical exercises for beginners, until approximately our own days.” Our translation from Georgios J. Hadzitheodorou, *Βιβλιογραφία της Βυζαντινής Εκκλησιαστικής Μουσικής. Περίοδος Α΄ (1820–1899)* [Bibliography of Byzantine ecclesiastical music. First period (1820–1899)] (Thessaloniki: Patriarchal Institute for Patristic Studies, 1998), 219.

Κλίμαξ τοῦ Δευτέρου ἤχου κατὰ τρίχορδον.

λεγαλιώ $\sigma^x$	7	Νη $\nu'$ λεγαλιώ
λεχέαλιες $\theta$	12	Ζω $\zeta'$ λεαλιές
λεγαλιώ $\sigma^x$	9	Κε $\kappa'$ λεγαλιώ
λεχέαλιες $\theta$	12	Δι $\delta'$ λεαλιές
λεγαλιώ $\sigma^x$	7	Γα $\gamma'$ λεγαλιώ
λεχέαλιες $\theta$	12	Βου $\beta'$ λεαλιές
λεγαλιώ $\sigma^x$	9	Πα $\pi'$ λεγαλιώ
λεχέαλιες $\theta$		Νη $\nu'$ λεαλιές
	68	

Ἐν Καταβάσει. Ἐν Αναβάσει.

Fig.4.14. Phocaeus' canonion (intervallic table) for the Second Mode Scale A with its intervallic approximations corrected according to Chourmouziος<sup>317</sup>

Taken together, the interventions of Chourmouziος and Phocaeus demonstrate both the historical persistence of the problem and the manner in which theoretical ideals

<sup>317</sup> The canonion is taken from the 1872 edition, only because it provides a clearer copy: Theodoros Papa Parashos Phocaeus, *Κρητις τοῦ θεωρητικοῦ καὶ πρακτικοῦ τῆς ἐκκλησιαστικῆς μουσικῆς, συνταχθεῖσα πρὸς χρῆσιν τῶν σπουδαζόντων αὐτὴν κατὰ τὴν νέαν μέθοδον παρὰ τῶν τριῶν ἐνδόξων Μουσικοδιδασκάλων Χρυσάνθου Μητροπολίτου Προύσης, Γρηγορίου Πρωτοψάλτου καὶ Χουρμουζίου Χαρτοφύλακος· ἐκδοθεῖσα πρότερον διηγηματικῶς παρὰ Παναγιώτου Πελοπίδου, εἶτα κατ' ἐρωταπόκρισιν παρὰ Θεοδώρου Φωκαέως· νῦν δὲ τὸ τέταρτον ἐκδίδεται παρὰ τοῦ γαμβροῦ αὐτοῦ Μηναῖ Δομενίου* (Ἀθῆναι: Τύποις Χ. Ν. Φιλαδελφείως, 1872), 49.

were negotiated, corrected, or even abandoned in response to the empirical demands of Byzantine performance. A wide range of later theorists subsequently felt the same impulse to “correct” the chromatic Scale A of Chrysanthos.<sup>318</sup> Yet such corrective interventions do not dissolve the essential connection of this intervallic structure to Chrysanthos. The continued use of the designation “Chrysanthine” in describing the “soft” chroma is both necessary and justified: necessary, because it identifies the precise ratio-structure that grounds the genus; justified, because it reflects the historical fact that later theorists corrected but did not replace Chrysanthos’ fundamental system. To abandon the term would not only obscure the lineage of the ratios themselves but would risk misrepresenting the dialectic between theoretical abstraction and practical correction integral to Byzantine chant theory. It is precisely this dialectic that the following paragraphs will pursue, situating the so-called “Chrysanthine” intervals of the soft chroma within their broader historical and comparative frame.

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<sup>318</sup> In the theoretical writings produced after Chrysanthos, notable differences emerge. For a summary of the main subsequent attempts to apply corrections to the soft chromatic scale of Chrysanthos, see Nikolaos Theotokatos, “Ο β’ ἦχος κατὰ τὸν Χρύσανθο ἐκ Μαδύτων” [The Second Mode according to Chrysanthos of Madytos]. online pdf, [http://www.sholeionpsaltikis.gr/media/files/eggrafa\\_pdf/N. TH. 2os ixos perilipsi.pdf](http://www.sholeionpsaltikis.gr/media/files/eggrafa_pdf/N. TH. 2os ixos perilipsi.pdf).

## Section V — On organology and the acoustic archaeology of neutral intervals

Historical organology also suggests that Chrysanthos' diatonic tuning, including versions of it producing so-called “soft” chroma, is most profitably understood as a reference system resonating with much older musical traditions of the Eastern Mediterranean. We have already noted that its conceptual foundations lie in the Ptolemaic smooth diatonic (*homalon diatonon*), subsequently revisited and theorized by the Arabic theorists, such as al-Farabi and Ibn Sīna, and subsequently reflected in both Byzantine and Islamic modal theory. This framework was not only preserved in theory but also sustained in forms of performance practice that have shaped modal intonation across the Eastern Mediterranean and Middle East into modern times.

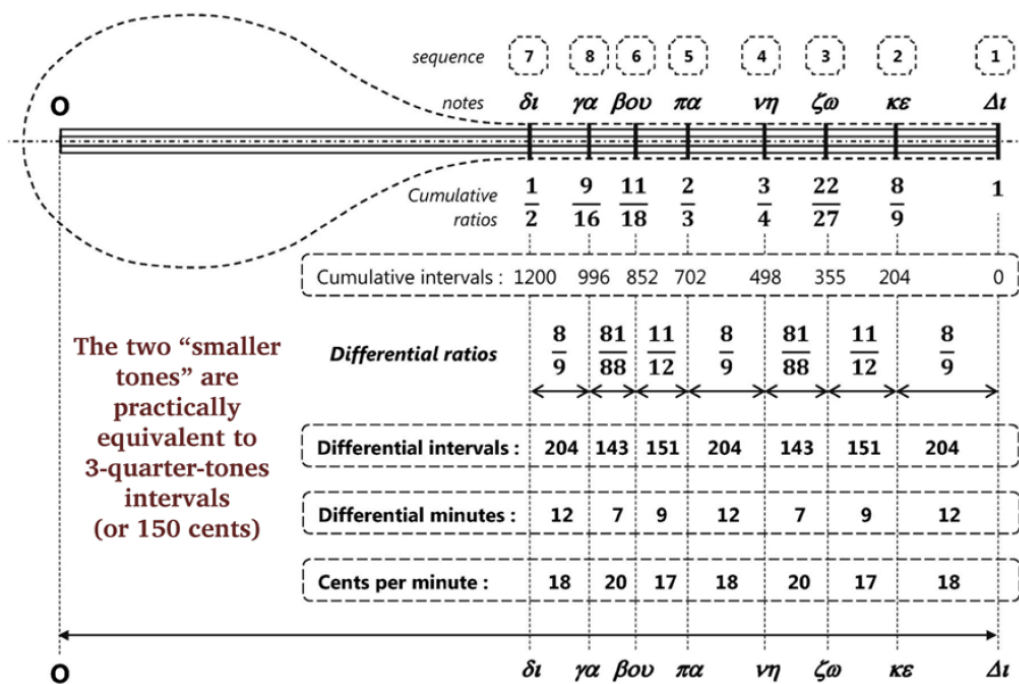


Fig.4.15. The division of the tambour (*pandouris*) by Chrysanthos in a more detailed explanation by Beyhom - from Beyhom, “Theory and Practice of Psaltiki,” 630

Organological evidence further supports this claim.<sup>319</sup> Chrysanthos’ reference to a fixed-pitch wind instrument—not subject to temperament (unless deliberately)—suggests that his intervallic ideal was grounded in natural acoustical behaviour, a point reinforced by the historical consistency of ney construction and its approximate 150-cent step intervals.

### *The Ney “witness”*

In Chapter IV (On Musical Instruments) of the Great Theory (§.436) Chrysanthos writes:

The aulos comes second in the instruction of music, because it represents the tones with the holes and it is not possible to remake or remove them according to our need or the need of the music of foreign nations as it was said about the *pandouris*. The auloi are divided into straight and transverse, depending on their application. And their kinds are many, but two are the most perfect and regular transverse auloi: the Arabic, called in Turkish *ney*, and the European called in French *flûte traversière*; [between which the Arabic is more proper than the European to perform the intervals demanded for our music.] The

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<sup>319</sup> Cf. Skoulios, “Modern theory and notation,” 23–24, 28–29; and idem, “Τα ανατολικά Μακάμ και ο ‘ορθός’ τρόπος Ραστ” [Eastern makams and the ‘right’ mode Rast], *Πολυφωνία* 25 (2014): 103–105 on the continuity of Arab–Persian modal frameworks through living practice; 111–115, esp. figs. 1–5, where comparative tanbur fret diagrams from the 17<sup>th</sup> to the 20<sup>th</sup> centuries are presented as organological evidence for the sustained shaping of modal intonation.

The preference for this Arabic end-blown flute over European instruments reinforces Chrysanthos’ concern for intervals generated naturally, without forced temperament. The ney, like the tanbur or setar, produces interval steps close to 150 cents, further substantiating the acoustic basis of the 12/11 interval.

Arabic gives ne, and the European, di, so that the Arabic transverse aulos is a fifth below the European [...].”<sup>320</sup>

His suggestion of using particular instruments to “to perform the intervals demanded for our music” is significant. Although Chrysanthos could not offer a firsthand account of correct intonational practice, he recommends the use of a ney or French *flûte traversière* with a preference for the former.<sup>321</sup> . The end-blown flute known by the name *ney* (in Persian: Ney/نای and in Arabic: Al-Nay/ناي) seems to be one of the oldest musical instruments still in use. Dating back about 5,000 years, it remains today a prominent instrument in Persian, Arabic Ottoman, Turkish, and Jewish folk and art musics.<sup>322</sup>

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<sup>320</sup> Once more in Romanou’s translation. It is surprising however that the highly important sentence of the original, which we have restored in our translation and highlighted, is completely absent (!) in hers.

<sup>321</sup> The baroque flute (traverso, traversière) will not further concern us here, in part because of its relative youth. The baroque flute emerged only towards the end of the seventeenth century., apparently the invention of the Hotteterre family of woodwind players/makers in Paris. See Joe Wolfe, John Smith, Neville Fletcher, and Terry McGee, “The Baroque and Classical Flutes and the Boehm Revolution,” conference paper, Perugia, 2001; Anna Reisenweaver, “The Development of the Flute as a Solo Instrument from the Medieval to the Baroque Era,” *Musical Offerings* 2, no. 1 (2011): 11–21; cf. Johann Joachim Quantz, *On Playing the Flute* (New York: Schirmer Books, 1966).

<sup>322</sup> Amnon Shiloah, *Music in the World of Islam: A Socio-Cultural Study* (Detroit: Wayne State University Press, 1995), 126–127; Jean During, *The Spirit of Sounds: The Unique Art of Ostad Elahi* (New York: Cornwall Books, 2003), 41–43; Owen Wright, *The Modal System of Arab and Persian Music, A.D. 1250–1300* (Oxford: Oxford University Press, 1978), 3–6; Henry George Farmer, *A History of Arabian Music to the XIIIth Century* (London: Luzac, 1929), 52–55; Lois Ibsen al-Faruqi, “Music, Musicians and Muslim Law,” *Asian Music* 17, no. 1 (1985): 3–36.

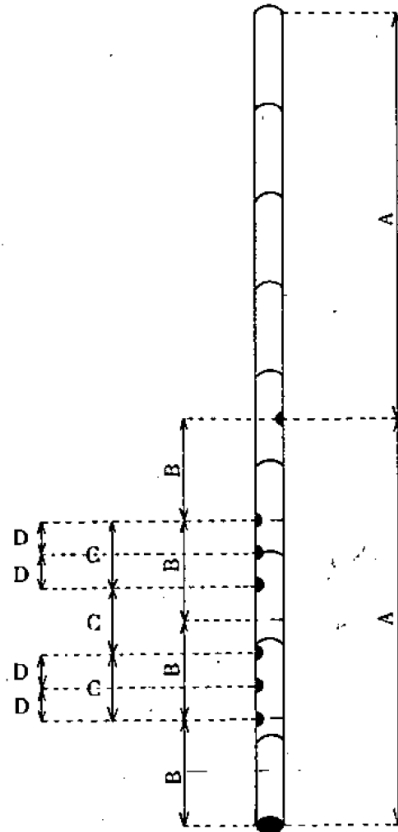


Fig.4.16. Instructions on how to drill a ney - from Salah el Mahdi, *La Musique Arabe*, 62<sup>323</sup>

The reasoning behind Chrysanthos' selection is simple. He acknowledges that it is easiest to teach using the string instrument of pandouris (tambouras or tanbur)<sup>324</sup> when it is perfectly tuned.<sup>325</sup> To avoid the difficulty of tuning, he suggests using a woodwind instrument with the correct intervals are already drilled into it, eliminating

<sup>323</sup> Salah el Mahdi, *La musique arabe: structures, histoire, organologie: 39 exemples musicaux extraits du répertoire traditionnel* (Paris: Alphonse Leduc, 1972)..

<sup>324</sup> A Greek traditional string instrument generally used century-long in middle east varying in size and strings according to place and time; dating in Greece in particular from Roman times. According to Kallimopoulou, tambouras (Greek: ταμπουράς [tabu'ras]) is a Greek traditional string instrument of Byzantine origin. It has existed since at least the 10th c., when it was known in Assyria and Egypt. At that time, it might have between two and six strings, but Arabs adopted it, and called it a Tanbur. The characteristic long neck bears two strings, tuned five notes apart. Eleni Kallimopoulou (2009), *Paradosiaká: Music, Meaning and Identity in Modern Greece*, SOAS Musicology Series, Ashgate Publishing, 50 & 53.

<sup>325</sup> From *Great Theory* §.435 [436]. Among the melodic instruments, the pandouris is the easiest to teach with; on it the tones, the semitones and, simply, every interval is perceived more clearly. It is also called pandoura and phandouros and among us, tambura or tambur.

the need to tune or temper (also why modern orchestras tune from an oboe). Chrysanthos' references to ancient auloi and advocacy of the ney have a more particular significance. Neys and other woodwind instruments exhibit a consistent method of fabrication, involving equidistant and aliquot drilling, over centuries. This construction reliably produces intervals of approximately three-quarters of a tone, thereby confirming both the theoretical importance of the instrument and its acoustical identity over time.<sup>326</sup>

#### *Woodwinds as a heuristic key*

The study of preserved ancient auloi, particularly those recovered from sites such as Pompeii, Delphi, and Meroë, has significantly advanced our understanding of ancient Greek tuning systems and intervallic structure. Through meticulous reconstruction and acoustic modeling, Stefan Hagel has demonstrated that the aulos did not adhere to a fixed temperament, but rather enabled a flexible, context-dependent intonation system. For example, Hagel's work with the Pompeii aulos (Naples National Archaeological Museum inv. 76869)<sup>327</sup> reveal intervals of approximately 150 cents (three-quarter-tones), suggesting the presence of Zalzalian or "neutral" intervals, even if not named as such in antiquity. Hagel's acoustic experiments show that, by altering

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<sup>326</sup> See Wright, *The Modal System*, 125–130; Jean During, *La musique traditionnelle de l'Azerbaydjan et la science des muqâms* (Paris: Geuthner, 1988), 64–67; Henry George Farmer, *Historical Facts for the Arabian Musical Influence* (London: H. Reeves, 1930), 33–34; Amine Beyhom and Hamdi Makhoulouf, "Frettagage du 'Ūd (luth arabe) dans la théorie musicale arabe et influence sur la pratique," *The fifth Conference on Interdisciplinary Musicology (CIM09)* (Paris, Oct 2009), online, <https://hal.science/hal-01446756v1>; Amine Beyhom, "Two common errors about the proportions of the 'Ūd," in *The ūd from its earliest sources to modern times, in the Near-East*, ed. Richard Dumbrell (London, 2011), 81–110, online, <https://hal.science/hal-01446781v1>; Stefan Hagel, *Ancient Greek Music: A New Technical History* (Cambridge: Cambridge University Press, 2009), 172–176; Also Mahmoud Effat (2005). *Beginner's Guide to the Nay*. Translated by Jon Friesen; originally published in Arabic in 1968. Pitchphork Music.

<sup>327</sup> Hagel, *Ancient Greek Music*, 147–176 (on the Meroë aulos reconstruction and implications for polyphony).

embouchure pressure and using finger shading techniques (documented in iconography and matched by performance tests), ancient players could manipulate pitches with sub-semitonal precision.<sup>328</sup> This lends credence to the theory that melodic inflection—what later Byzantine theory would term *chroa* or even melodic attraction—was already embedded in ancient instrumental technique. Such findings help us reconsider Chrysanthos’ reference to the *ney*: although he could not have had archaeological access to ancient *auloi*, his empirical observation that the *ney* preserves the proper intervals of the Byzantine diatonic system resonates with the organological and acoustical continuity now evidenced between ancient end-blown reed instruments and their modern descendants.<sup>329</sup>

A further step along this road is to identify “western” instruments drilled to the Chrysanthine intervals. The acoustic design of Baroque and English-drilled recorders offers a remarkable confirmation of the intervallic structures described by both medieval and nineteenth-century theorists of Byzantine and Islamic music. As Wolfe, Smith, Fletcher, and McGee have shown, the placement and relative sizing of tone holes on pre-Boehm woodwinds, dictated more by ergonomics than by abstract acoustical theory, inevitably producing intervallic deviations not only from equal temperament but even from *Jl*.<sup>330</sup> In particular, cross-fingered notes and the reduced size of certain holes yield consistent downward “pulls” in pitch, producing steps that are neither full tones nor semitones but neutral intervals of about 150 and 143 cents. These deviations are not the result of advanced embouchure control or professional shading, but rather the direct consequence of the drilling pattern itself. Thus, the

<sup>328</sup> *Ibid.*, esp. 112–142 (Pompeii *aulos*) and 248–267 (performance technique and tuning flexibility).

<sup>329</sup> Hagel, “Calculating *auloi*—Reconstructing the pipe from measurements,” *Music in Art* 31, no. 1–2 (2006): 29–47.

<sup>330</sup> Joe Wolfe, John Smith, Neville Fletcher, and Terry McGee, “The Baroque and Classical flutes and the Boehm revolution,” in *Proceedings of the International Symposium on Musical Acoustics* (Perugia, 2001), 505–508.

recorder—much like the Middle Eastern ney—embodies in its construction a scale system rich in “natural” neutral seconds, corresponding closely to the 12/11 and 88/81 intervals later theorized in the Byzantine and Arabic traditions.<sup>331</sup>

Lekkas has drawn this connection explicitly, arguing that the English recorder, by virtue of its drilling inherently reproduces the sequence  $9/8 \times 88/81 \times 12/11$  defining the soft diatonic framework.<sup>332</sup> In one of his more recent studies, titled “Byzantine church chant and Islamic art music on the English recorder: theory and practice,”<sup>333</sup> Lekkas proposes that the English recorder could serve as an ideal instrument for the study and performance of the shared archetypal intervallic frameworks of both Byzantine and Islamic traditions. Central to his argument is the so-called “spondeiac hexachord,” a six-note primary diatonic cell that, according to Lekkas, forms the basis for both modal systems. The paper offers a historical-systemic genealogy of these hexachordal structures, connecting them to the drilling practices of ancient flutes and showing their preservation through the standardized fingering of the recorder. This synthesis culminates in a proposed pedagogical and structural re-evaluation of the recorder as a tool of significant utility for understanding and executing Eastern modal logic.

Lekkas draws much on Kathleen Schlesinger’s 1939 study on the subject (*The Greek aulos*), as one of the first to approach ancient music through both experimental and comparative methods, producing a work which stimulated a generation of theorists to consider instrument design as a formative force in musical structure. Her ideas continue to influence current discussions on early tuning, intervallic perception, and

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<sup>331</sup> Ibid.

<sup>332</sup> Lekkas, “Byzantine church chant and Islamic art music,” 111–142.

<sup>333</sup> Ibid.

musical cognition. Lekkas underlines that she is the only one to have produced a truly mathematical systematic theory commencing from the postulate of his theory that all intervallics begin with the equidistant aliquot drilling on flutes, meaning flutes on which the holes are of equal size and distance.<sup>334</sup> The reason behind such an assumption is that such a hole-drilling process is so simple and spontaneous and does not require special knowledge that it was possible even back to the Lower Paleolithic [c. 3.3 Ma (millions of years) – 300 ka (thousands years)].<sup>335</sup>

But, if an ostensibly Western instrument like the recorder embodies the same intervallic logic as the Middle Eastern ney, then the choice made by Chrysanthos to

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<sup>334</sup> Barker, *The Science of Harmonics*, 282–283; Mathiesen, *Apollo's Lyre*, 421–424; West, *Ancient Greek Music*, 239–240.

<sup>335</sup> One of Schlesinger's errors though, is that she presumed that the equidistant drilling covers a whole octave range (diapason), instead of a perfect fourth (diatessaron), which is the main scalar core of the flute system, as also of most medieval chant repertory (even modern in the case of the Byzantine). While Schlesinger's assumption that equidistant flute-drilling yields a full octave (diapason) is now understood to be incorrect -- organological evidence favors a fourth (diatessaron) -- her contribution remains foundational (see all right above sources for an evaluation).

We need to lay here the following caveat: while Kathleen Schlesinger's reconstructions of ancient instruments and tuning systems were groundbreaking for her time, they have drawn substantial criticism from later scholars for methodological oversimplification. Notably, Andrew Barker points out that her approach "assumes a priori that ratios equal finger-hole distances, ignoring alternative tuning methods (e.g., lip pressure, reed adjustment)," thereby overlooking the complex performance techniques available to ancient players (see his *Greek Musical Writings II*, 14); and such a critique underscores a broader concern that her conclusions rest on speculative reconstructions rather than empirical or philologically grounded evidence.

But such an argument about varying finger and lip and breath play on the reeds does not really seem to hold. What seems to be the case to the unfudged output, is pure statistical micro-variation around a theoretical mean position, describable not via a different theoretical depot, but through known probabilistic/statistical variations given in probability theory through normal distributions, and their mean values, variances and standard deviations. Ancient instrument makers and players did not vary their pitch by changing the distances of the holes by trial and error. The ney, an extremely versatile end-blown long flute, capable of many exemplary lip- and breath-induced idiomatic and often individual modal chroai/hues/shades, does NOT achieve that by playing around with the distances and sizes of the finger-holes, which do stay perfectly equal in size and absolutely aliquot; therefore, in flutes, the player would change intonation by staying aliquot, they do not change distances in order to vary intonation.

Moreover, what holds for flutes does not hold for reed pipes, except when the reed goes in between the lips and perhaps teeth; in reeds, it is wise to adapt diameters and lengths precisely, because, unlike flutes, precision demands to switch hole distances and perhaps sizes. And that kind of counter-argument weakens importantly the initial argument above about the effect of lips and fingers. All that goes away to a large extent when one plays double aulos, because it is anatomically prohibitive to apply different breath intensities and lip forces to the two auli of the same pair played simultaneously; and when one puts those pipes on a bagpipe, then the argument is completely refuted, since armpits have no breath and bags have no fingers or lips.

cite both a ney and a transverse flute as capable of serving as aids to proper intonation can be read not as manifesting delusions of grandeur, but as an acknowledgement of sonic continuity between flutes and chant. By experimenting with the diatonicism of Chrysanthos—whether expressed as a sequence of 12-9-9 commas or as 12-9-7)—we may consider how his modal system reflects, and perhaps emerges from, the acoustic realities of simple flute drilling.

## Section VI — On neutral thirds as structural constants: Arabic, Ottoman, and Persian evidence

A core claim of this chapter is that Chrysanthos' use of neutral intervals—especially his “middle third,” constructed as  $88/81 \times 9/8$  ( $= 11/9$ ,  $\approx 347$  cents)—has deep historical analogues across Arabic, Persian, and Ottoman musical systems. This third is not unique to Chrysanthos, but a recurring modal solution that transcends any single tradition or notation system. Establishing the historical durability of this Zalzalian third supports the methodological premise of the thesis: that Chrysanthos' tuning can serve as a historically plausible reference framework for experimental reconstructions of medieval melodies.

### *Zalzalian Foundations and Neutral Thirds*

One of the most persistent and historically plausible features in the comparative study of Arabic, Persian, and Byzantine tuning traditions is the so-called “neutral third,” hovering between the JI minor (6:5,  $\sim 316$  cents) and JI major (5:4,  $\sim 386$  cents) thirds. This intermediate interval, often measured around 347–355 cents, plays a central role in what Beyhom identifies as a shared intonational logic across modal cultures rooted in antiquity and restructured through medieval Islamic thought.<sup>336</sup> Baron D'Erlanger states that “Zalzal's tone (11:9), also called *wuṣṭa* [the middle], is regarded by several

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<sup>336</sup> Amine Beyhom, “Un lexique de la modalité,” *NEMO-Online* 2, no. 1 (2012): 5–7, online, <https://hal.science/hal-01447269v1>.

Arab authors as the foundation of an alternative system to the perfect tone (9:8), demonstrating the richness of Arab musical practices in the medieval period.”<sup>337</sup>

The endurance of the so-called *Zalzalian* fret, traditionally associated with the neutral third of approximately 11/9 (~347 cents), is well attested in medieval Arabic theoretical sources and in later Persian practice. As Stefan Hagel’s analysis of al-Farabi shows, the *wuṣṭa Zalzal* (“Zalzal’s middle finger”) remained a recognized and debated reference point centuries after its introduction. In *Kitab al-Mūsīqī al-Kabīr*, al-Farabi distinguishes between two interpretations of this fret: one placed roughly equidistant within the tetrachord, yielding a neutral third, and another shifted to produce pure JI thirds. Both were in circulation in his time, with “expert musicians” determining the precise location according to modal needs.<sup>338</sup>

Importantly, Hagel mentions that al-Farabi employs the term “Zalzalian” not only in the context of the ‘ūd, but also in tuning the *ṭunbūr al-Baġdadī*, the *ṭunbūr Ḥurasanī*, other open-string instruments, and even in rabab tuning exercises, indicating its practical relevance across a range of fretted and plucked instruments in the medieval period.<sup>339</sup> The persistence of both the name and its associated intervallic region in such a variety of contexts demonstrates that Zalzal’s contribution was not an ephemeral experiment but a durable component of modal theory and practice.

George Dimitri Sawa, a leading scholar on medieval Arab music, provides critical insight into the tuning practices of the early Islamic period, particularly during the Abbasid era. Drawing on Al-Kindi, Al-Farabi, and Safī al-Din, Sawa reconstructs a

<sup>337</sup> Erlanger, *La musique arabe* II, 70–78.

<sup>338</sup> Stefan Hagel, “Al-‘ūd, pípá, Lute: An Ancient Greek Perspective on Their Prehistory,” *Oriens* 51 (2023), 91–94.

<sup>339</sup> *Ibid.*

practice that was grounded in Pythagorean ratios but adjusted intuitively through oral transmission. The neutral third, especially the 11:9 Zalzal interval (~347 cents), emerges not as a theoretical abstraction but as a performative constant in maqam music. Fretted instruments like the ‘ūd were central to this logic, with movable frets allowing fine-grained intonational adjustments for each modal context.

**Type of Third    Ratio    Cents (approx.)**

Minor (Just)	6:5	316
Neutral (Zalzal)	11:9	347
Major (Just)	5:4	386

Tab.4.3. Comparison of sizes in cents among the intervals of the two Just thirds and the Zalzalian neutral

Sawa writes:

The practice of tuning in Abbasid times was more fluid and oral than systematic; the tuning of instruments was done mostly by the ear. The Zalzalian third (11/9) was widely assumed and practical fretting was often adjusted per maqam. [...] He continues: "The ‘ūd was the primary instrument of this period, and its frets were tied and adjustable. Performers used neutral intervals, particularly Zalzal’s third, as a functional space between major and minor thirds, suited to maqam like Sikah."<sup>340</sup>

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<sup>340</sup> Sawa, "Survival," 7–13.

The perceptual span between 9/8 and 6/5 allowed for expressive elasticity. This is evident in the complex fretting schemes of the ‘ūd as reconstructed by Beyhom. In his “Un lexique de la modalité,” he defines Zalzal as “Arab lutenist and theorist of the ninth century, reputed to have introduced the ‘middle tone’ (*wuṣṭā*), equivalent to the ratio 11/9. This tone, situated between the minor and major tone, constitutes one of the earliest attempts at systematic microtonal intonation.”<sup>341</sup>

*The Ottoman Legacy: Kantemiroğlu and Maqamic Anchoring*

The Ottoman theoretical tradition provides an important documentary layer within the broader post-medieval Eastern Mediterranean modal ecology between medieval Arab–Persian modal theory and the musical environment in which the post-Byzantine Greek tradition developed. Ottoman makam theory is recorded in a long tradition of treatises (*edvâr*) extending from fifteenth-century authors such as Hızır bin Abdullah to late-eighteenth-century systematizers such as Abdülbâkî Nâsır Dede.<sup>342</sup>

In his *Edvâr-ı Mûsikî*, Kantemiroğlu (Dimitrie Cantemir, 1673–1723) outlined a pitch system replete with microtonal gradations, including a third close to 347–355 cents.<sup>343</sup>

Feldman confirms: "Cantemir was the first musician of the Ottoman court to make systematic use of a compound 17-tone scale. This scale, unlike the later 24-tone equal divisions, was designed to reflect real performance practice and preserve the microtonal detail inherent to makam structure."<sup>344</sup>

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<sup>341</sup> Beyhom, “Un lexique,” 7. My translation of the original french text: “Luthiste et théoricien arabe du IXe siècle, réputé pour avoir introduit le 'ton moyen' (*wuṣṭā*), équivalent au rapport 11:9. Ce ton, situé entre le ton mineur et majeur, constitue une des premières tentatives d’intonation microtonale systématique.”

<sup>342</sup> Deniz Ertan, “Cycles and Peripheries: An Ottoman ‘Kitâb el-Edvâr,’” *Asian Music* 38, no. 1 (2007): 31–60.

<sup>343</sup> Feldman, *Music of the Ottoman Court*, 84–85.

<sup>344</sup> *Ibid.*

Source	Neutral Third (cents)	Fret System	Interval Ratios
Zalzal (Abbasid)	347	Tied movable frets	11:9
Cantemir (Ottoman)	350–355	17/24-tone system	Composite (53-TET)

Tab.4.4. Ottoman vs Abbasid Tuning Schemes for Thirds

As Beyhom notes: “Several thirds exceed 330 cents without reaching the Just major third (5/4), indicating an intonation specific to the Ottoman era that remained respectful of Arab and Persian modal traditions.”<sup>345</sup> These comparative findings also clarify why Byzantine theorists could treat such thirds as structurally functional within genera and modal identities, rather than as exotic deviations.

### *Persian Modal Structures and Interval Theory*

The Persian modal system, as transmitted in medieval treatises and preserved in living traditions, exhibits a systematic incorporation of neutral intervals, especially the 11:9 and 27/22 ratios. This approach is not an incidental occurrence but a defining characteristic of Persian intonational logic. In a 2009 study, Beyhom offers technical

<sup>345</sup> Amine Beyhom, “Dossier: Influence des théories européanisées du XIXe siècle sur la notation et la pratique des modes de la musique arabe et d’autres musiques, à travers la mise en exergue du mythe du genre *hijaz* semi-tonal,” *NEMO-Online* 2, no. 3 (2013), 109. Our translation of the original french text: “Plusieurs tierces dépassent les 330 cents sans atteindre le ton majeur (5/4), ce qui montre une intonation spécifique à l’époque ottomane, respectueuse des traditions modales arabes et persanes.”

evidence for the precise placement of these intervals on fretted instruments like the ‘ūd. His measurements and reconstructions show that Persian theorists and musicians alike treated neutral thirds not only as legitimate melodic intervals but as functional modal components with stable perceptual roles. “The fret ratios used in Persian treatises regularly include 11/9 and 27/22, indicating a well-established tradition of neutral intonation within the modal system.”<sup>346</sup> Additionally, in his “Lost Art of Maqam” Beyhom further stresses that “The Persian modal architecture is based on perceptually stable intervals, rather than strict mathematical subdivision of the octave, distinguishing it clearly from Western traditions.”<sup>347</sup>

Recent comparative work has further reinforced the view that post-Byzantine chant theory and practice cannot be adequately understood in isolation from the broader Near Eastern modal environment. Particularly significant in this respect is Rosy Azar’s study of Byzantine theories of scale and Arab-Byzantine chant practices, which builds extensively on Beyhom’s research. Rather than treating reform in Byzantine chant of late eighteenth and early nineteenth centuries as a process of rationalization toward Western norms, this work situates the theories of Chrysanthos within a continuum of non-equal, Zalzalian intervallic practices shared across Byzantine, Arab, and Ottoman musical cultures. By foregrounding performance evidence (especially pitch measurements from living chant traditions in Lebanon) Azar, following Beyhom, reasserts the primacy of practice over theory and challenges the long-standing assumption of an originally ditonic or semitonally fixed Byzantine system. This perspective provides an essential corrective to Westernized theoretical

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<sup>346</sup> Beyhom and Makhlof, “Frettage du ‘ūd,” 4–7. Our translation of the original French text: “Les rapports de frettes utilisés dans les traités persans incluent régulièrement 11:9 et 27:22, indiquant une tradition bien établie d’intonation neutre au sein du système modal.”

<sup>347</sup> Beyhom, *The lost art of maqam*,” 27–36. Our translation of the original French text: “L’architecture modale persane repose sur des intervalles perceptivement stables, plutôt que sur une subdivision mathématique stricte de l’octave, ce qui la distingue nettement des traditions occidentales.”

models and offers a historically grounded framework for evaluating modern performance hypotheses based on Chrysanthine intervallic structures.<sup>348</sup>

*Support for continuity appears in Poorhaydari's analysis of medieval Persian treatises, which describe the mode of Humayūn as a compound structure incorporating the hijaz tetrachord, defined by neutral thirds. These tetrachordal formations, recurring across the writings of Maraghi, Shirazi, and Banayi, reveal an intonational system that relied on flexible but perceptually stable intervals equivalent to 11/9 and 27/22.*<sup>349</sup> Empirical studies of modern Persian music further confirm the acoustic survival of Zalzal's neutral third. Poorhaydari's measurements of contemporary tar and setar fret placements reveal average step sizes that correspond closely to historical ratios such as *wuṣṭa Zalzal* ( $72/59 \approx 344.7$  cents) and *mujannab-i fars* ( $64/59 \approx 140.8$  cents).<sup>350</sup> Poorhaydari notes that one of the most persistent features of the contemporary Persian fretting system is the placement of an intermediate third between the canonical major and minor thirds, a finding which aligns precisely with the intervallic space historically associated with Zalzal's repositioned fret.<sup>351</sup> Empirical analyses of modern Persian performance practice indicate that scale degrees functioning as thirds frequently occupy an intervallic range of approximately 340–350 cents. These values reflect a neutral intervallic category

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<sup>348</sup> See Rosy Azar, "Byzantine Theories of Scale and Arab-Byzantine Chant Practices: A Comparative Analysis Proposing a New Resolution to the Theoretical System of Chrysanthos of Madytos," *Yale Journal of Music & Religion* 11, no. 2 (2025): 32–53.

<sup>349</sup> Kioumars Poorhaydari, "Historical Examination and Theoretical Analysis of Maqam Humayūn in Persian Art Music," *Music Theory Spectrum* 47, no. 2 (2025): 159–161; idem, "Examination of neutral intervals," 31–35, 41–43.

<sup>350</sup> Idem, "Historical examination," 158–163; idem, "Empirical evaluation," 3–6.

<sup>351</sup> Idem, "Examination of neutral intervals," 31–33 and 41–43; cf. Beyhom, "Two common errors", 81–110; idem, "Le mythe du genre hijaz."

characteristic of contemporary Persian music, realised however flexibly in performance rather than as a fixed, temperament-based pitch.<sup>352</sup>

Such evidence underscores that the *Zalzalian third* has not only endured as a theoretical construct but continues to function as a stable and performatively relevant interval in modern modal traditions. Together, these sources reinforce the idea that Persian theory and practice preserved a deeply rooted, acoustically informed system of modal intonation. Far from being derivative, Persian contributions to intervallic theory articulate a sophisticated understanding of tuning as a perceptual and structural phenomenon—an understanding that shares critical overlap with Byzantine and Arabic traditions, and in particular with Chrysanthos’ middle third.

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<sup>352</sup> See Sepideh Shafiei, “An analysis of Iranian music intervals based on pitch histogram,” arXiv:2108.01283 [cs.SD] (submitted 3 Aug 2021), accessed via DOI:10.48550/arXiv.2108.01283., 3 (Table 1 and accompanying discussion); Hormoz Farhat, *The Dastgāh Concept in Persian Music* (Cambridge: Cambridge University Press, 1990), 7–18; also Poorhaydari, “Examination of neutral intervals.”

## Section VII — Application to Byzantine chant reconstruction and performance practice

Chrysanthos' ratios are unusual within Byzantine chant treatises until the nineteenth century precisely because they quantify what earlier phases of the tradition transmitted primarily through oral-aural formation. John Plemmenos argues that the reform codified in ratios material that had long existed as practical and pedagogical knowledge, suggesting that Chrysanthos' intervallic claims may preserve older norms in mediated form.<sup>353</sup> Skoulios likewise emphasises, from the perspective of Near Eastern modal rationalisations, that later theoretical systems often preserve the *structural skeleton* of modal organisation even when local intonational detail remains flexible.<sup>354</sup>

This is also where a controlled model becomes especially useful: the point is not that Chrysanthos “proves” medieval tuning, but that his ratios provide an explicit and repeatable intonational grid which can be evaluated against medieval modal behaviour. This aligns with the interpretative logic developed by Antonopoulos in his work on Chrysaphes: later theoretical formulations may illuminate earlier modal functions, provided they are used as analytical instruments rather than as anachronistic authorities.<sup>355</sup>

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<sup>353</sup> John Plemmenos, “Η μεταρρύθμιση του 1814 και η επίδρασή της στην εξωτερική μουσική: ρυθμικά και μελωδικά ζητήματα [The reform of 1814 and its impact on external music: Rhythmic and melodic issues],” in *Η Βυζαντινή Μουσική μέσα από την Νέα Μέθοδο Γραφής 1814–2014: Πρακτικά Διεθνούς Μουσικολογικού και Ψαλτικού Συνεδρίου [Byzantine Music through the New Method of Notation 1814–2014: Proceedings of the International Musicological and Psaltic Conference]* (2021), 8.

<sup>354</sup> Skoulios, “Modern theory and notation,” 25–27, where later Byzantine theoretical systems are shown to preserve the structural organisation and modal philosophy of earlier frameworks despite variability in practical intonation; see also 27–29 on the shared Near-Eastern modal rationalisations underlying this continuity.

<sup>355</sup> See p.16 of *Appendices to Chapters 1–5* in Antonopoulos, *The Life and Works of Manuel Chrysaphes*.

The applicability of Chrysanthos depends not only on quantification but also on conceptual structure. Byzantine modality is fundamentally based on tetrachords and their species rather than octave scales.<sup>356</sup> Remaining grounded in tetrachordal divisions, Chrysanthos' system is structurally compatible with Middle Byzantine modal mechanics, since it models the same unit of organisation through which modal identity is typically realised: fourths, fifths, and their internal step distributions. Comparative research further supports this structural plausibility. Wright's study of Arabic and Persian modal theory (c. 1250–1300) documents tetrachordal formations containing neutral thirds ( $\approx 350$  cents) and characteristic step sizes comparable to those of Chrysanthos, strengthening the argument we have been making that his tetrachords are consistent with modal structures found elsewhere in the Eastern Mediterranean.<sup>357</sup>

All of this reinforces the usefulness of approaching Byzantine “chromaticism” as an alteration of diatonic order and function rather than as the compulsory adoption of a fixed chromatic genus. Lekkas articulates this principle directly: the diatonic is not merely one genus among others, but the stable backbone from which chromatic and enharmonic colours derive.<sup>358</sup> Makris' work on the Second Modes confirms this performance-oriented point: even in contexts theorised as chromatic, the melodic framework remains anchored to a diatonic disposition, while chromatic degrees function as inflected and expressive modifications rather than as an independent scalar foundation.<sup>359</sup> Wright's earlier documentation of comparable diatonic

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<sup>356</sup> Wright, *The Modal System*, 122.

<sup>357</sup> *Ibid.*

<sup>358</sup> Lekkas, “Η διατονική βάση,” 3.

<sup>359</sup> Makris, “The Chromatic Scales,” 7.

frameworks with integrated neutral intervals reinforces the same claim in Arabic-Persian contexts.<sup>360</sup>

Sawa's analysis of medieval Arabic performance practice offers a parallel methodological support: modal identity persists through stable structural behaviour even when surface realisation varies.<sup>361</sup> Beyhom's formulation of modal intonation as a negotiation between system and performer further supports using a ratio-based scheme cautiously—as a model that must remain compatible with living variability rather than as a rigid prescription.<sup>362</sup>

Within this conceptual framework, the practical value of Chrysanthine tuning as a standard of reference can be summarised in three points:

1. *Repeatability*

A ratio-defined tuning makes transcription and demonstration repeatable: a melody can be realised consistently and compared under alternative tunings without relying on implicit or unspoken assumptions.<sup>363</sup>

2. *Non-exaggerated chromaticism*

It permits chromatic colour without forcing an augmented-second ideology onto repertoires whose melodic syntax and cadential behaviour often contradict such caricatured chromatic scales.<sup>364</sup>

3. *Cross-traditional plausibility*

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<sup>360</sup> Wright, *The Modal System*, 95–96.

<sup>361</sup> Sawa, "Survival," 12.

<sup>362</sup> Beyhom, "Un lexique," 15.

<sup>363</sup> Antonopoulos, "Chrysaphes" - *Appendices*, 16.

<sup>364</sup> Makris, "The Chromatic Scales," 7.

Because the intervallic logic has strong analogues in Near Eastern systems (neutral thirds; unequal step sizes), the Chrysanthine model is historically more plausible than equal-tempered or overly regularised substitutes.<sup>365</sup>

In Chapter 5 these points will be illustrated in comparative transcriptions.

### *Performance Practice and Oral Modality*

The approach to medieval Byzantine chant performance that Lingas articulated in the liner notes to Cappella Romana's recordings (*The Fall of Constantinople* [2002], *Byzantium in Rome* [2015], *Lost Voices of Hagia Sophia* [2019]) provides an important methodological counterpoint to both post-Chrysanthine orthodoxy and purely notational reconstructions. Lingas explicitly rejects the uncritical projection of modern Western cathedral performance practices, especially those of the Anglican choral tradition codified within the last century,<sup>366</sup> onto earlier repertoires. Instead, he creates a performance style through the triangulation of medieval sources, comparative oral traditions (Georgian, Syriac, Arabic), and empirical listening, yielding a historically based but pluralistic modal framework.<sup>367</sup> Peter Jeffery has similarly emphasized the inherent limitations of notation for conveying the sonic reality of past musical cultures, arguing that ethnomusicological reconstruction must

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<sup>365</sup> Wright, *The Modal System*, 125–126.

<sup>366</sup> Surveys are Christopher Page, "The English *a cappella* Renaissance," *Early Music* 21, no. 3 (August 1993): 433–71; and Timothy Day, *I Saw Eternity the Other Night: King's College, Cambridge, and an English Singing Style*. London: Allen Lane, 2018.

<sup>367</sup> Lingas, liner notes to *The Fall of Constantinople* (2002), *Byzantium in Rome* (2015), *Lost Voices of Hagia Sophia* (2019).

integrate comparative oral traditions and performance practice studies to avoid misleading literalism.<sup>368</sup>

One of Lingas' principal departures from modern cantorial orthopraxy lies in his treatment of pitch and tuning. In contrast to fixed intervallic schemes or equal-tempered approximations, his realizations adopt non-uniform intonation determined by modal function and melodic gravity. This reflects an awareness that medieval practice was likely shaped by microtonal nuance and intonational flexibility not reducible to the scalar grids of Chrysanthine theory. Lingas' approach here intersects with the work of Alexander Khalil, whose ethnographic and analytical research demonstrates that chromatic-sounding intervals in modern oral chant traditions often arise from perceptual effects within a diatonic modal framework.<sup>369</sup>

For Lingas, melismatic elaboration can serve to reinforce modal centres or articulate transitions without recourse to later, formulaic cadential patterns. He also avoids rigid assignment of modern ἤχοι labels to medieval chants.

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<sup>368</sup> Jeffery, *Re-Envisioning Past Musical Cultures*, 123-141.

<sup>369</sup> See the relevant study Alexander K. Khalil (2009), *Echoes of Constantinople: oral and written tradition of the psaltes of the Ecumenical Patriarchate of Constantinople*, PhD Thesis, University of California, San Diego.

## Section VIII — On Observational Error theory

Observational Error Theory, as applied in the physical sciences, addresses the reality that all measurements are subject to deviations arising from both systematic and random errors. In experimental physics, this recognition leads to the prioritization of minimizing probable error over attempting to achieve perfect accuracy. As Bevington and Robinson note, “[m]easurements are never exact... the task is to reduce uncertainty to the smallest practicable value and to characterize what remains.”<sup>370</sup> The philosophical basis aligns with Jaynes’s view that scientific inference deals not in certainties but in probabilities, aiming to reduce uncertainty rather than assert absolute truth.<sup>371</sup>

In historical research—and particularly in historical musicology—this translates into an acceptance that reconstructions of the past will always be approximations. Bayesian inference parallels this method, understood not as statistical computation but as a formal model of rational belief revision: combining prior probabilities (based on theoretical plausibility, comparative data, or ethnographic evidence) with new observations, updating hypotheses with each new piece of evidence.<sup>372</sup>

Applying this framework to Chrysanthos’ nineteenth-century tuning system reveals its utility. While Chrysanthos’ intervals cannot be assumed to represent a direct survival of medieval practice, they can be tested against comparative data from Arabic, Persian, and Ottoman sources, as well as ethnographically documented Byzantine chant traditions. Certain intervals—such as the neutral third—demonstrate a cross-

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<sup>370</sup> Philip R. Bevington and D. Keith Robinson, *Data Reduction and Error Analysis for the Physical Sciences*, 3rd ed. (Boston: McGraw-Hill, 2003), 3.

<sup>371</sup> E. T. Jaynes, *Probability Theory: The Logic of Science* (Cambridge: Cambridge University Press, 2003), xxii.

<sup>372</sup> Colin Howson and Peter Urbach (2006), *Scientific reasoning: the Bayesian approach*, 3rd ed., Open Court, pp. 1–11.

traditional stability that strengthens their plausibility as historical survivals. This aligns with the “least-wrong” determination: Observational Error Theory encourages privileging reconstructions that match both modal logic and perceptual constants.<sup>373</sup>

We have been grounding our rationale for applying Chrysanthine intervals to the reconstruction of medieval chant not only in the recurrence of Pythagorean elements in ancient and Byzantine theory, but also in the documented prevalence of these intervals across Arabic, Persian, and Ottoman traditions. By treating each historical tuning system as an observational dataset, and cross-referencing it with ethnographic and organological evidence, we can assign greater probabilistic weight to configurations that demonstrate both theoretical coherence and perceptual stability.

In this light, Chrysanthos’ scale—though a product of nineteenth-century rationalisation—aligns closely with these historical constants. Observational Error Theory supports privileging such alignments: they represent “least-wrong” reconstructions that are resilient against the uncertainties inherent in medieval notation and transmission. Thus, the convergence of Chrysanthine intervals with those described by al-Farabi, Ibn Sīna, Zalzal, and their successors is not coincidental, but indicative of a long-standing modal logic that transcends geographic and chronological boundaries. This logic can serve as a historically grounded and perceptually validated framework for modern reconstructions of medieval Byzantine chant.

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<sup>373</sup> Observational Error Theory can be extended beyond Chrysanthine tuning to other historical modal systems. Ancient and medieval theorists—Pythagorean, Aristoxenian, and their successors—produced intervallic prescriptions of varying precision and reproducibility. Treating each tuning as an observational dataset allows for plausibility testing against cross-traditional evidence.

### Section IX — On the 1881 Patriarchal Committee: Ideology and arithmetic bias

Despite its deep historical lineage, the Chrysanthine sequence of diatonic intervals was challenged by the Ecumenical Patriarchate itself approximately half a century after the publication of the *Great Theory*. It formed a committee in 1881 with the assignment to redefine the intervals of the New Method, the findings of which were published in 1883. The Patriarchal Committee was composed of leading clergy and chanters.<sup>374</sup> According to the preface of its 1883 publication, the committee carried out its work with the aid of a monochord device, the so-called *Ioakeimeion psalterion*, functioning as a Pythagorean canon. This instrument was later criticized for “serious defects,” reconsidered by a subsequent committee in 1895, and eventually abandoned.

The Committee proceeded by producing specific intervals on the monochord for submission to chanters and specialists for evaluation. Instead of exploring the full continuum of possible tunings, the process relied on pre-selected lengths expressed as ratios drawn from classical theory. The operator of the monochord would present a given ratio and ask whether it sounded correct. If approved, it was accepted as normative. If judged “too high,” it would be adjusted downward by a fixed quantum—specifically the Didymean comma (81/80)—in accordance with the Committee’s numerically based theoretical framework.

By repeating this procedure, certain intervals were established. For example, the step from *ni* (do/rast) to *pa* (ré/ndūgah) was confirmed as a major tone of 9/8. From *pa* to the altered *vu* (mi), another 9/8 was initially tested, leading to the Pythagorean *mi+*

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<sup>374</sup> See the relevant study of Merih Erol, *Greek Orthodox Music in Ottoman Istanbul: Nation and Community in the Era of Reform* (Bloomington: Indiana University Press, 2015). Although Erol provides valuable insights into the cultural and ideological dimensions of the nineteenth-century “musical question,” her work does not engage with the concrete intervallic and mathematical aspects of Byzantine chant, which are the focus of the present analysis and thesis.

(*mī busalik*,  $2187/2048 \approx 113.7$  cents), which was perceived as too wide. It was then reduced by one Didymean comma: this yielded a minor tone (*epeñatos* or *T-*), producing a major third of  $5/4$  ( $\approx 386$  cents) above the tonic. This interval, however, was also judged too wide and “European” in character. It was therefore reduced by another comma: thus the *mi-* was set at  $100/81$  ( $\approx 407.8$  cents above the tonic). This final value was considered acceptable, as it approximated the *segah* of Ottoman/Persian practice, even if not with complete precision.

Whereas Chrysanthos had followed the Zalzalian tradition of forming a triad of steps, from the ratios  $9/8$ ,  $12/11$ ,  $88/81$ , the Committee established and accepted the ratios  $9/8$ ,  $800/729$ ,  $27/25$ , plus the semitone:  $256/243$  as designating, respectively, a major tone, minor tone, minimum tone, and half-tone. In this way, the Committee systematically imposed adjustments in accordance with a predetermined numerical culture—relying on successive applications of the Didymean comma as the sole measure of correction—until intervals were judged satisfactory. The outcome was then presented as a mathematically grounded correction of Chrysanthos, although in reality it emerged from a selective and ideologically guided process. (see Appendix for details.)

Some years after the publication of the Committee’s findings, Archimandrite Pankratios of the Athonite Monastery of Vatopedion voiced his skepticism about its procedures. In *The Musical Scale* (Ἡ Μουσικὴ Κλίμαξ), a treatise printed 1917 by the Ecumenical Patriarchate itself, he emphasises that

this division of the scale [...] is not scientifically accurate, because it was not immediately derived from mathematical calculations, but was established on the basis of tests. But everything that is done on the basis of tests cannot be

found scientifically accurate, especially matters of hearing; because that, which I perceive and consider through my hearing as correct, another sharper and more sensitive hearing might prove wrong; and I am unable to confute their perception and opinion, because I do not have a scientific mathematical basis to prove the opposite.<sup>375</sup>

Beyhom treats the 1881 Patriarchal Musical Committee as the decisive moment in which the Psaltic Art became anchored to an “official” scale theory that, even though it does not correspond closely to praxis, has dominated chant pedagogy since the late nineteenth century.<sup>376</sup> He stresses that the Committee claimed its intervallic system was derived from scientific monochord measurements of intervals sung by cantors, yet it provided no usable methodological documentation: no information about the cantors involved, no measurement protocol, and no statistical treatment of discrepancies between singers, leaving the reliability of the results fundamentally questionable.<sup>377</sup> More importantly, Beyhom argues that the Committee’s “Second Reform” was rhetorically presented as a defence against Western musical infiltration, but in practice it Westernised the scalar logic of chant theory. Preferring “harmonic/pure” interval ratios and semitonal thinking, it weakened the older “Oriental” (Zalzalian) intervallic traditions inherited through Chrysanthos. The

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<sup>375</sup> Archimandrite Pankratios Vatopedinos, *The Musical Scale* (E Mousice Climax), Patriarchal Typography, 1917.

<sup>376</sup> From Beyhom, “Theory and Practice of Psaltiki,” 651-656.

<sup>377</sup> The sceptical stance toward the Committee’s method is further corroborated by other contemporary mathematicians who have engaged with the intervallic theory of Psaltiki. Antones Constantinides and Demetrios Lekkas are among them; during the years in which this dissertation was being written, we were in personal communication with both concerning this matter. The issue is discussed in detail in the Appendix.

broader consequence was that theory progressively came to be mistaken for rule, rather than being employed as an approximate descriptive guide.

From this we may conclude that the work of the Patriarchal Committee of 1881, presented as a scientific correction of Chrysanthos, was in fact a selective and circular process, grounded not in demonstrable acoustical necessity but in the mechanical imposition of the 81/80 comma as a universal regulator. By applying this unit repetitively and arbitrarily, the Committee generated ratios that were neither acoustically distinctive nor historically attested, thereby subordinating musical theory to a numerological scheme and to the ideological imperatives of its time. The resulting structure (intervals  $9/8$ ,  $800/729$ ,  $27/25$ ,  $256/243$ ) diverges subtly but significantly from the spondeiac archetype ( $9/8$ ,  $12/11$ ,  $88/81$ ) attested in Arabic and Persian sources (Zalzal, al-Farabi). For example, the Committee's "minor tone" ( $800/729 \approx 160.9$  cents) is perceptibly wider than the spondaic  $12/11$  ( $\approx 150.6$  cents), demonstrating the effect of arithmetic bias upon structural integrity.

By contrast, the Chrysanthine diatonic system draws on the Zalzalian heritage and corresponds to intervallic structures repeatedly evidenced in ancient, Byzantine, and Near Eastern musical practice. Its reliance on the epenatos ( $10/9$ ) and related tones, accessible through natural harmonics and widely documented in theory and performance, demonstrates a deeper historical rootedness and a stronger mathematical coherence. Accordingly, the Committee's reform should be understood less as a genuine theoretical advance than as an ideologically guided standardization. The Chrysanthine intervals, far from requiring correction, remain the more historically grounded and acoustically meaningful point of reference for the diatonic framework of Byzantine chant.

## Conclusions

This chapter set out to address a central problem of historical chant studies: the reconstruction of intervallic reality in repertoires whose notation and theory do not fully specify pitch. In Byzantine chant, this problem becomes especially acute under the heading of chromaticism. Medieval sources and notational practice signal alteration—sometimes explicitly as corruption (*phthora*)—yet they do not offer the kind of intervallic fixity required by modern theoretical expectations. The debate over whether Middle Byzantine chant was “diatonic” or “chromatic” is therefore not merely empirical; it is definitional. It depends on what one means by chromaticism, and whether one approaches the medieval repertory through prescriptive interval systems or through the functional semiography of signatures, *phthorai*, and melodic behaviour.

The chapter’s first conclusion is therefore conceptual: chromaticism in the medieval Byzantine context cannot be equated with the ideologically charged augmented-second tetrachords that became the focus of debates during the later nineteenth and early twentieth centuries. The evidence of modal signatures, the function of medial signatures as turning points, and the early usage of *phthorai* all indicate that chromaticism was understood primarily as a disturbance or reconfiguration of the normative diatonic disposition. In this sense, the Byzantine notion of corruption aligns structurally with medieval Western language of *vitia* and *absoniae*: it designates a controlled deviation from the modal framework, not a stable “scale” in the modern sense. This conclusion supports the broader methodological stance of the dissertation: a medieval chromatic phenomenon may exist as a *perceptual and functional* reality

without requiring the kind of explicit scalar construction later demanded by systematic music theory.

Building on this, the chapter's second conclusion is that nineteenth-century Byzantine music theory articulates two conceptually distinct definitions of chroma. This duality is conscious, as standard terminology itself reveals, attaching two different adjectives to the noun "chroma" or "chromaticism". The first one conforms closely to the ancient Greek definition of the chromatic genus, as formulated in Aristoxenian and post-Aristoxenian theoretical approaches, in which chromaticism is defined by way of a specific intervallic structure of the tetrachord. This structure is characterized by the coexistence of intervals larger and smaller than their diatonic equivalents, with the augmented second functioning as the principal defining intervallic marker (Chrysanthos' Scale B for the Second Mode). In later Byzantine theoretical discourse, this conception is codified as "tense chroma" and preserves the essential genus-based logic of ancient harmonic science.

The second conception of chroma (Chrysanthos' Scale A for the Second Mode), which constitutes the primary focus of the present dissertation, departs from a strictly genus-based definition determined by fixed intervallic magnitudes. It is rather understood as a qualitative modification or inflection of an underlying scalar or modal structure. Such chromatic coloration may occur without the introduction of intervals foreign to the diatonic genus, emerging instead through the rearrangement of diatonic intervals within a given melodic framework, and aligns more closely with the ancient Greek notion of chroa (hue), in this case a diatonic one. It is precisely this understanding of ("soft") chroma that converges with medieval Latin theoretical

conceptions, in which chromaticism is frequently treated not as a distinct genus, but as a modal or structural inflection within an otherwise stable diatonic system.

The third (methodologically decisive) conclusion is that Chrysanthos' tuning system can be defended as a historical reference model. This does not imply that it reproduces medieval Byzantine practice in an unmediated way. Rather, the chapter argued that Chrysanthos provides a coherent ratio-framework whose internal steps are acoustically meaningful and historically plausible: the major tone ( $9/8$ ), the minor tone ( $12/11$ ), and the minimum tone ( $88/81$ ). These steps produce neutral intervals and especially a neutral third ( $\sim 347$  cents) whose structural importance is repeatedly attested across Arabic, Persian, and Ottoman traditions. The historical persistence of the Zalzalian third region, the multiple placements discussed by al-Farabi, and the empirical stability of neutral thirds in Persian fretting systems together support the claim that Chrysanthos' system is not an arbitrary nineteenth-century invention but a rational crystallisation of a logic of tuning found throughout the Eastern Mediterranean.

A fourth conclusion concerns the problem of "correction." The chapter showed that the internal inconsistency of Chrysanthos' Scale A, particularly its failure to form frameworks of pure consonances, prompted an early intervention by Chourmouzius Chartophylax and later disseminated by Phocaeus. These interventions did not reject the Chrysanthine system; they re-ordered its intervallic inventory to satisfy octave and tetrachordal integrity. This dialectic is itself historically important: it demonstrates that the New Method system was presented—implicitly and sometimes explicitly—as a framework open to refinement rather than as a dogma. The "Chrysanthine soft chromatic" used in performance may therefore be historically post-Chrysanthos in its

ordering, yet still Chrysanthine in its ratio-material. This distinction is essential for analytical clarity and for avoiding category errors in attribution.

Fifth, this chapter established that organology offers one of the most powerful external tests of tuning plausibility. Chrysanthos' reference to the ney, and the broader argument about flute drilling logic, supports a thesis of acoustic continuity: neutral intervals arise naturally from hole placement constraints and cross-fingering. The convergence between ney-based interval practice and recorder acoustics further weakens the assumption that neutral steps must represent later "orientalisation." Instead, it suggests that neutral intervals may represent one of the most persistent acoustic realities of the broader Mediterranean soundscape.

Finally, the chapter introduced a necessary epistemological framework for the dissertation: observational error theory as a guiding logic for reconstruction. In a field defined by the absence of direct measurement, reconstructions cannot be validated absolutely. They can only be evaluated as better or worse hypotheses. When Chrysanthos' ratios demonstrate internal coherence and cross-cultural corroboration, they become methodologically preferable—not because they are "true," but because they are *least-wrong* among available systems. This logic also clarifies why the Patriarchal Committee's reforms fail as a corrective: their procedure relies on arithmetic repetition of comma adjustments, producing ratios that are neither perceptually stable nor historically attested, and reflecting ideological standardisation more than musical necessity.

In sum, the chapter has argued that Chrysanthos' tuning should be treated neither as a medieval survival nor as a modern fabrication, but as a historically anchored reference environment. It provides a workable and defensible intervallic framework for testing

Middle Byzantine melodies in performance, and it prepares the dissertation's next step: the application of this reference tuning to concrete chant material, where the validity of the model will be evaluated not only theoretically but musically—through modal behaviour, melodic attraction, and perceptual coherence in reconstructed performance.

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Chapter 3 clarified that both Eastern and Western medieval chant traditions encode intervallic behaviour indirectly, and Chapter 4 established the conditions under which a historically grounded reference tuning may be adopted responsibly. Chapter 5 will move from theory into application: the transcription and performance-practice demonstration of medieval Byzantine melodies using the Chrysanthine reference system.

## Chapter 5

## CASE STUDY:

TOWARDS THE PERFORMANCE OF SELECTED HEIRMOI AND STICHERA  
OF THE 13<sup>TH</sup> – 14<sup>TH</sup> CENTURIES

This chapter examines selected troparia – three heirmoi, three stichera, and one kontakion – of the late thirteenth and early fourteenth centuries as a case study in the interaction between modal behaviour, melodic syntax, and the realisation in performance of musical intervals. Building on the historical and theoretical foundation established in the preceding chapters, it shifts the focus from abstract intervallic systems to concrete musical material. Its guiding question is not only how the Second and Second Plagal Modes may be described in theory, but how they behave melodically in repertoires of the later Byzantine period. Here, modal identity is approached primarily as a melodic reality: something expressed through focal tones, cadential routines, and characteristic melodic turns, rather than as a purely scalar framework.

The methodological premise of the chapter is that such behaviour can be demonstrated most clearly through comparison. The vital point of the present transcriptions is therefore their systematic alignment with the melodies of the received tradition of Psaltike. Medieval witnesses are placed directly beside their

corresponding melodies transmitted in nineteenth-century manuscripts and printed books, allowing the reader to evaluate visually degrees of melodic continuity across the historical gap.

The transcriptions presented here function as controlled analytical demonstrations. Staff notation is used as a practical medium to clarify melodic contour, register, and cadence, and to facilitate systematic comparison across periods. In this sense, the chapter treats transcription as a form of comparative melodic inquiry: it makes visible how melodies evolve, and it provides a clear basis for evaluating continuity and transformation within the same modal tradition.

Within this comparative framework, the chapter then turns to the question of intervallic plausibility. Since the received Psaltic tradition preserves important aspects of melodic and modal grammar across centuries, it becomes possible to ask whether a historically grounded intervallic model can support that grammar when applied to earlier melodies. By exploring this problem through the soft diatonic/chromatic intervallic framework articulated by Chrysanthos for the Second Mode(s), we are not aiming at a direct reconstruction of medieval practice, nor do we mean to suggest that his system is universally authoritative. Rather, we will be testing it as a coherent reference model, historically situated within the broader Eastern Mediterranean tradition, for evaluating melodic behaviours documented in the sources.

### On the modal language of the Heirmologion and the Sticheraion

The Heirmologion is a collection of hymns for the Hagiopolitis, the Divine Office of the ancient church of Jerusalem, consisting primarily of the *heirmoi* of canons by both anonymous and named composers. The oldest copies to provide their texts with Palaeobyzantine forms of music notation date from the tenth century. As such, it constitutes one of the oldest musically notated liturgical books of the Byzantine rite. Approximately forty-five medieval Greek Heirmologia are preserved in libraries on Mount Athos, at Sinai, in Italy, on Patmos, and in the National Libraries of Athens, Paris, and elsewhere.<sup>378</sup> St John Koukouzeles edited the repertoires of the middle Byzantine Heirmologion early in the fourteenth century, marking its first clearly recognisable stage of transformation.<sup>379</sup> As a distinct repertory, the Koukouzelian Heirmologion retains strong structural and melodic connections with the earlier melos. Yet it also reflects a growing stylistic separation between the melodies of heirmoi and stichera, earlier notated versions of which clearly belonged to the same compositional traditions of Hagiopolitan hymnody, sharing the same modal bases, the same scalar frameworks, and the same melodic formulas (*theseis*).<sup>380</sup>

According to Wolfram, the Sticheraion is

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<sup>378</sup> See Spyridon Antoniou, *To ειρμολόγιον και η παράδοση του μέλους του*, Μελέται 8 (Αθήνα: Ίδρυμα Βυζαντινής Μουσικολογίας, 2004), 90-91.

<sup>379</sup> *Ibid.*, 245-248.

<sup>380</sup> See Arvanitis relevant work on this: Arvanitis, Ioannis. "A Way to the Transcription of Old Byzantine Chant by means of Written and Oral Tradition" in *Byzantine Chant: Tradition and Reform. Acts of a Meeting held at the Danish Institute at Athens, 1993*, ed. Christian Troelsgård, Monographs of the Danish Institute at Athens, vol. 2 (Athens: Danish Institute at Athens, 1997), 123–141; and "On the Meaning and Purpose of the Treatise by Manuel Chrysaphes." *Tradition and Innovation in Late- and Postbyzantine Liturgical Chant: Acta of the Congress held at Hernen Castle, April 2005*, ed. Gerda Wolfram. Leuven-Paris-Dudley MA: Peeters, 2008, pp. 105-128.

A liturgical book in the Byzantine rite containing the stichera, the hymns inserted between the verses of psalms at Vespers (Hesperinos) and Matins (Orthros). Sticheraria include both stichera idiomela and stichera automela: stichera idiomela have their own melodies and are usually sung only once during the Church year; stichera automela do not in themselves constitute a sung repertory but function as melodic and metrical models for the generation of stichera prosomoia. [...T]he oldest Sticheraria were notated collections of Idiomela and discovered in the library of the Great Lavra on the Mount Athos and can be dated back to the 10th (Ms. γ.12, γ.67 is the only manuscript with an octoechos) and 11th century (γ.72, γ.74). The oldest notation used was theta notation, later replaced by Chartres and Coislin notation.”<sup>381</sup>

Having noted above their common features, it is also important for us to recall certain differences between the Sticherarion and the Heirmologion identified long ago by Oliver Strunk.<sup>382</sup> He observed that the Sticherarion was a text-bound repertory sustained through written copying,<sup>383</sup> whereas the Heirmologion functioned primarily as a pedagogical auxiliary to oral transmission and memorisation of melodies continuously recalled and adapted to metrical contrafacta of their heirmoi.<sup>384</sup> Variability in the transmission of heirmoi is therefore not evidence of corruption, but a predictable consequence of a tradition in which melodic identity is maintained through modal behaviour, cadential logic, and formulaic syntax rather than the preservation of fixed melodic “texts.” Strunk’s observation that model melodies were sometimes not copied precisely because they were too familiar to require written

<sup>381</sup> Gerda Wolfram, “Stichērarion,” *Grove Music Online*, Oxford University Press, accessed [21 Dec 2025], <https://www.oxfordmusiconline.com>

<sup>382</sup> His relevant work in Oliver Strunk, *Essays on Music in the Byzantine World* (New York: W. W. Norton & Company, 1977).

<sup>383</sup> *Ibid.*, 248.

<sup>384</sup> *Ibid.*, 310-311.

transmission anticipates later conceptions of the automelon as a generative framework.<sup>385</sup>

Christian Troelsgård subsequently developed these points by explicitly treating the heirmos as a model melody: a stable melodic outline designed for repeated realisation in performance.<sup>386</sup> In order to advance the discussion through more recent research, Troelsgård stresses that *Sticheraria* themselves functioned as reference copies. Owing to their generally small format, they were rarely suitable for direct use as choirbooks. Consequently, Troelsgård observes that phenomena which Strunk had treated as characteristic of the *Heirmologion* are likewise present in the *Sticherarion*, suggesting a broader scribal and performative logic underlying both repertoires.<sup>387</sup> He identifies a gradual shift in the written transmission of heirmologic material, particularly from the late thirteenth century onward. He judges increasing notational consistency in the recording of melodies as a gradual normalisation of written transmission in relation to established practice, not a rupture or the creation of a new repertory.<sup>388</sup>

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<sup>385</sup> *Ibid.*, 99.

<sup>386</sup> Christian Troelsgård, “Melodic Variation in the ‘Marginal’ Repertoires of Byzantine Musical MSS, Exemplified by *Apolytikia/Kontakia* and *Exapostelaria Anastasima*,” in *Cantus Planus: Papers Read at the 9th Meeting of the IMS Study Group* (Sopron, 1995), 602–605; *idem*, “The Repertoires of Model Melodies (*Automela*) in Byzantine Musical Manuscripts,” *Cahiers de l’Institut du Moyen-Âge Grec et Latin* 71 (2000): 5–8, 11–18; *idem*, “Simple Psalmody in Byzantine Chant,” in *Cantus Planus: Papers Read at the 12th Meeting of the IMS Study Group, Lillafüred/Hungary 2004* (Budapest: Institute for Musicology of the Hungarian Academy of Sciences, 2006), 84–86. See also Strunk’s, *Essays*, esp. 99–107 (“The Notation of the Chartres Fragment”) where Strunk explicitly states that *automela* and other model melodies were excluded from copying because they were already known by singers. Strunk’s formulation of the *Heirmologion* as an *auxiliary book* recurs in several essays (notably in “Melody Construction in Byzantine Chant” and in the discussions following the *Chilandari* choir books).

<sup>387</sup> See Christian Troelsgård, “What Kind of Chant Books Were the Byzantine *Sticheraria*?” In *Cantus planus: Papers read at the 9th meeting, Esztergom & Visegrád, Hungary, 1998*, edited by László Dobszay, 563–74. Budapest: Institute for Musicology of the Hungarian Academy of Sciences, 2001; *idem*, “Byzantine chant notation: Written documents in an aural tradition” [In memory of Kenneth Levy (\* New York 1927 — † Princeton 2013)], in *Aural architecture in Byzantium: Music, acoustics, and ritual*, ed. Bissera V. Pentcheva (London: Routledge, 2017), 52–77. Additionally *idem*, “Melodic Variation,” 605–607; and *idem*, “Simple Psalmody,” 87–89.

<sup>388</sup> *Idem*, “Byzantine Chant Notation,” 61–66; cf. *idem*, “The Repertoires,” 19–22.

## **On the automela of the Second Modes as modal frameworks: continuity and differentiation across the centuries**

Irina Shkolnik's comparative studies of sticheraric model melodies confirms Troelsgård's understanding of notated automela as modal and formal frameworks rather than fixed melodic entities.<sup>389</sup> Although Shkolnik's is concerned with the automela underpinning the performance of their contrafacta (prosomoia), her findings are methodologically relevant here because they further clarify how modal identity, especially in the Second Modes, is preserved through *structural* behaviour (ambitus, cadence, focal degrees, and recurrent contour types). In this sense, her work provides an empirical framework for assessing continuity across notational strata and repertorial categories, including examination of heirmoi and idiomela. Shkolnik's manuscript comparisons demonstrate that automela were never transmitted as a closed repertory: their number, ordering, and internal structure vary substantially across Byzantine and Slavonic traditions from the late eleventh century onward. Yet the Second Modes retain stable modal identity even when melodic surfaces diverge.

In her transcriptions (Figures 5.1, 5.2, and 5.3), Shkolnik compares selected manuscript sources from the eleventh to the nineteenth centuries. Musical coherence is maintained both within individual melodies and through their transmission across time and space primarily through cadential organisation and tonal orientation around a limited set of focal degrees, rather than exact melodic replication. One of Shkolnik's most important conclusions is historiographical: differentiation does not imply

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<sup>389</sup> Irina Shkolnik, "Byzantine prosomoion singing, a general survey of the repertoire of the notated stichera models (automela)," in *Cantus Planus: Papers read at the 7th meeting, Sopron, Hungary 1995*, ed. László Dobszay (Budapest: Hungarian Academy of Sciences, 1998), 521–536; Irina Shkolnik, "Stichera-automela in Byzantine and Slavonic sources of the late 11th–late 18th centuries," in *Palaeobyzantine notations II: Acta of the congress held at Hernen Castle (The Netherlands) in October 1996*, ed. Christian Troelsgård (Hernen: A.A. Brediusstichting, 1999), 81–97.

rupture. Indeed, later sources can preserve cadential patterns that appear archaic in comparison with some medieval witnesses, complicating linear narratives of development and suggesting that Second Mode traditions are conservative modal spaces in which older melodic gestures remain functional.

Particularly relevant to the present chapter is Shkolnik's discussion of what she terms "G-modality" as a characteristic of chants in the Plagal Second Mode, which she identifies as a persistent feature of the automelon *Αἱ ἀγγελικαί*. She holds that this modal behaviour, observable also in the melodies of the received tradition of Byzantine chant that we shall examine below, preserves characteristics of an oral modal tradition diverging both from the theoretical system of the medieval Octoechos and from the later tendency to render the Second Plagal mode chromatically. The gradual difficulty of accommodating this G-modal framework to common expectations for chants the Second Plagal Mode is already apparent in medieval sources, where efforts to avoid G-modality manifest as modal shifts (usually to la note in her staff transcriptions), unusual intervallic leaps, or unstable melodic behaviour (as seen in manuscripts such as Sinai 1250 and A 917). These phenomena suggest that the modal organization of the automela, rooted in oral tradition and defined by final tones and ambitus that remained relatively stable until undergoing partial reconfiguration in the eighteenth century, differs fundamentally from that of the Sticherarion system. A general historical tendency toward raising both the ambitus and pitch level of these automela culminated in the modern preference for replacing their earlier G-modality framework with one based on E.<sup>390</sup>

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<sup>390</sup> See Shkolnik, "Stichera-Automela," 88-91.

RNL 674  
 Αἱ ἀγ-γε-λι- καὶ προ-πο-ρεύ- ε - σθε δυ - νά - μεις

Vatop 1493

Sinait 1250

A 917

Petr.

---

674  
 οἱ ἐν Βη-θλε- ἐμ ἐ- τοι-μά- σα- τε τὴν φάτ-νην·

1493

1250

917

Petr.

---

RNL 674  
 ὁ Λό-γος γὰρ γεν-νᾶ-ται ἡ σο-φί- α προ-έρ-χε- ται·

Vatop 1493

Fig.5.1. Automelon comparison (beginning) - from Shkolnik, "Stichera-Automela," 89

Sinai 1250

A 917

Petr.

---

674

1493

1250

917

Petr.

---

RNL 674

Vatop 1493

Sinai 1250

A 917

οέ-χου άσ-πασ-μδν ή έκ-κλη-σί-α'

είς τήν χα-ράν τής θε-ο-τό-κου λα-οί εί-πω-μεν'

Fig.5.2. Automelon comparison (continued) - from Shkolnik, "Stichera-Automela," 90

Fig.5.3. Automelon comparison (end) - from Shkolnik, "Stichera-Automela," 91

### On the tonal language of heirmoi in the second modes: transcription problems

Among the mele we have selected for comparative staff transcriptions, those of the Koukouzelian Heirmologia differ in melodic contour from those of such Middle Byzantine Heirmologia as MS Grottaferrata E.γ. III, copied in Southern Italy between the first and second quarters of the twelfth century.<sup>391</sup> The melodies of these earlier Heirmologia contain frequent leaps that can create difficulties for singers when performed in tunings other than the Pythagorean (ditonic diatonic). This is why Arvanitis has argued, as noted above, for their transcription and performance within a framework of ditonic diatonicism.

<sup>391</sup> Sandra Martani, "Modal References in the Byzantine Heirmologion: The Medial Signatures in the Manuscript Grottaferrata E.γ.III," *Series Musicologica Balcanica* 1, no. 2, 394.

In order to represent the pitch structure required for rendering the Second Modes in Chrysanthine tuning—following the Chourmouzian correction of the Chrysanthine soft chromatic scale—the key signature in our transcriptions contains four quarter-tone flats (reversed: ♯) on D, E, A and B of the staff). Therefore the authentic’s basis is on B♯, and the plagal’s basis is a perfect fifth lower on E♯), making pure most of the usual melodic leaps found chants of the Second Modes. The only problematic point is the impurity between the usual leap re♯ and sol (ascending leap of a fourth). For example, see σεσωμένων in the heirmos of Ode 1 of *Κύματι θαλάσσης*, a tetraodion for Holy and Great Saturday in the Plagal Second Mode attributed (doubtfully<sup>392</sup>) in some sources to Kassía:

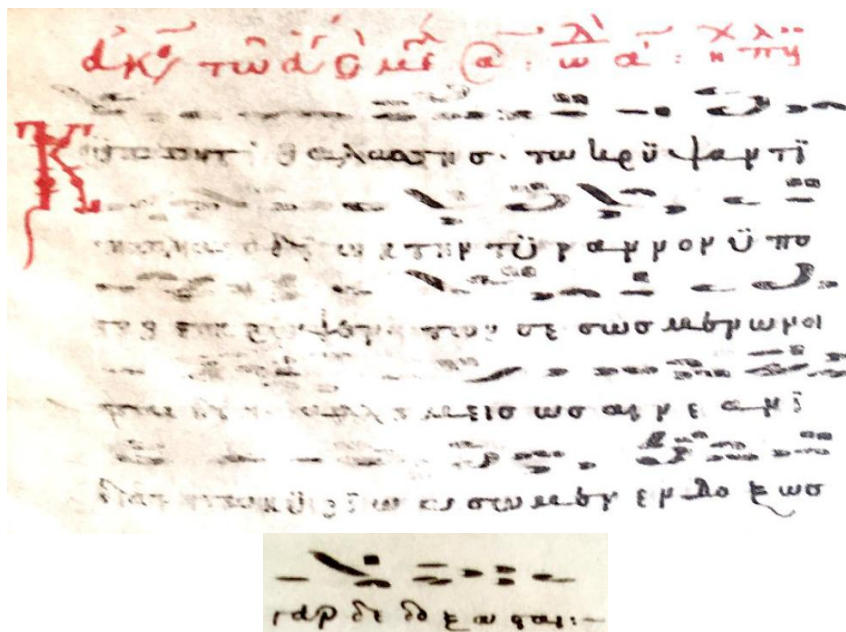


Fig.5.4. Beginning of Kassía’s Tetraodion (the Heirmos, *Κύματι θαλάσσης*) for the Holy and Great Saturday in Ms Crypt. Gr. E. γ. II (Heirmologion, 1281), f.171 r-v

<sup>392</sup> For a current review of the evidence for Kassía’s authorship, see Stig Simeon R. Frøyshov, Aleksandra Nikiforova, and Natalia Smelova, “Byzantine Influence before Byzantinisation: The Tropologion Sinai Greek NE ΜΓ 56+5 Compared with the Georgian and Syriac Melkite Versions,” *Religions (Basel, Switzerland)* 14, no. 11 (2023): 13–63.

## HEIRMOS

Κύματι θαλάσσης

MS Cryptensis  
Gr. E. γ. II  
Heirmologion (1281)  
ἦχος ᾠδ.

Κυ - μα - τι θα - λασ - σης τον κρυ - ψα - ντα πα - λαι  
 δι - ω - κτην τυ - ραν - νον υ - πο γην ε - κρυ - ψαν των  
 σε - σω - σμε - νων οι παι - δες αλλ' η - μεις ως αι νε - α -  
 - νι - δες τω Κυ - ρι - ω α - σω - μεν εν - δο - ζως γαρ  
 δε - δο - ζα - σαι

Fig.5.5 Digitised version of A. Lingas' staff transcription of Kassia's Tetraodion (only the Heirmos, *Κύματι θαλάσσης*) for the Holy and Great based on I. Arvanitis' exegesis to the NM) – reproduced by kind permission of the author.

The leap-dominated melodic contour of this Middle Byzantine heirmos, also typical of the chants found in contemporary Sticheraria. After the Koukouzelian reform, however, as we shall see, such leaps become progressively less frequent in Heirmologia, although they remain characteristic of most stichera. The exceptions that

we have found of Second-Mode chants with fewer leaps and more cadences on the medial Second (*mesos*, i.e. on G in staff transcription = Shkolnik's "G-tonality") are:

1. Stichera of the Resurrection for Saturday Vespers and Sunday Matins (Ainoi=Lauds),
2. Apolytikia,
3. Kathismata, and
4. Kontakia.

It lies beyond the scope of the present thesis to provide an exhaustive catalogue of musical sources or specific melodies to which Chrysanthine intervallic models might be applied. Such an undertaking would constitute a substantial and promising direction for future research.

A pioneering study comparing medieval and received melodies for syllabic chants is "Adjustments of Modality in the Post-Byzantine Heirmologion" by Eustathios Makris.<sup>393</sup> It offers a lucid and methodologically careful survey of the historical development of the modal change in the Heirmologion from the late Byzantine period through its post-Byzantine reconfigurations. Makris begins with the so-called "classical" Heirmologion of the twelfth and thirteenth centuries (examples of which include MSS Mt Athos Iviron 470 and Grottaferrata E. γ. II) and proceeds next to the Koukouzelian redaction of the repertory in MSS St Petersburg RNL. gr. 121 ("1302"), and Sinai 1256 ("1309"). His post-Byzantine sources notated in MBN include those associated with Theophanes Karykes, Balasios the priest. Concluding in the NM with the Heirmologion of Ephesios, Makris shows changes of modality to have been both gradual and stylistically continuous rather than abrupt or revolutionary.

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<sup>393</sup> Eustathios Makris, "Adjustments of Modality in the Postbyzantine Heirmologion," in *Tradition and Innovation in Late- and Postbyzantine Liturgical Chant: Acta of the Congress Held at Hernen Castle, the Netherlands, in April 2005*, ed. Gerda Wolfram (Leuven: Peeters, 2008), 37-63.

Central to Makris' study is his reassessment of the Koukouzelian Heirmologion, which he characterizes as "beyond any doubt, the dominant one in the last years of the Empire and even some time after its fall."<sup>394</sup> Examining the musical transformation that occurred between it and the Middle Byzantine Heirmologion, he argues that it should be understood primarily as manifesting both change and continuity in modal and melodic behaviour. On the one hand, it is the Koukouzelian Heirmologion that first codified new features that would define the melodies of post-Byzantine Heirmologia. On the other hand, Makris demonstrates how the modality of the post-Byzantine Heirmologion is in fact deeply rooted in earlier practice. Comparing individual heirmoi across the classical, Koukouzelian, and post-Byzantine repertoires, he shows that while melodic surface details continue to evolve, their modality remains remarkably stable over several centuries. This insight underlies his broader conclusion that the Chrysanthine theoretical system of the nineteenth century should be understood not as a creative reimagining of modal practice, but as an attempt to accommodate an already existing melodic reality within a newly formalized theoretical framework.

To be more specific, Makris notes that Koukouzelian versions of the "classical" Heirmologion melodies exhibit a consistent tendency toward expansion of range and redistribution of modal weight. These late medieval versions frequently extend the melodic ambitus upward and assign increased structural importance to higher degrees of the mode. Although the *finalis* remains formally intact, it no longer functions as the exclusive or even primary point of modal gravity throughout the chant. Instead, upper dominants and secondary focal tones are emphasized through repetition, register placement, and clearer internal cadences. As a result, modality unfolds over time in a

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<sup>394</sup> Makris, "Adjustments of Modality," 40.

more dynamic and differentiated manner, producing a different perceptual experience of the same mode.

Crucially, Makris insists that these changes do not stem from melodic recomposition, but from the reinterpretation of existing formulas achieved by altering their functional roles within the modal structure.<sup>395</sup> Melodic contours often remain recognisable, but their placement within a broader ambitus and their interaction with internal cadences reshape the listener's sense of modal orientation. What was once a passing gesture may become a structural anchor; what was once marginal may acquire central importance. In this way, the transformation is both subtle and profound, operating at the level of modal syntax rather than surface melody. Makris situates this development within a broader musical context by pointing out that many of the modal behaviours emphasized in the Koukouzelian Heirmologion were already present in other chant repertoires, particularly the Sticherarion. The Koukouzelian manner thus represents a transfer and normalization of modal practices that had previously been peripheral or genre-specific. By integrating these practices into the Heirmologion, the Koukouzelian tradition reshapes a repertory that had long been associated with syllabic clarity and modal restraint, without abandoning its essential identity.

We reproduce in Figures 5.6 and 5.7 two samples of Makris' transcriptions of heirmoi in the Second Modes:

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<sup>395</sup> See also Strunk, *Essays*, 256–257.

"Classical"

Άν - τί - θε - ον πρό - ταγ - μα πα - ρα - νο - μούν - των τυ - ράν - νων μετ - άρ - σι - ον την φλό - γα άν - ερ - ρί - πι - σε· Χρι - στός δέ έφ - ή - πλω - σε θε - ο - σε - βέ - σι παι - σί δρό - σον την του πνεύ - μα - τος, ό ων εύ - λο - γη - μέ - νος και ύ - περ - έν - δο - ξος.

"Koukouzelian"

Άν - τί - θε - ον πρό - ταγ - μα πα - ρα - νο - μούν - των τυ - ράν - νων μετ - άρ - σι - ον την φλό - γα άν - ερ - ρί - πι - σε· Χρι - στός δέ έφ - ή - πλω - σε θε - ο - σε - βέ - σι παι - σί δρό - σον την του πνεύ - μα - τος, ό ων εύ - λο - γη - μέ - νος και ύ - περ - έν - δο - ξος.

Neobyzantine  
(originally from D)

Άν - τί - θε - ον πρό - ταγ - μα πα - ρα - νο - μούν - των τυ - ράν - νου μετ - άρ - σι - ον την φλό - γα άν - ερ - ρί - πι - σε· Χρι - στός δέ έφ - ή - πλω - σε θε - ο - σε - βέ - σι παι - σί δρό - σον την του πνεύ - μα - τος, ό ων εύ - λο - γη - μέ - νος και ύ - περ - έν - δο - ξος.

Fig.5.6. MBN transcription to staff: the 7<sup>th</sup> Ode heirmos of the authentic Second Mode Sunday Canon from the Octoechos (by monk Ioannes of Damascus) - from Makris, "Adjustments", 47

"Classical"

Τοῦ βί - ου τὴν θά - λασ - σαν ὑ - ψου - μέ - νην καθ - ο -  
 ρῶν τῶν πει - ρα - σμῶν τῷ κλύ - δω - νι, τῷ εὐ - δι - φ - λι - μέ - νι σου  
 προσ - δρα - μῶν βο - ῶ σοι ἀν - ά - γα - γε ἐκ φθο - ρᾶς τὴν ζω - ἦν μου,  
 πο - λυ - έ - λε - ε.

"Koukouzelian"

Τοῦ βί - ου τὴν θά - λασ - σαν ὑ - ψου - μέ - νην καθ - ο -  
 ρῶν τῶν πει - ρα - σμῶν τῷ κλύ - δω - νι, τῷ εὐ - δι - φ - λι - μέ - νι σου  
 προσ - δρα - μῶν βο - ῶ σοι ἀν - ά - γα - γε ἐκ φθο - ρᾶς τὴν ζω - ἦν μου,  
 πο - λυ - έ - λε - ε.

Neobyzantine  
(originally from F)

Τοῦ βί - ου τὴν θά - λασ - σαν ὑ - ψου - μέ - νην καθ - ο -  
 ρῶν τῶν πει - ρα - σμῶν τῷ κλύ - δω - νι, τῷ εὐ - δι - φ - λι - μέ - νι σου  
 προσ - δρα - μῶν βο - ῶ σοι ἀν - ά - γα - γε ἐκ φθο - ρᾶς τὴν ζω - ἦν μου,  
 πο - λυ - έ - λε - ε.

Fig.5.7. MBN transcription to staff: the 6<sup>th</sup> Ode heirmos of the plagal Second Mode Sunday Canon

from the Octoechos (by monk Ioannes of Damascus) - from Makris, "Adjustments", 55

One consequence of the drift over time toward the G-modality (the G-degree otherwise known as the medial Second Mode) in Mode-Two chants is that cadences are increasingly displaced by an interval of two scale degrees (literally *diphonos* or “two-voices.” From the fourteenth century onwards some cadences shift upward even further to the “three-voice” (*triphonos*) degree a fourth above the old final of E. Eventually this latter tendency becomes dominant in certain variants of the Second Mode. Similarly in chants of the Plagal Second Mode, melodies began to be pulled toward its *diphonos* mediant (G), with final cadences regularly settling there (two-scale degrees higher to the plagal’s basis). These melodic tendencies are not exclusive to heirmoi, but appear in other chants contemporaneous with them - see below in the *Original Transcriptions* section the stichera Ὁ Σταυρός σου, Κύριε and Ἐν τοῖς προφήταις ἀνήγγειλας ἡμῖν, both from Ms Cryptensis Gr. E. α. V). as well as the following short syllabic melody for the Kontakion automelon Τὰ ἄνω ζητῶν (Ms Petropolitanus Gr. 674, ca 1270):

## Trscr.5.1. KONTAKION

Τὰ ἄνω ζητῶν

Ms Petropolitanus  
Gr. 674 (ca 1270)  
ἦχος μ

Τα α - νω ζη - των τοις κα - τω συν - α - πτο - με - νος  
και αρ - μα πυ - ρος τον στυ - λον ερ - γα - σα - με -  
νος δι' αυ - του συν - ο - μι - λος των Αγ - γε - λων γε - γο - νας  
Ο - σι - ε - συν αυ - τοις Χρι - σω τω Θε - ω πρε - σβευ - ων  
α - παυ - ζως υ - περ πα - ντων  
η - μων

Trscr.5.1. Kontakion automelon *Tà ἄνω ζητῶν* (Ms Petropolitanus Gr. 674, ca 1270)

## Original Transcriptions

In the following transcriptions to staff from medieval Heirmologion and Sticherarion sources, we compare medieval melodies of the thirteenth and fourteenth centuries to their counterparts in the received repertoires of the nineteenth century. Although not identical, they often share some melodic phrases while showing many similarities in form, ambitus, and melodic contour. Having previously drawn on the studies of Shkolnik and Makris to highlight stylistic differences between the “classical” and Koukouzelian versions of the Heirmologion, our goal now is demonstrate structural continuities of melodic language and modal structure between medieval chants of the Second Modes and their descendants currently in use. Having done so, we will test the extent to which the Chrysanthine intervallic system as corrected by Chourmouzos may plausibly be applied to selected fourteenth-century melodies.

Our focus on the Second Modes (authentic and plagal Deuterios) is methodologically significant. The Koukouzelian treatment of these modes is characterized by a marked reduction of large intervallic leaps in favour of stepwise motion, gradual registral expansion, and internally articulated melodic spans. Such a melodic syntax privileges continuity of motion, attraction between neighbouring degrees, and stable cadential hierarchies over the articulation of wide intervallic distances. These features render the Second Mode particularly amenable to realization within a soft diatonic intervallic framework, which tolerates non-equal step sizes while preserving modal coherence. From this perspective, the close resemblance between Koukouzelian Second-Mode melodies and the received repertory of Neo-Byzantine chant is not merely superficial, but reflects a shared modal logic that persists across changes in notation, pedagogy,

and theoretical language. The staff transcriptions that follow are intended to make these continuities analytically visible.

For these Second Mode chants, as noted above, we have provided a key featuring four reversed (quarter-tone) flats on D, E, A and B. The E and B notes correspond to the diatonic *vu* and *zo'* of Chrysanthine solmisation, but need flattening by a quarter of tone to be equivalent. *Re* and *la* are flattened in the same fashion to correspond to the chromatic *pa* and *ke* (D and A) of the Second Modes under discussion. The authentic mode's basis is B♭, and the plagal's basis is a perfect fifth lower on E♭. Yet Koukouzelian melodies, with their flattened contours, end up making both scales virtually the same.<sup>396</sup> Medieval chants differ from the post-Byzantine melodies of Petros Byzantios in employing a final cadence to the plagal, as well as in their brief passages emphasising the fourth degree of the Plagal Second tetrachord.

Finally, while the rhythmic and metrical organization of Byzantine chant has been the subject of detailed scholarly investigation—most notably by Arvanitis<sup>397</sup>—the present chapter deliberately refrains from imposing an explicit metrical framework on its transcriptions. This choice reflects the methodological priority of the present study, which lies in the examination of intervallic relations and modal behaviour as they emerge through melodic contour and articulation rather than rhythmic quantification. The transcriptions thus serve as the analytical ground on which the plausibility—and

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<sup>396</sup> Transcription 5.2, is an exception because we transposed it to a plagal ambitus to facilitate comparison.

<sup>397</sup> For a detailed account of rhythmic organization in Byzantine chant, see Arvanitis, “The Rhythmical and Metrical Structure of the Byzantine Heirmoi and Stichera as a Means to and as a Result of a New Rhythmical Interpretation of the Byzantine Chant,” *Acta Musicae Byzantinae*, vol. VI (2003): 15–29 or his Thesis “Ο ρυθμός των εκκλησιαστικών μελών.” The present study follows Arvanitis in recognizing the structural importance of rhythm, but brackets metrical reconstruction in order to concentrate on intervallic and modal analysis.

the limits—of applying a Chrysanthine intervallic framework to Koukouzelian repertory can be critically assessed.

All staff transcriptions by Georgios V. Savvas subsequently digitised in January 2026 by music engraver Christos Christodoulou (Athens, Greece) using the Avid Sibelius score-writer program.

### Original Transcriptions into staff notation

Kontakion automelon (presented earlier in the present chapter)

Trscr.5.1. Τὰ ἄνω ζητῶν [Ta anō zētōn]

Source: Ms Petropolitanus Gr. 674 (ca 1270), f.12v

Liturgical text:

Τὰ ἄνω ζητῶν, τοῖς κάτω συναπτόμενος,  
καὶ ἄρμα πυρός, τὸν στῦλον ἐργασάμενος,  
δι' αὐτοῦ συνόμιλος, τῶν Ἀγγέλων γέγονας Ὅσιε,  
σὺν αὐτοῖς Χριστῷ τῷ Θεῷ,  
πρεσβέων ἀπαύστως ὑπὲρ πάντων ἡμῶν.

Comparisons between melodies  
in Middle Byzantine and New Method Notations:

### Heirmoi

Trscr.5.2. Ἐν βυθῷ κατέστρωσέ ποτε [En bythō katestrōse pote]

Sources: Ms Petropolitanus Gr. 121 (1302), f.30(29)v / Heirmologion of Petros Byzantios (Constantinople, 1825), 35

Liturgical text:

Ἐν βυθῷ κατέστρωσέ ποτε,  
τὴν Φαραωνίτιδα πανστρατιάν  
ἢ ὑπεροπλος δύναμις,  
σαρκωθεὶς ὁ Λόγος δέ,  
τὴν παμμόχθηρον ἀμαρτίαν ἐξήλειπεν,  
ὁ δεδοξασμένος Κύριος·  
ἐνδόξως γὰρ δεδόξασται.

Trscr.5.3. Ὡ τῶν ὑπὲρ νοῦν [Ō tōn hyper noun]

Sources: Ms Sinaiticus Gr. 1256 (1309), f.47r-v / Heirmologion PB (1825), 56

Liturgical text:

Ὡ τῶν ὑπὲρ νοῦν, τοῦ τόκου σου θαυμάτων!

Νύμφη πάναγνε, Μῆτερ εὐλογημένη·

Δι' ἧς τυχόντες παντελοῦς σωτηρίας,

Ἐπάξιον κροτοῦμεν ὡς εὐεργέτη,

Δῶρον φέροντες ὕμνον εὐχαριστίας.

Trscr.5.4. Ὡς ἐν ἠπειρῷ πεζεύσας ὁ Ἰσραήλ [Hōs en epeirō pezeusas ho Israel]

Sources: Ms Petropolitanus Gr. 121 (1302), f.130r-v / Heirmologion PB (1825), 101

Liturgical text:

Ὡς ἐν ἠπειρῷ πεζεύσας ὁ Ἰσραήλ,

ἐν ἀβύσσῳ ἴχνεσι,

τὸν διώκτην Φαραῶ,

καθορῶν ποντούμενον,

Θεῶ ἐπινίκιον ὠδήν, ἐβόα, ἄσωμεν

#### Stichera

Trscr.5.5. Ὁ Σταυρός σου, Κύριε [Ho stauros sou, Kyrie] – plagal Second Mode

Sunday Matins (variation: Good Friday Matins, 15<sup>th</sup> Antiphon; see relevant comment below)

Sources: Ms Cryptensis Gr. E. α. V (13<sup>th</sup> c.), f.138r / Anastasimatarion of Ioannes Protosaltes (1863), 455

Liturgical text:

This sticheron is of additional interest as a poem because, it appears as a prosomoion in the fifteenth antiphon of the Good Friday Matins with a slightly differentiated text.<sup>398</sup> The variation is as follows:

Standard text :

Ὁ σταυρός σου, Κύριε,

ζωὴ καὶ ἀνάστασις ὑπάρχει τῷ λαῷ σου·

καὶ ἐπ' αὐτῷ πεποιθότες,

σε τὸν ἀναστάντα Θεὸν ἡμῶν ὑμνοῦμεν·

ἐλέησον ἡμᾶς.

“Triodion” version:

Ὁ σταυρός σου, Κύριε,

ζωὴ καὶ ἀντίληψις ὑπάρχει τῷ λαῷ σου·

καὶ ἐπ' αὐτῷ πεποιθότες,

<sup>398</sup> I should thank my supervisor Alexander Lingas for bringing to my attention this textual variant, which seems to exist only in Triodia (such as this one, E. α. V of the 13<sup>th</sup> c.).

σὲ τὸν σταυρωθέντα Θεὸν ἡμῶν ὑμνοῦμεν·  
ἐλέησον ἡμᾶς.

Trscr.5.6. Ἦνοιγησάν σοι, Κύριε, φόβῳ πύλαι θανάτου [Enoigesan soi, Kyrie, phobō pylai thanatou] -- Second Mode Sunday Vespers

Sources: Ms Parisinus Gr. 260 (14<sup>th</sup> c.) f.224v / Ms Anastasimatarion of Petros Lampadarios (1819-1821), f.9r

Liturgical text:

Ἦνοιγησάν σοι Κύριε, φόβῳ πύλαι θανάτου, πυλωροὶ δὲ ἄδου ἰδόντες σε ἔπηξαν· πύλας γὰρ χαλκᾶς συνέτριψας, καὶ μοχλοὺς σιδηροῦς συνέθλασας, καὶ ἐξήγαγες ἡμᾶς ἐκ σκοτόυς, καὶ σκιᾶς θανάτου, καὶ τοὺς δεσμοὺς ἡμῶν διέρρηξας.

Trscr.5.7. Ἐν τοῖς προφήταις ἀνήγγειλας ἡμῖν [En tois prophetais anengeilas hemin] – Pentecost Vespers

Sources: Ms Cryptensis Gr. E. α. V (13<sup>th</sup> c.), f.198r / Ms Triodion-Pentecostarion of Chourmouziος (1826), 138

Liturgical text:

Ἐν τοῖς Προφήταις ἀνήγγειλας ἡμῖν ὁδὸν σωτηρίας, καὶ ἐν Ἀποστόλοις ἔλαμψε, Σωτὴρ ἡμῶν, ἡ χάρις τοῦ Πνεύματός σου· σὺ εἶ Θεὸς πρῶτος, σὺ καὶ μετὰ ταῦτα, καὶ εἰς τοὺς αἰῶνας, σὺ εἶ ὁ Θεὸς ἡμῶν.

Additional information:

- The Ms *Triodion-Pentecostarion* of Gregorios Protopsaltes and Chourmouziος Chartophylax, is autograph of Chourmouziος (1826) from Constantinos Psachos Music Library (Gregorios the Protopsaltes' Archive, University of Athens, Greece).

Record No: Files K' & Λ'. Url: <https://pergamos.lib.uoa.gr/uoa/dl/object/110520>

- The Ms *Ἀναστασιματᾶριον κυρ Πέτρου Λαμπαδαρίου τοῦ Πελοποννησίου* [*Anastasimatarion of Kyr Petros Lampadariος the Peloponnesian*] (1819–1821) of the Euxeinos Club of Pontian [Εὐξεινίου Λέσχης Ποντίων] 52 (392 Σ) now in the National Library of Argypourpolis “Kyriakidis” (Naoussa, Greece - digitised by the Aristotelian University of Thessaloniki)

[*Ἀναστασιματάριον σύντομον κατὰ τὸ ὕφος τῆς μεγάλης ἐκκλησίας : / μελοποιηθὲν παρὰ κυρ Πέτρου Λαμπαδαρίου τοῦ Πελοποννησίου· ἐξηγηθὲν κατὰ τὸν νέον τῆς μουσικῆς τρόπον παρὰ Γρηγορίου Πρωτοψάλτου = Short Anastasimatarion according to the style of the Great Church, / composed by Kyr Petros Lampadarios the Peloponnesian; transcribed according to the new musical method by Gregorios Protopsaltes]*

Constantinou notes that it was corrected by Chourmouzos: see Georgios N. Constantinou (ed.), *Σύντομον Ἀναστασιματάριον Πέτρου Πελοποννησίου* (Ιερά Μεγίστη Μονή Βατοπαιδίου, 2022), *Βατοπαιδινή Μουσική Βίβλος – Μουσικολογικά Μελετήματα 3* [*Syntomon Anastasimatarion of Petros Peloponnesios* (Holy and Great Monastery of Vatopaidion, 2022), *Vatopaidion Musical Bible – Musicological Studies 3*], 35-36.

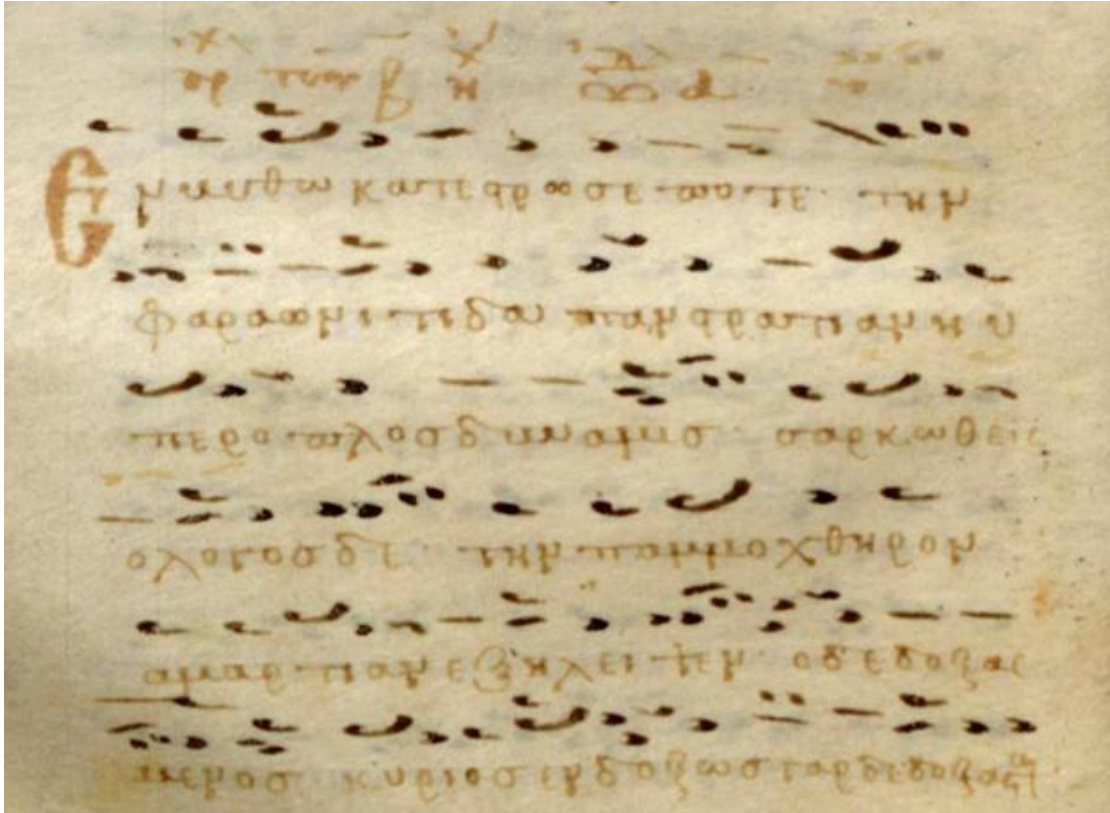
Trscr.5.2.

### Brief Comment

The Koukouzelian melody is transcribed a fifth lower (on the classical basis of the plagal Second) to facilitate comparison of contour to the 1825 melody. Byzantios (or in fact Chourmouzos, who transcribed it to the NM) uses pa / D as the basis of the troparion; however, this constitutes an exception, since the basis of the troparion is vu / mi♯ in almost all of the major editions of the Anastasimatarion by officials of the Patriarchate, namely Chourmouzos (!) himself (1832, 61)<sup>399</sup>, Constantinos (1839), Phocaeus (*Mousike Melissa*, 1847), and Ioannis (1863). Therefore in our transcription, we have restored the basis to E♯. Persistence of 1825 melody around A♯, compared to the 1302 melody.

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<sup>399</sup> Chourmouzos Chartophylax, *Néon Anastasimatarion* (*Neon Anastasimatarion*), ed. Theodoros Phōkaios (Constantinople [Galata]: British Press of Isaac de Castro, 1832), 61; Petros Lampadarios and Constantinos, Protopsaltēs of the Great Church of Christ, *Αναστασιματάριον ἀργόν* (*Anastasimatarion argon*), ed. Constantinos and Theodoros Papa-Paraschos Phocaeus (Constantinople: Printing House of the Ignatiades Brothers, 1839), 57; Theodoros P. P. Phocaeus, *Μουσική Μέλισσα, περιέχουσα τὸ ἀργὸν καὶ σύντομον Ἀναστασιματάριον* (*Mousikē Mélissa, periechousa to argon kai syntomon Anastasimatarion*), ed. Theodoros P. P. Phocaeus (Constantinople [Galata]: Castro Press, 1847), 81; Petros Lampadarios ho Peloponnēsios, *Αναστασιματάριον νέον ἀργὸν καὶ σύντομον* (*Anastasimatarion néon argon kai syntomon*), ed. Ioannis, Protopsaltēs of the Great Church of Christ (Constantinople: Typois Th. Dēmētziān, 1863), 70.



Ms Petropol. Gr. 121 f.30(29)v

ο το κον οι πι σοι με γα λυ υ νω μεν ἤχος. Πα.

**Ε** Ν θυ θω κα τερω σε πο τε Δ την Φα ρα ω

νι τι θα παν στρα τι αν η υ πε ροπλος θυ να μεις π

σαρ κω θεις ο λο γος δε Δ την παμ μο οχθηραν α

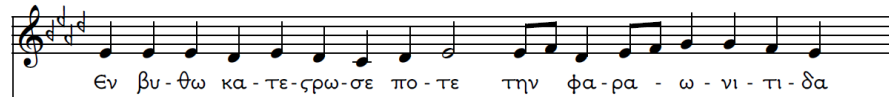
μαρ τι ι αν ε ξη λει ψεν π ο δε δο ξα σμε νος

Κυ ρι ος εν δο ξως γαρ δε δο ξα σαι Πα.

## Trscr.5.2. HEIRMOS

Ἐν βυθῷ κατέστρωσε ποτέ

[orig. ex B♭]

MS Petropolitanus  
Gr. 121 (1302)  
ἤχος μ=Heirmologion of  
Petros Byzantios  
(Constantinople, 1825)  
ἤχος μ= Πα<sup>α</sup>



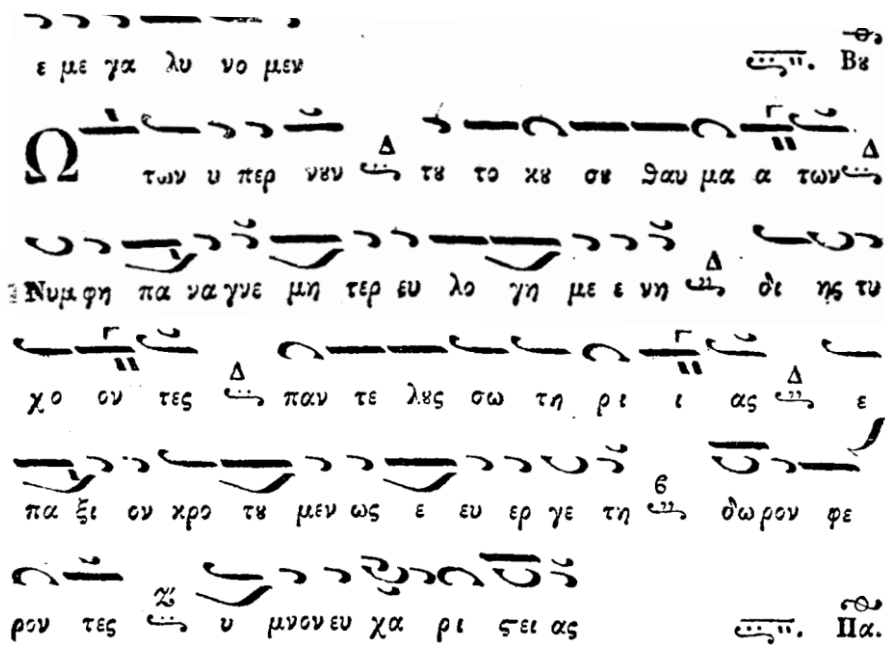
## Trscr.5.3

## Brief Comment

Similar melodic contour and range, though differentiation in finalis (1309 melody ends on the authentic's basis). Persistence of Koukouzelian melody around A $\flat$ , compared to the 1825 melody. The once occurring dissonant leap D $\flat$ -G, a relic of the older melopoiia, may turn pure easily by performer's initiative through a temporary elxis of D $\flat$  to D natural (a perfect fourth below G), to facilitate performance.



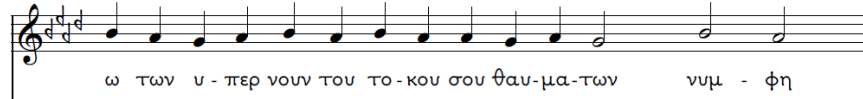
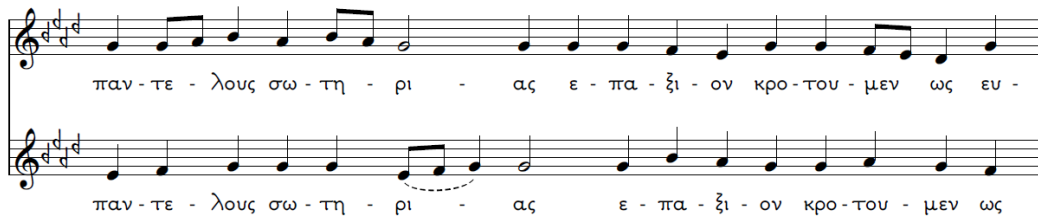
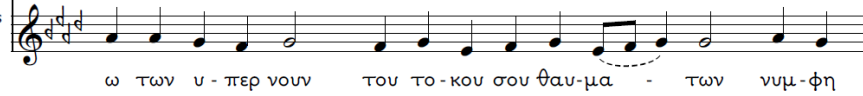
Ms Sin. Gr. 1256 f.47r-v



Heirmologion of Petros Byzantios (Constantinople, 1825), 56

## Trscr.5.3. HEIRMOS

Ὡ τῶν ὑπὲρ νοῦν

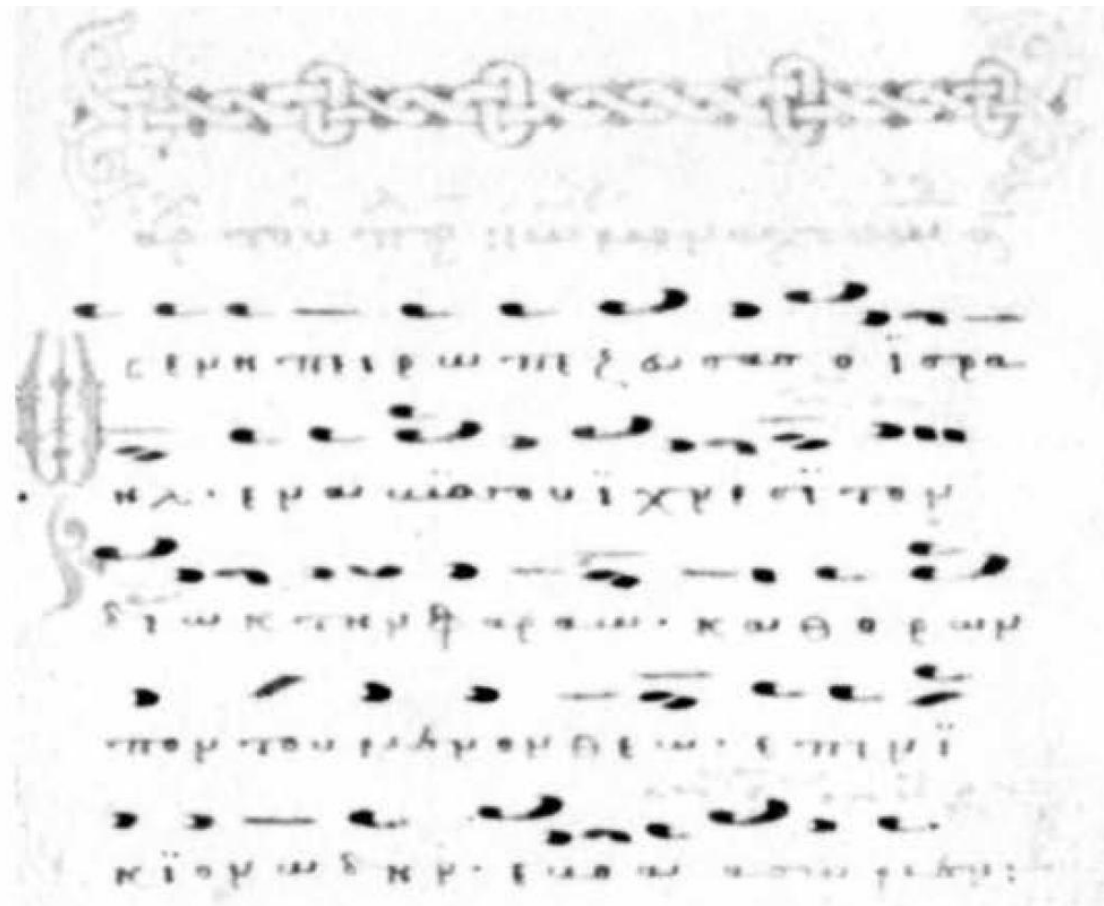
MS Sinaiticus  
Gr. 1256 (1309)  
ἦχος ὡHermologion of Petros  
Byzantios (1825)  
ἦχος ὡ→B♭→ε



Trscr.5.4

Brief Comment

Similar melodic contour, differentiation in finalis. 1825 melody does not rest on A♭.



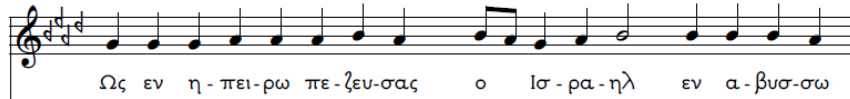
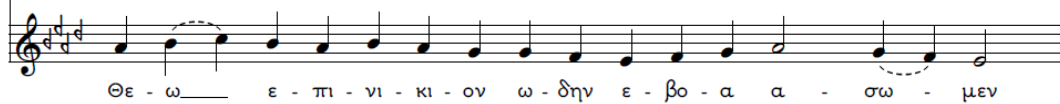
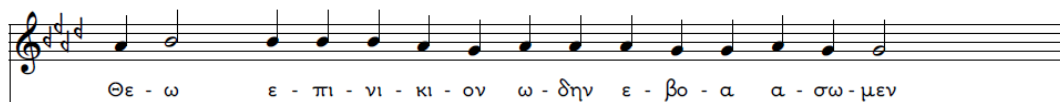
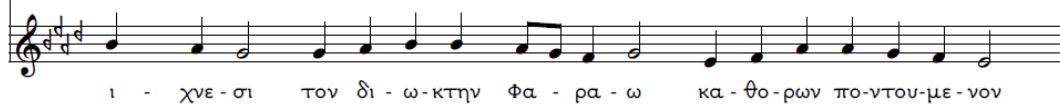
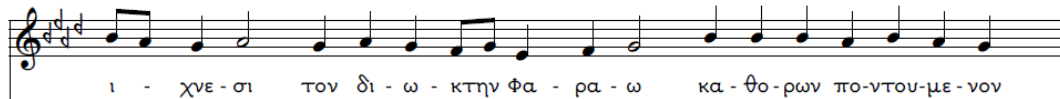
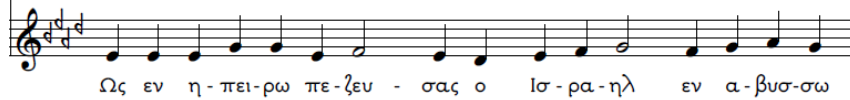
Ms Sinai. Gr. 1256 f.130r-v

Ωδή. α. Bv  
 ο σε θε ο το κε με γα λυ νο μεν ἦχος. λ.

Ως εν η πεε ρω πε ζευ σας ο Ι σρα ηλ εν α  
 βυσσω ι χνε σι τον δι ω κτην Φα ρα ω κα θο  
 ρων που τσ με νου θε ω ε πι νι κι εν ω θην ε  
 βο α α σω ω μεν Δ

## Trscr.5.4. HEIRMOS

ᾠδὸς ἐν ἠπείρῳ πεζεύσας ὁ Ἰσραήλ

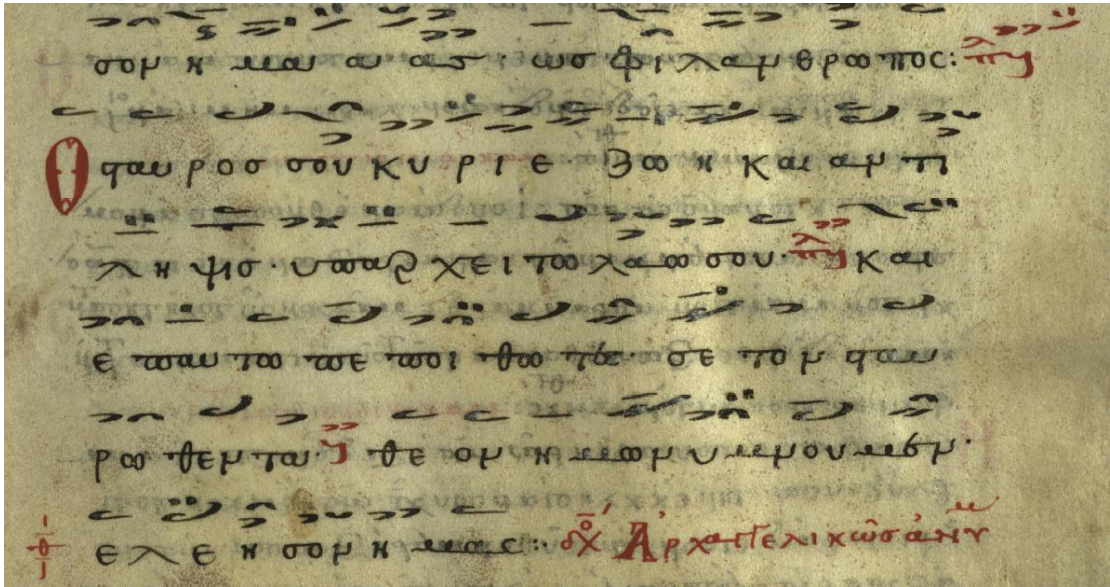
MS Petropolitanus  
Gr. 121 (1302)  
ἦχος βῆ-αHeirmologion of Petros  
Byzantios (1825)  
ἦχος βῆ-Ββ-α



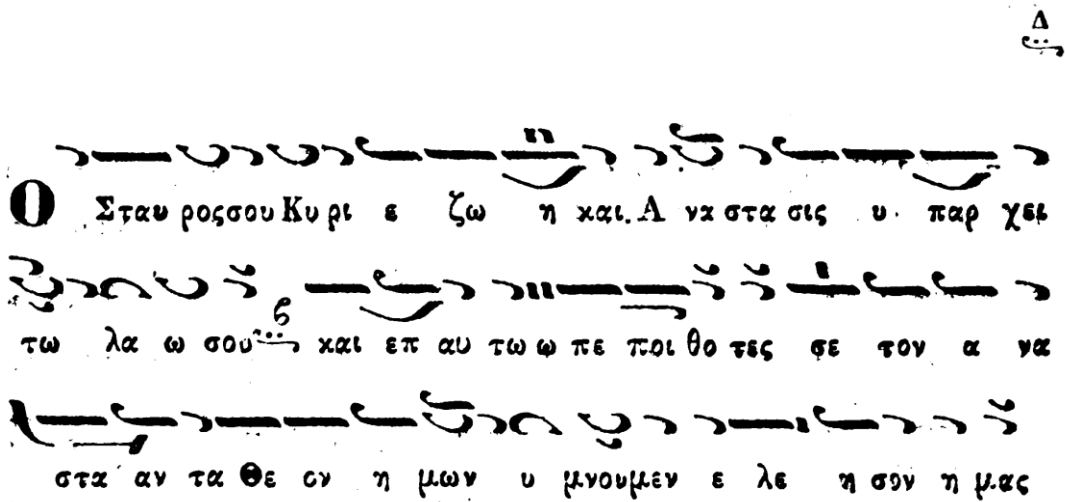
Trscr.5.5.

#### Brief Comment

Sticheraric melodies as this, generally retain more archaic features. However, we observe that the contour of the 13<sup>th</sup> c. melody is very similar to the 1825, with the exception of the earlier actively persisting around the fourth note of the plagal's tetrachord (here once more the tendency to A $\natural$  avoiding the G pseudo-tonic). Occurrence of the impure D-G leap in the 13<sup>th</sup> c. melody (see comment in Trscr.5.3).



Ms Cryptensis Gr. E.a.V f.138r



Anastasimatarion of Ioannes Protopsaltes (1863), 455

## Trscr.5.5. STICHERON

Ὁ Σταυρός σου, Κύριε [Ὁρθρος Κυριακῆς πλ.β' ἤχου / Ὁρθρος Μ. Παρασκευῆς - Ἀντίφωνον ΙΕ']

MS Cryptensis  
Gr. E. α. V (13th c.)  
ἤχος ζυ=

Anastasimatarion of  
Ioannes Protopsaltes (1863)  
ἤχος ζυ=δι=θ

Ο σταυ - ρος σου Κυ - ρι - ε ζω - η

Ο σταυ-ρος σου Κυ - ρι - ε ζω - η και α - να -

και α - ντι - λη - ψις υ - παρ - χει τω λα - ω σου και ε - παυ - τω

σα - σις υ - παρ - χει τω λα - ω σου και ε - παυ - τω πε - ποι -

πε - ποι - θο - τες σε τον σταυ - ρο - θε - ντα θε - ον η - μων

θο - τες σε τον α - να - στα - ντα θε - ον η - μων υ -

υ - μνου - μεν ε - λε - η - σον η - μας

μνου - μεν ε - λε - η - σον η - μας



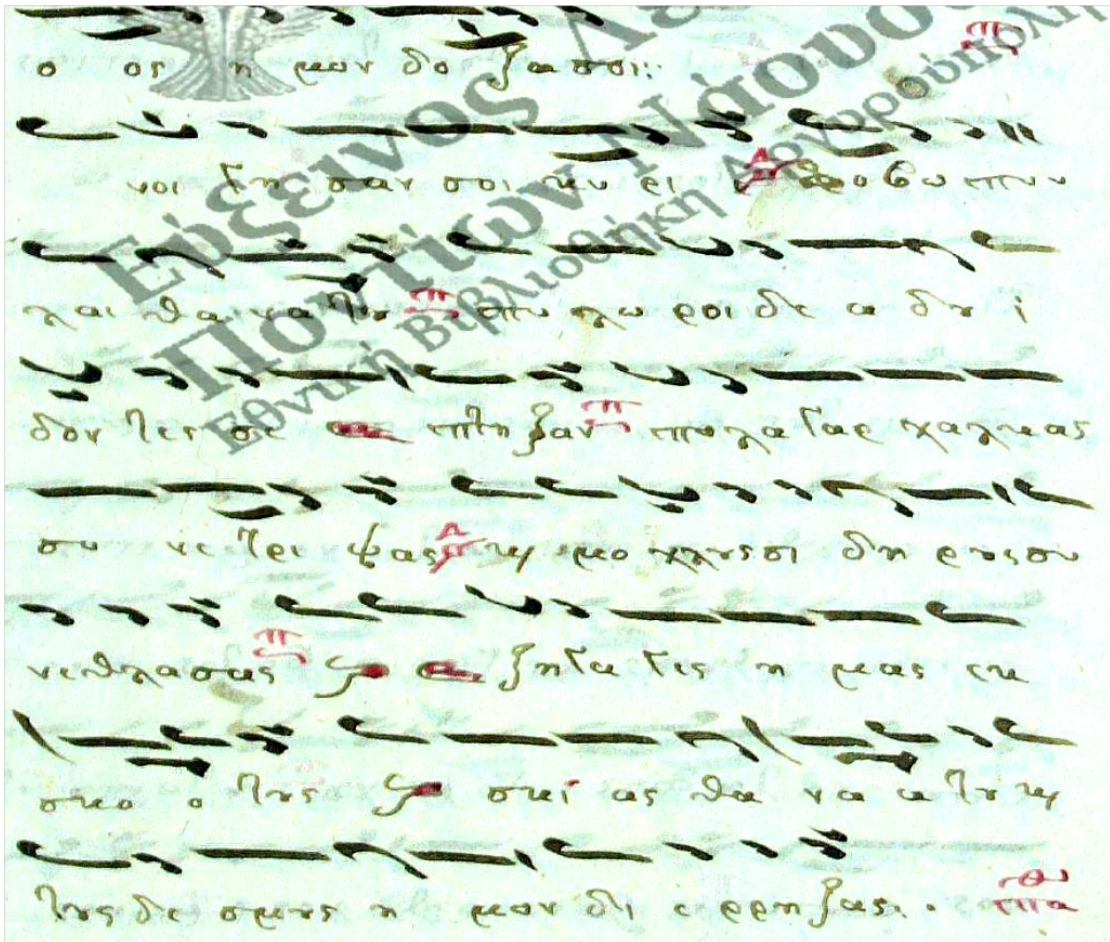
Trscr.5.6.

### Brief Comment

This troparion belongs to the Anatolika troparia of the Sunday Vespers. However, the contour of both melodies bears more similarities than differences. Older melody persisting once more around the fourth note of the plagal's tetrachord, A $\flat$ . In our transcription of Petros's syllabic melody, and for the sake of consistency with the classical basis of the mode, we retain E $\flat$  as the modal basis (instead of the pa / D in NM). This choice is supported not only by the classical basis, but additionally by the fact that the Chourmouzian correction of the soft-chromatic scale allows for the formation of a perfect tetrachord from the basis vu. Thus, our present transcription choice is justified and does not create structural intervallic problems.



Ms Parisinus Gr. 260 f.224v



Ms Anastasimatarion of Petros Lampadarios (1819-1821) f.9r

## Trscr.5.6. STICHERON

Ἦνοίγησάν σοι, Κύριε, φόβω πύλαι θανάτου (Ἐσπέρας Κυριακῆς β' ἡχοῦ)

MS Parisinus  
Gr. 260 (14th c.)  
ἡχος ᾠαMs Anastasimatarion of  
Petros Lampadariou  
(1819-1821)  
ἡχος ᾠα (Πα)

Η - νοι - γη - σαν σοι Κυ - ρι - ε φο - βω πυ - λαι θα - να -  
 Η - νοι - γη - σαν σοι Κυ - ρι - ε φο - βω πυ - λαι θα -  
 του πυ - λω - ροι δε Α - δου ι - δο - ντες σε ε - πτη - ζαν  
 να - του πυ - λω - ροι δε Α - δου ι - δο - ντες σε ε - πτη - ζαν  
 πυ - λας γαρ χαλ - κας συν - ε - τρι - ψας και μο - χλους σι - δη - ρους  
 πυ - λας γαρ χαλ - κας συν - ε - τρι - ψας και μο - χλους σι - δη - ρους συν - ε - θλα -  
 συν - ε - θλα - σας και ε - ξη - γα - γες η - μας εκ σκο - τους και  
 σας και ε - ξη - γα - γες η - μας εκ σκο - τους και σκι - ας θα - να -  
 σκι - ας θα - να - του και τους δε - σμους η - μων δι - ερ - ρη - ζας  
 του και τους δε - σμους η - μων δι - ερ - ρη - ζας



Trscr.5.7

### Brief Comment

Strikingly similar melodies once more, even though the melopoiia is sticheraric in style. Chourmouzos' setting is somewhat more melismatic.



## Trscr.5.7. STICHERON

Ἐν τοῖς προφήταις ἀγγέιλαις ἡμῖν (Ἑσπερινὸς Πεντηκοστῆς)

MS Cryptensis  
Gr. E. α. V (13th c.)  
ἦχος α-ε

MS Triodion-Pentecostarion  
of Chourmouziot (1826)  
ἦχος α-ε-ε

Ἐν τοῖς προ - φη - ταις ἀ - νηγ - γει - λας ἡ - μιν

Ἐν τοῖς προ - φη - ταις ἀ - νηγ - γει - λας ἡ - μιν

ο - δον σω - τη - ρι - ας καὶ ἐν α - πο - ρο - λοῖς

ο - δον σω - τη - ρι - ας καὶ ἐν α - πο - ρο - λοῖς

ἐ - λαμ - ψε σω - τηρ ἡ - μων ἡ χά - ρις τοῦ πνευ - μα - τος σου

ἐ - λαμ - ψε σω - τηρ ἡ - μων ἡ χά - ρις τοῦ

πνευ - μα - τος σου εἰ θε - ος πρῶ - τος

πνευ - μα - τος σου εἰ θε - ος πρῶ - τος

συ καὶ με - τα ταῦ - τα καὶ εἰς τοὺς αἰ - ῶ -

συ καὶ με - τα ταῦ - τα καὶ εἰς τοὺς αἰ - ῶ - νας

- νας συ εἰ ο θε - ος ἡ - μων

συ εἰ ο θε - ος ἡ - μων

### **Conclusions regarding the Transcriptions**

Taken together, the comparative transcriptions presented in Chapter 5 indicate a striking degree of continuity between pre-Koukouzelian, Koukouzelian, and nineteenth-century melodic repertories. In nearly all cases examined, the overall melodic contour and ambitus remain largely stable across periods, despite differences in notation, genre, and surface elaboration. The principal divergences concern not melodic shape but tonal focus, particularly the placement of the basis and the finalis. Earlier melodies frequently exhibit persistence around structurally significant internal degrees—most notably the fourth degree of the plagal tetrachord (NM: ke / staff: A♯)—whereas later Neo-Byzantine versions persist more around the medial Second (or, from the perspective of the plagal, the diphonos Second) on di / G in their regularized cadential organization. This pattern is especially evident in sticheraric repertory, traditionally associated with greater conservatism, where medieval melodies show sustained activity on internal focal tones that later versions either suppress or reinterpret.

## Conclusions

This chapter has examined selected heirmoi and stichera of the late thirteenth to early fourteenth centuries comparing them with their counterparts in the repertoires of the nineteenth century. Building on the historical, theoretical, and methodological foundations established in the preceding chapters, its aim was not to reconstruct a lost medieval soundscape, but to test whether a historically grounded intervallic framework—specifically the Chrysanthine diatonic system, applied with Chourmouzian correction—can function as a plausible *referential tuning model* for certain Koukouzelian-period melodies of the Second Modes.

The comparative transcriptions presented here demonstrate a striking degree of continuity in melodic structure across two (and even three if we add pre-Koukouzelian mele) broad chronological layers: Koukouzelian medieval sources, and the nineteenth-century Neo-Byzantine repertory. In nearly all cases examined, the fundamental parameters of melodic identity—contour, ambitus, phrase structure, and cadential articulation—remain recognizably stable, despite differences in notation, genre, and surface elaboration. Where divergences occur, they concern primarily the redistribution of modal weight and the stabilization of tonal reference points, rather than the invention of new melodic material.

A recurring feature of the medieval sources is the sustained melodic activity around internal focal degrees, most notably the fourth degree of the plagal Second tetrachord, which functions as a structurally significant point of melodic attraction. In later Neo-Byzantine realizations, this internal focus is increasingly regularized into a more explicitly diphonic organization, with cadential gravity shifting toward Di / Sol and the modal system articulated more systematically around stable bases and finals. This

process, already anticipated in Koukouzelian redactions, reflects not a rupture in melodic language but a gradual normalization of modal emphasis—precisely the type of development identified by Makris and Shkolnik in their respective studies of heirmologic and sticheraric repertoires.

The transcriptions further confirm that Koukouzelian *melopoiia* does not constitute the creation of a new repertory, but a reconfiguration of inherited melodic material. Expansion of ambitus, increased stepwise motion, redistribution of cadential weight, and the stabilization of secondary focal tones all operate within a modal logic that remains fundamentally continuous with earlier practice. These features align closely with the characteristics of the Second Mode as codified in Neo-Byzantine theory, reinforcing the view that nineteenth-century theoretical formulations articulate, rather than invent, long-standing perceptual and melodic tendencies.

Within this context, the application of Chrysanthine diatonic intervals to selected Koukouzelian melodies proves analytically viable. When employed as a heuristic framework rather than a prescriptive reconstruction, the Chrysanthine system is capable of sustaining the modal hierarchies, cadential intelligibility, and melodic syntax evident in the medieval sources without introducing structural contradiction. Its unequal step sizes and soft diatonic organization accommodate the stepwise motion, internal attractions, and gradual registral unfolding that characterize Second Mode melodies in both heirmologic and sticheraric repertoires.

Crucially, this study does not claim theoretical identity between Koukouzelian and Chrysanthine systems, nor does it assert that nineteenth-century tuning accurately reproduces fourteenth-century practice. Instead, it proposes the Chrysanthine framework as an *error-minimizing approximation*—a historically informed reference

model that allows medieval melodic behaviour to be realized with a high degree of internal coherence where direct evidence of tuning is unavailable. In this sense, the criterion of evaluation shifts from absolute historical correctness to modal plausibility: the preservation of structural relationships that would have been perceptually intelligible and functionally operative within the chant tradition.

The methodological choice to employ staff notation in this chapter serves this evaluative purpose. Used not as a translation of Byzantine chant into a Western theoretical idiom, but as an analytical tool, staff transcription makes visible relationships of contour, register, and cadential function that can be compared across historical layers. By bracketing rhythmic reconstruction and focusing instead on intervallic and modal behaviour, the transcriptions function as controlled analytical tests of tuning plausibility rather than as performative prescriptions.

Taken together, the findings of Chapter 5 support a broader conclusion with implications beyond the specific repertory examined. They suggest that continuity in Byzantine chant operates primarily at the level of modal perception and melodic syntax rather than at the level of fixed melodic texts or explicitly articulated tuning systems. The Second Mode emerges as a particularly revealing case, demonstrating how a stable modal logic can accommodate considerable melodic variability while remaining perceptually coherent across centuries.

In this light, the Chrysanthine intervallic system may be understood not as a retrospective imposition on medieval chant, but as a late theoretical crystallization of modal behaviours that were already operative in performance. Its use as a referential framework for Koukouzelian repertory is therefore justified not by claims of historical identity, but by demonstrable continuity in melodic organization and modal function.

The present chapter thus contributes to a performance-oriented understanding of Byzantine chant history, in which theory follows practice, and tuning systems are evaluated by their capacity to sustain the internal logic of the music they seek to explain.

## FINAL CONCLUSIONS

This thesis has addressed a fundamental epistemic problem in the study of Byzantine chant: how intervallic structure may be reasoned about responsibly in a musical tradition whose transmission is predominantly oral, whose notation does not encode quantitative pitch with precision, and whose theoretical sources are historically layered, heterogeneous, and often retrospective. Rather than attempting to reconstruct medieval intonation directly, the study has pursued a methodologically constrained approach, asking under what conditions a later, historically situated tuning system may function as a legitimate reference framework for analytical and performative engagement with selected medieval repertoires.

The central conclusion of the thesis is that the diatonic intervallic system articulated by Chrysanthos of Madytos in the nineteenth century—when applied with Chourmouzian correction—can be defended as a historically grounded, least-wrong reference tuning for specific late medieval Byzantine melodies, particularly within the Second Modes. This claim does not rest on assumptions of continuity by authority, nor on the projection of modern psaltic practice backward in time. Rather, it is supported by a convergence of independent constraints: the historical plurality of diatonic systems in Greek antiquity; the demonstrable persistence of asymmetric and neutral-step diatonicism across Arabic, Persian, and Ottoman theoretical traditions; the acoustic and organological plausibility of neutral intervals; and, most decisively, the capacity of the Chrysanthine framework to sustain coherent modality in controlled analytical tests of medieval melodies.

A key theoretical result of the dissertation is the clarification of diatonicism itself. The study has shown that diatonicism cannot be treated as a single fixed scale inherited intact from antiquity, but must be understood as a historically mobile family of intervallic organisations negotiated between arithmetic reasoning, perceptual continuity, instrumental constraints, and vocal practice. Within this field, Ptolemy's smooth diatonic emerges not as an eccentric theoretical specimen but as a structurally coherent and perceptually motivated model whose afterlife in the Eastern Mediterranean—particularly through its Zalzalian correction—forms a historically intelligible bridge to later Byzantine theory. Citation of Ptolemy by Byzantine theorists does not demonstrate performance practice -- we treat Ptolemy as one historically attested instance within a broader Eastern Mediterranean family of diatonic intervallic models. The methodological question we pursue is experimental: whether a tuning derived from this tradition can function as a coherent and historically plausible reference framework for interpreting medieval repertory. The congruence of this inheritance and the intervallic logic later formalised by Chrysanthos is therefore best explained as continuity of intervallic reasoning rather than as coincidence or late innovation.

The thesis has also redefined the problem of chromaticism in Byzantine chant. It has argued that medieval chromatic phenomena cannot be equated with the presence of fixed chromatic scales or augmented-second tetrachords, nor can they be read directly from notation. Instead, chromaticism emerges historically as a functional deviation or reconfiguration of an underlying diatonic disposition, comparable in structure to medieval Western notions of corruption and *vitium*. The nineteenth-century Byzantine theoretical distinction between hard chroma and a softer chromatic colouring—arising through redistribution of diatonic intervals rather than through non-diatonic

material—provides the conceptual key for resolving long-standing terminological confusion in both Byzantine and Western scholarship. This reframing constitutes a central conceptual contribution of the thesis.

The presence of *phthorai* in the manuscripts does not contradict our approach; on the contrary, it supports the thesis that chromaticism may arise through the reconfiguration of diatonic intervallic material rather than through a separate genus; the functional role of *φθοραί* as agents of systemic transposition is fully compatible with—and implicitly presupposed by—the methodological framework we adopt. We do not therefore in any way deny, minimise, or exclude the phenomenon of modal transposition (*μεταβολή κατὰ τόνον* / shift of mode = ἤχος), one discussed even in the earliest treatise to deal with Byzantine chant, the *Hagiopolites*.

We argue that the “chromaticism” of such systemic transpositions does not always need to involve tetrachords including a tri-semitone; the existence of transposition does not entail a specific tuning; it only entails relational movement within a system. Our claim concerns the plausibility of one such system, not the exclusion of others. Therefore, my argument is that—within the limits imposed by the sources—there is no positive contradiction in interpreting certain melodic types of the Second Modes through the soft diatonic Chrysanthine intervals (and not that Second Mode melodies were *inherently* or *exclusively* soft diatonic in practice). This interpretation is advanced not as a historical assertion of fact, but as a constrained and testable working hypothesis: it is accepted where it sustains modal coherence without forcing ad hoc or contradictory pitch decisions, and it remains open to revision where it does not.

Methodologically, the study has demonstrated the necessity of abandoning reconstructionist expectations in favour of a constrained inferential model. By introducing observational error theory as an explicit epistemic framework, the dissertation has argued that historical tuning systems should be evaluated not as true or false representations of the past, but as better or worse hypotheses under conditions of evidential underdetermination. Within this framework, the Chrysanthine system gains methodological weight not because it is authoritative, but because it minimizes contradiction across multiple domains: theoretical coherence, cross-cultural attestation, acoustic feasibility, and success in sustaining the modal grammar of the repertory under examination.

The analytical application of this framework in Chapter 5 confirms that the Chrysanthine diatonic system can, for a defined corpus of *heirmoi* and *stichera* of the Koukouzelian period, sustain melodic contour, ambitus, cadential articulation, and modal syntax without *ad hoc* intervallic interventions. Continuity across medieval and post-Byzantine witnesses is shown to operate primarily at the level of modal perception and melodic organisation rather than at the level of fixed pitch templates. In this light, the Chrysanthine system is best understood not as a retrospective imposition, but as a late theoretical crystallisation of modal behaviours already operative in performance.

In sum, this dissertation does not claim to have recovered a lost medieval tuning. Its contribution lies instead in articulating a disciplined, examinable method for moving from underdetermined notational evidence to historically grounded performance propositions. By reframing chroma, redefining the scope of diatonicism, and advancing a least-wrong inferential approach grounded in comparative theory and

musical testing, the study provides a model for future work on Byzantine chant that is both historically responsible and musically operational.

While the present study advances a historically grounded intervallic framework and tests it through selected medieval Second Mode case studies, it does not aim to exhaust the repertory or to provide a comprehensive catalogue of (pre-)Koukouzelian melodies to which Chrysanthine intervallic models might be applied. Extending the method to a broader range of sources—including additional heirmoi, stichera, automela, and earlier manuscript layers—would require systematic consultation of primary manuscript witnesses and further controlled transcriptional work beyond the scope of this thesis. Likewise, the application of the proposed framework to other modal families, repertorial strata, and performance contexts remains an open question, to be explored through continued analytical, comparative, and performance-based investigation. In this sense, the present study is intended not as a conclusive account of medieval Byzantine intonation, but as a methodological foundation for further research into the intervallic, modal, and perceptual dimensions of chant practice.

The argument developed in this thesis opens directly onto a programme of empirical and interdisciplinary research. If the non-identity between theoretical tuning, perceptual intonation, and vocal realisation is taken as foundational, then future work may profitably investigate the interaction between these domains through systematic measurement of contemporary psaltic performance. In particular, the comparison between (i) theoretically defined intervallic frameworks (e.g., Chrysanthine ratios), (ii) perceptual categorisation of pitch regions by trained singers, and (iii) acoustically measured vocal output offers a means of testing the extent to which historically grounded “reference tunings” correspond to, approximate, or diverge from realised

practice. Within this framework, the present thesis may be extended by integrating performance data, psychoacoustic analysis, and computational modelling, thereby refining the notion of a “least-wrong” tuning through measurable convergence between theoretical coherence, perceptual stability, and vocal realisation. Such an approach would not aim to collapse these domains into a single system, but to map their interactions more precisely, offering a more comprehensive account of intonation as a dynamic and historically conditioned phenomenon.

## APPENDIX

*A mathematically grounded methodological critique, employing reductio ad absurdum to expose the category error and systemic incoherence of the Committee's comma-based interval stacking used to "correct" Chrysanthos, thereby justifying the necessity of low-prime, historically stable intervallic frameworks.*

In Didymus's diatonic tetrachord,  $[9/8, 10/9, 16/15]$ , the difference between the two tones—the epogdoos ( $9/8$ ) and the epenatos ( $10/9$ )—yields the Didymean comma ( $\kappa$ ):  $9/8 \div 10/9 = 81/80$  (22 cents). While this specific ratio holds validly between these two tones for mathematically rigorous reasons, its transference to other intervals, as used by the Committee, constitutes a mathematical arbitrariness.<sup>400</sup>

Based on mathematics and intervallic mechanics, the Didymean comma ( $81/80$ ), elementary regulator of intonation, is not a simple marker of intervallic distance. Intervals, literally and metaphorically, are additive or subtractive quantities; in this instance, if distance  $A$  is decreased by  $d$ , then it becomes  $A-d$ ; if then distance  $A-d$  is decreased by  $d$  again, it becomes  $A-2d$ , and so on.

This is not the case with musical intervals, however, as their behavior is multiplicative in nature and must therefore be treated in terms of proportional factors. Therefore shrinking  $A$  by  $d$  gives  $A \div d$ , shrinking again by  $d$  gives  $A \div d^2$ , then  $A \div d^3$  and so on. Therefore, flattening by a Didymean comma  $\kappa$  gives  $A \div 81/80 = A \times 80/81$ , then descending by an extra Didymean comma down gives  $A \times 6400/6561$  and still an

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<sup>400</sup> I wish to thank Demetrios Lekkas for many hours of discussion that helped clarify this delicate mathematical matter.

extra Didymean comma down gives  $A \times 512000/531441$ . It should already be apparent why the multiplicative stacking of a numerically invariant intervallic distance is mathematically untenable, and why such an operation is not employed in music theory.

This pseudo-theory was proposed by the 1881 Committee, supposedly based on the work of ancient theorists, who in this way get subjected to misunderstanding. It is clear that the Didymean comma is a significant ratio in harmonic theory, as the stretch between an epenatos tone T ( $10/9$ ) and an epidecatos or grave tone T- or t ( $11/10$ ), both intervals of the harmonic series (easily accessible on natural trumpets and bugles); it is mathematically invalid however to accumulate it or use it in other instances. Indeed, going by a Didymean comma down from T:  $9/8$  gives T- or t:  $10/9$  (because  $9/8 \times 80/81 = 10/9$ ); but going another Didymean comma down will give T-- or t--:  $800/729$  (because  $10/9 \times 80/81 = 800/729$ ), and then still one more would yield T--- or t---:  $64000/59049$ . It should already be evident why this approach represents a slippery and ultimately arbitrary schematic, shaped by ideological presuppositions and resulting in an unmanageable numerical proliferation, given that the only excuses put forth are an acoustically valid rough impression of intervallic distance treating it as length -- which would be additive, while intervals are not.

To further illustrate this disorder, let us point out for instance that, distance-wise, a Didymean comma, product of the specific numerical setup as  $81/80$  (21.51 cents), is acoustically indistinguishable from a clearly theoretical schematic Pythagorean comma of  $3^{19}/2^{12}$  ( $531441/524288$ , 23.46 cents), which is the reason behind both of these intervals being called “commas”, both proportionately approaching about  $1/9$  of an epogdoos tone. It is also acoustically totally indistinguishable from its two next

superparticular fractions, i.e., the one before,  $80/79$  and the one after,  $82/81$ . What would be the result of selecting these for lowering the grave tone instead of  $81/80$ ? The following: i.  $10/9 \div 80/79 = 10/9 \times 79/80 = 79/72$ , ii.  $10/9 \div 82/81 = 10/9 \times 81/82 = 45/41$ . Although the results align far more closely with harmonic theory, they nevertheless remain schematic in nature.

Such interval ratios, being absolutely indistinguishable to the ear from  $800/729$ , are so much numerically better<sup>401</sup> and less dissonant and farfetched, except for one crucial factor: they introduce extra-systemic prime factors, as  $79/72$  involves prime factor 79, and  $45/41$  requires prime factor 41, introducing conceptual disorder to the systemic frames and limitations. We are thus faced with a stark alternative: either we accept unwieldy, highly dissonant—indeed anti-mathematical, anti-theoretical, and anti-Greek—numerators and denominators, following the suggestion of the Committee members, or we resign ourselves to extra-systemic and analytically intractable factors, thereby abandoning the very principles that led classical acoustic theory to articulate standard intervallic systems and to found music theory as a discipline. In such a scenario, the ear alone would remain the sole sufficient criterion.

However, this does not qualify as theory, since it relies predominantly on subjective empiricism without a coherent structural framework, leaving no room for numerical articulation; being in position to distinguish among fractions of  $800/729$ ,  $79/72$  or  $45/41$  seems rather improbable.

On the contrary, the basic structures rigorously giving us intervals *tonos ephendecatos* (minor)  $12/11$ , followed by *tonos epidecatos*  $11/10$ , have shown up repeatedly in

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<sup>401</sup> According to the small integer principle.

world history, by all sources as the ones we have demonstrated in Chapters 1 and 2 of the present thesis.<sup>402</sup>

It takes a minor correction for this system (9/8, 10/9, 11/10, 12/11) to purify the fourth inside its framework of a pure fifth and the intervals are converted to an ephendecatos 12/11, yet followed by a slightly smaller but identifiable epidecatos (minimal tone) 88/81; these are none other than the Chrysanthine intervals for a diatonic pentachord (2 major tones of 9/8, 12/11, and 88/81).

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<sup>402</sup> The intervals can clearly be heard in bass trumpets and end-blown flutes (trombones, tubas, Alphorns, Tibetan long trumpets and bugles, Andean flutes etc. etc.), and then in practically all aliquot folk flutes from every continent with phenomenal precision.

## BIBLIOGRAPHY

## Manuscripts

STICHERARIA, TRIODIA, PENTECOSTARIA, OKTOECHOI, ANASTASIMATARIA

- Athos, Monastery of the Great Lavra, Ms. γ 67.** Incomplete Triodion, Pentecostarion, and Oktoechos with Old Byzantine Chartres notation. 11th century.
- Athos, Monastery of the Great Lavra, Ms. γ 72.** Incomplete Triodion (beginning with Holy Week) and Pentecostarion with Old Byzantine Chartres notation. 11th century.
- Athos, Monastery of the Great Lavra, Ms. γ 74.** Incomplete Menaion (beginning with 24 October) with Old Byzantine Chartres notation. 11th century.
- Copenhagen, Det Kongelige Bibliotek, Ms. NkS 4960, 4<sup>o</sup>.** Complete Sticherarion with Menaion, Triodion, Pentecostarion, and Oktoechos with Middle Byzantine notation. 14th century.
- Grottaferrata, Biblioteca statale del Monumento nazionale, Ms. Crypt. E.a. II.** Sticherarion (Menaion), containing 746 stichera idiomela for all months of the Byzantine calendar. Late 13th century.
- Grottaferrata, Biblioteca statale del Monumento nazionale, Ms. Crypt. E.a. V.** Sticherarion (Triodion–Pentecostarion), containing 456 stichera idiomela and prosomoia for Lent and the Easter season; includes kalophonic-style items. 13th century.
- Naoussa (Greece), National Library of Argypoupolis “Kyriakidis,” Ms. 52 (392 Σ).** Ἀναστασιματάριον κυρ Πέτρου Λαμπαδαρίου τοῦ Πελοποννησίου (Anastasimatarion of Ky Petros Lampadarios the Peloponnesian), transcribed in the New Method by Gregorios Protopsaltes and corrected by Chourmouzius Chartophylax. 1819–1821.
- Paris, Bibliothèque nationale de France, département des Manuscrits, grec, Ms. 260.** Sticherarion. 14th century.
- Paris, Bibliothèque nationale de France, département des Manuscrits, grec, Ms. 360. Composite codex** Sticherarion and Menaion fragments; grammatical texts including Manuel Moschopoulos, *Schedographia*; and Hagiopolites / tractatus de musica ecclesiastica, ff. 216–237. 14th century.
- Saint Petersburg, National Library of Russia, Manuscript Department, Ms. Petropolitanus Gr. 674.** Sticherarion. ca 1270.
- Sinai, Saint Catherine’s Monastery, Ms. Gr. 1217.** Greek Sticherarion (Menaion only) with Old Byzantine Coislin notation. 11th–12th century.
- Sinai, Saint Catherine’s Monastery, Ms. Gr. 1219.** Greek Sticherarion (Menaion only; lacking beginning and end) with Old Byzantine Chartres notation. 11th century.
- Athens, National and Kapodistrian University of Athens, Library and Information Centre, K. A. Psachos Music Library Collection, Gregorios Protopsaltes Archive, Files K’ & Λ’.** Triodion–Pentecostarion, autograph of Chourmouzius Chartophylax (and Gregorios Protopsaltes). 1826.

HEIRMOLOGIA

- Athos, Monastery of the Great Lavra, Ms. β 32.** Incomplete Greek Heirmologion arranged in canon order (KaO) with Old Byzantine Chartres notation. 11th century.
- Grottaferrata, Biblioteca statale del Monumento nazionale, Ms. E.γ.II.** Heirmologion. 1281.
- Grottaferrata, Biblioteca statale del Monumento nazionale, Ms. E.γ.III.** Heirmologion in Old Byzantine Coislin notation; written in Southern Italy between the first and second quarter of the 12th century. Early 12th century.
- Paris, Bibliothèque nationale de France, fonds Coislin, Ms. 220.** Greek Heirmologion arranged in canon order (KaO) with Old Byzantine Coislin notation. 11th century.
- Saint Petersburg, National Library of Russia, Manuscript Department, Ms. Petropolitanus Gr. 121.** Notated Heirmologion. 1302.
- Sinai, Saint Catherine’s Monastery, Ms. Gr. 929.** Greek Heirmologion arranged in ode order (OdO) with Old Byzantine Coislin notation; palimpsest over pages of a former Tropologion. 12th century.
- Sinai, Saint Catherine’s Monastery, Ms. Gr. 1256.** Greek Heirmologion arranged in canon order (KaO) with Middle Byzantine notation. 1309.
- Sinai, Saint Catherine’s Monastery, Ms. Gr. 1257.** Greek Heirmologion arranged in canon order (KaO), with an anthology of Orthros and Great Vespers, in Middle Byzantine notation. 1332.

## KONTAKARIA, ASMATIKA, AND PSALTIKA

- Moscow, Gosudarstvenny Istorichesky Muzei (Государственный исторический музей), Ms. Sin. 777.** Sinodal'ny Kondakar'. 13th century.
- Moscow, Russian State Library (Российская государственная библиотека), Fond 304, Ms. 23.** Troitsky Kondakar' of the Trinity Lavra of Saint Sergius. ca 1200.
- Paris, Bibliothèque nationale de France, fonds grec, Ms. 397.** Incomplete Kontakarion (Prokeimena; stichologia for Christmas and Theophany; allelouaria; hypakoai anastasima; kontakia), in short psaltikon style, with Middle Byzantine round notation. Late 13th century.
- Rome, Biblioteca Apostolica Vaticana, Vat. gr. 1606.** Kontakarion–Psaltikon with Asmatikon (kontakia and hypakoai; allelouaria; prokeimena; koinonika), with Middle Byzantine round notation; Archimandritate of SS. Salvatore, Messina. 13th century.
- Rome, Biblioteca Apostolica Vaticana, Vat. gr. 345.** Kontakarion–Psaltikon (Prokeimena, allelouaria, hypakoai, kontakia) with Middle Byzantine round notation. About 1300.
- Sinai, Saint Catherine's Monastery, Ms. Gr. 925.** Kontakarion organised as a Menaion, Triodion (at least in part), and Pentecostarion. 10th century.
- Sinai, Saint Catherine's Monastery, Ms. Gr. 1280.** Psaltikon (Prokeimena, allelouaria, hypakoai, anti-cherouvikon for the Liturgy of Presanctified Gifts) and Kontakarion (Menaion with integrated movable cycle), with Middle Byzantine round notation; written in a monastic context. About 1300.
- Sinai, Saint Catherine's Monastery, Ms. Gr. 1314.** Psaltikon–Kontakarion (Prokeimena, allelouaria; kontakarion with integrated hypakoai; hypakoai anastasima; complete Akathistos hymn; kontakia anastasima; stichera heothina; appendix with refrains of the allelouaria in oktoechos order), written by the monk Neophyte. Mid 14th century.

## AKOLOUTHIAI AND ANTHOLOGIES OF THE PAPADIKE

- Athens, National Library of Greece (Ethnikē Vivliothēkē tēs Hellados), Ms. 2458.** Akolouthiai of Hagia Sophia, Constantinople: Ἀκολουθίαι συντεθειμέναι παρὰ τοῦ Μαῖστοροῦ κυροῦ Ἰωάννου τοῦ κουκουζέλη ἀπ' ἀρχῆς τοῦ μεγάλου ἑσπερινοῦ μέχρι καὶ τῆς συμπληρώσεως τῆς θείας λειτουργίας. 1336.
- Athens, National Library of Greece (Ethnikē Vivliothēkē tēs Hellados), Ms. 2061.** Akolouthiai of Hagia Sophia, Thessalonica. Early 15th century.
- Moscow, Russian State Library, Fond 304, Ms. 407.** Anthology including Irmologion in ode order (OdO), Voskresnik, and sanctoral cycle beginning with the Christmas cycle, in Old Church Slavonic with sematic notation. 1437.
- Vienna, Österreichische Nationalbibliothek, Cod. theol. gr. 185.** Βιβλίον σὺν Θεῷ ἀγίῳ περιέχον τὴν ἅπασαν ἀκολουθίαν τῆς ἐκκλησιαστικῆς τάξεως, compiled by Maistor Kyros Ioannes Koukouzeles of Thessalonica; with compositions associated with Koukouzeles, Ioannes; Korones, Xenos; and Kladas, Ioannes. ca 1400.

### Editions of Music Theory Treatises

- al-Fârâbî, Abû Nasr Mohammad ibn Farûkh. *Kitâb al-mûsiqî al-kabîr*. Transl. into French as *Grand traité de la musique*. In: d'Erlanger, *La musique Arabe I*, Paris, Paul Geuthner [in French].
- Aristides, Q. & Mathiesen, T. J. (1983). *On music, in three books*. New Haven: Yale University Press.
- Aristoxenus (1902). *The Harmonics of Aristoxenus: Edited with Translation, Notes, Introduction, and Index of Words* (trans. Henry Stewart Macran). Oxford: Clarendon Press.
- Aurelianus Reomensis. & Gushee L. (1975) *Musica Disciplina* (9<sup>th</sup> c.). Corpus Scriptorum de Musica 21. Rome: American Institute of Musicology
- Babb, W., Palisca, C. V., Hucbald, Guido, & Johannes. (1978). *Hucbald, Guido, and John on music: three medieval treatises*. New Haven: Yale University Press.
- Barbera, André. “Metabolē”. *Grove Music Online*. *Oxford Music Online*. Retrieved 21 October 2011.
- Barker, Andrew (1984). *Greek Musical Writings I: The Musician and His Art*. Cambridge: Cambridge University Press.
- Barker, Andrew (1989). *Greek Musical Writings II: Harmonic and Acoustic Theory*. Cambridge: Cambridge University Press.
- Barontini, Marco & Tonietti, Tiziana M. (2010). “Umar al-Khayyâm’s contribution to the Arabic mathematical theory of music.” *Arabic Sciences and Philosophy* 20(2), 255–280. <https://doi.org/10.1017/S0957423910000032>
- Bellermann, Johann Friedrich and Najock, Dietmar, eds. (1972). *Drei anonyme griechische Traktate über die Musik*. Göttingen: Hubert.
- Boethius, Anicius Manlius Torquatus Severinus. (1989). *De institutione musica liber III*; manuscript: Cambridge, Trinity College. [in Latin]. English Transl.: Bower Calvin D., *Fundamentals of music* (New Haven Connecticut, Yale University Press.
- Boyer, John M. *Byzantine Chant: The Received Tradition – A Lesson Book*. Portland, OR: Cappella Romana Publishing, 2023.
- Callinicos, Theodoulos. (1977). *Μέγα Θεωρητικὸν Ἐκκλησιαστικῆς Βυζαντινῆς Μουσικῆς* [Great theoretical treatise of ecclesiastical Byzantine music]. Nicosia.
- Chourmouziou Chartophylax, Georgios. (2014). *Εἰσαγωγή εἰς τὸ θεωρητικὸν καὶ πρακτικὸν τῆς Ἐκκλησιαστικῆς Μουσικῆς* [Introduction to the theoretical and practical aspects of Ecclesiastical Music]. Edited by Georgios N. Constantinou. Series: Vatopaidinē Mousikē Biblos – Musicologica Meletemata 2. Mount Athos: Holy Great Monastery of Vatopaidion.
- Chourmouziou, Stylianos. (1934). *Ὁ Δαμασκηνός, ἥτοι Θεωρητικὸν πλῆρες τῆς Βυζαντινῆς Μουσικῆς* [Damascene, or a complete theoretical treatise of Byzantine music]. Nicosia.
- Chrysanthos of Madytos (1821). *Εἰσαγωγή εἰς τὸ θεωρητικὸν καὶ πρακτικὸν τῆς Ἐκκλησιαστικῆς Μουσικῆς, συνταχθεῖσα πρὸς χρῆσιν τῶν σπουδαζόντων αὐτὴν κατὰ τὴν νέαν μέθοδον, παρὰ Χρυσάνθου τοῦ ἐκ Μαδύτων, Διδασκάλου τοῦ Θεωρητικοῦ τῆς Μουσικῆς* [Introduction to the theoretical and practical aspects of Ecclesiastical Music, composed for the use of those studying it according to the New Method, by Chrysanthos of Madytos, Teacher of the Theory of Music]. Paris: Rigniou.
- Chrysanthos of Madytos (1832). *Θεωρητικὸν μέγα τῆς μουσικῆς συνταχθὲν μὲν παρὰ Χρυσάνθου ἀρχιεπισκόπου Δυρραχίου τοῦ ἐκ Μαδύτων, ἐκδοθὲν δὲ ὑπὸ Παναγιώτου Γ. Πελοπίδου Πελοποννησίου διὰ φιλοτίμου συνδρομῆς τῶν ὁμογενῶν* [The Great theoretical treatise of music, composed by Chrysanthos, archbishop of Dyrrachion, from Madytos, and published by Panagiotis G. Pelopides the Peloponnesian through the generous subscription of compatriots]. Trieste: Michele Weis.
- Chrysanthos of Madytos (2007). *Θεωρητικὸν μέγα τῆς μουσικῆς: Τὸ ἀνέκδοτο αὐτόγραφο τοῦ 1816. Τὸ ἔντυπο τοῦ 1832* [The Great Theoretical Treatise of Music: the unpublished autograph of 1816; the printed edition of 1832]. Critical edition, ed. Georgios N. Constantinou. Athens: Holy Great Monastery Vatopedion.
- Chrysanthos of Madytos* (2010). *Great Theory of Music*. trans. Katy Romanou. New Rochelle, NY: Axion Estin Foundation.
- Cleonides (1965). “Harmonic introduction.” In Strunk, Oliver (ed.), *Source readings in music history*. Vol. 1: *Antiquity and the Middle Ages*. Translated by Oliver Strunk, 35–46. New York, NY: W. W. Norton.
- Conomos, Dimitri, ed. (1985). *The Treatise of Manuel Chrysaphes, the Lampadarios: On the Theory of the Art of Chanting and on Certain Erroneous Views that some hold about it [Περὶ τῶν ἐνθεωρουμένων τῆ ψαλτικῆ τέχνῃ καὶ ὧν φρουνοῦσι κακῶς τινες περὶ αὐτῶν]* (Mount Athos, Iviron Monastery MS 1120, July 1458). *Monumenta Musicae Byzantinae - Corpus Scriptorum de Re Musica 2*. Vienna: Verlag der Österreichischen Akademie der Wissenschaften.

- Constantinou, Georgios N. (1997). *Θεωρία και Πράξη της Ἐκκλησιαστικῆς Μουσικῆς*. [Theory and practice of Ecclesiastical Music] Athens: Nektarios D. Panagopoulos.
- Cserba, Simon M., ed. (1935). *Hieronymus De Moravia O.P.: Tractatus De Musica*. Regensburg: F. Pustet.
- d' Erlanger, Rodolphe. (1930-1959). *La Musique Arabe, 6 Tomes – I. [Al-Fārābī] (1930); II. [Al-Fārābī et Ibn Sīnā] (1935); III. [Commentaires Sur Le Livre Des Cycles de Safīyy-a-d-Dīn Al-Urmawī] (1938); IV. [Anon. – a-Sh-Shirwānī – et Al-Lādhiqī] (1939); V. [Échelles et Modes] (1949); VI. [Rythmes et Formes] (1959)*. 6 vols. Paris: Librairie orientaliste Paul Geuthner.
- Georgios the Lesbian (1840). *Εἰσαγωγή εἰς τὸ θεωρητικὸν καὶ πρακτικὸν τῆς μουσικῆς τέχνης τοῦ Λεσβίου συστήματος / συντεθεῖσα πρὸς χρῆσιν τῶν σπουδαζόντων αὐτὴν παρὰ Γεωργίου Λεσβίου τοῦ εὔρετοῦ τῆς μεθόδου* [Introduction to the theoretical and practical aspects of the musical art of the Lesbian system, composed for the use of those studying it by Georgios the Lesbian, the inventor of the method]. Athens: Printing House of L. Papadopoulos and I. Leonidis.
- Gerbert, Martin. (1963). *Scriptores ecclesiastici de musica sacra potissimum 3 vols (Vol. I)*. St. Blaise: Typis San-Blasianis, 1784: reprint, Hildesheim: Olms.
- Gerlach, Oliver. (2014). “The Heavy Mode (ēchos varys) on the Fret Arak’ — Eastern Chant in Istanbul and the Various Influences during the Ottoman Empire”. *Porphyra* 22: 82–95.
- Giannopoulos, Emmanouil St. (2011). *Θεωρητικὲς ὑπηγήσεις καὶ μουσικὲς κλίμακες Γρηγορίου τοῦ Πρωτοψάλτου* [Theoretical intonations and musical scales of Gregorios the Protopsaltēs]. Thessaloniki: University Studio Press.
- Guido and Pesce, D. (1999). *Guido d'Arezzo's Regule Rithmice, Prologus in Antiphonarium, and epistola ad Michahalem: a critical text and translation; with an introduction, annotations, indices, and new manuscript inventories*. Ottawa: Inst. of Mediaeval Music.
- Guido and Smits van Waesberghe, J. (1955). *Micrologus*. Nijmegen, Netherlands: American Institute of Musicology.
- Hannick, Christian and G. Wolfram, eds. (1985). *Gabriel Hieromonachus: Abhandlung über den Kirchengesang [Περὶ τῶν ἐν τῇ ψαλτικῇ σημαδιῶν καὶ τῆς τούτων ἐτυμολογίας]*. *Monumenta Musicae Byzantinae - Corpus Scriptorum de Re Musica I*. Vienna: Verlag der Österreichischen Akademie der Wissenschaften.
- Hannick, Christian and G. Wolfram, eds. (1997). *Die Erotapokriseis des Pseudo-Johannes Damaskenos zum Kirchengesang*. *Monumenta Musicae Byzantinae - Corpus Scriptorum de Re Musica 5*, Vienna: Verlag der Österreichischen Akademie der Wissenschaften.
- ibn Sīnā (Avicenna), Abū 'Āli al-Husayn ibn 'Abd-Allāh. (1935). *Kitābu 'š-šifā'*. Transl. into French as *Avicenne mathématiques*. In d'Erlanger, *La musique Arabe II, Al-Farabi, Grand traité de la musique, livre 3 et Avicenne, Mathématiques (Kitabu s-sifa')*. Paris, Paul Geuthner [in French].
- Jonker, Goverdus H. (1970). *The harmonics of Manuel Bryennius*. Groningen: Wolters-Noordhoff.
- Karas, Simon. (1982). *Μέθοδος τῆς Ἑλληνικῆς Μουσικῆς: Θεωρητικόν [Method of Greek Music: Theoretical Treatise]*. Athens: Σύλλογος πρὸς Διάδοσιν τῆς Ἐθνικῆς Μουσικῆς.
- Keltzanides, Panagiotēs. (1881). *Μεθοδικὴ διδασκαλία θεωρητικὴ τὲ καὶ πρακτικὴ πρὸς ἐκμάθησιν καὶ διάδοσιν τοῦ γνησίου ἐξωτερικοῦ μέλους τῆς καθ' ἡμᾶς Ἑλληνικῆς Μουσικῆς κατ' ἀντιπαράθεσιν πρὸς τὴν Ἀραβοπερσικὴν [Methodical theoretical and practical instruction for the learning and dissemination of the genuine external melos of our Greek music, in juxtaposition with the Arabo-Persian]*. Istanbul: A. Koromela & Sons.
- Levin, Flora R. (1994). *The manual of harmonics of Nicomachus the Pythagorean: translation and commentary*. Grand Rapids: Phanes Press.
- Nicomachus, Gerasenus. (1926). “Arithmētikē eisagōgē”. Transl. into English in D'Ooge Martin Luther, *Nicomachus of Gerasa, introduction to arithmetic, with notes by F.E. Robbins and L.C. Karpinski*. New York: The MacMillan Co., repr. 1938, Ann Arbor: University of Michigan Press.
- Oikonomos, Charalambous. (1940). *Βυζαντινῆς Μουσικῆς Χορδὴ* [The string of Byzantine Music]. Paphos.
- Papa Paraschos Phocaeus, Theodoros (1842). *Κρητὶς τοῦ θεωρητικοῦ καὶ πρακτικοῦ τῆς ἐκκλησιαστικῆς μουσικῆς. Συνταχθεῖσα, πρὸς χρῆσιν τῶν σπουδαζόντων αὐτὴν, κατὰ τὴν νέαν μέθοδον, παρὰ τῶν τριῶν ἐνδόξων Μουσικοδιδασκάλων, Κυρίου Χρυσάνθου Μητροπολίτου Προύσης, Κυρίου Γρηγορίου Πρωτοψάλτου τῆς τοῦ Χριστοῦ Μεγάλης Ἐκκλησίας, καὶ Κυρίου Χουρμουζίου Χαρτοφύλακος. Ἐκδεδομένη πρότερον μὲν διηγηματικῶς παρὰ Παναγιώτου Πελοπίδου· νῦν δὲ αὐτὴς εἰς τύπον ἐκδοθεῖσα κατ' ἐρωταπόκρισιν, μετὰ προσθήκης πολλῶν ἀναγκασιούτων τὰ μάλιστα εἰς φιλολογικὴν γνῶσιν, παρὰ Θεοδώρου Παπᾶ Παράσχου Φωκαέως, ἐπιστασία τοῦ*

- ιδίου και ἀναλώμασιν αὐτοῦ τε καὶ τῶν φιλομούσων συνδρομητῶν. Ἐν Κωνσταντινουπόλει. Ἐκ τῆς τοῦ Γένους ἡμῶν Πατριαρχικῆς Τυπογραφίας* [Foundation of the theoretical and practical instruction of ecclesiastical music. Compiled for the use of those studying it, according to the New Method, by the three illustrious Teachers of Music: Lord Chrysanthos, Metropolitan of Prussa; Lord Gregorios, Protopsaltis of the Great Church of Christ; and Lord Chourmouzios, Chartophylax. Previously published in narrative form by Panagiotis Pelopides; now again issued in print in question-and-answer form, with the addition of many other matters, especially those necessary for philological knowledge, by Theodoros Papa Paraschos of Phocaea, under his own supervision and at his own expense as well as that of the music-loving subscribers]. Constantinople: Patriarchal Printing House.
- Plato. (1939). *Timaeus*, ancient text with introduction, translation (into Modern Greek) and comments by Th. Vlyziotis and Ch. E. Papanastasiou, Library of Ancient Greek Writers and Poets, Athens Greece: Ioannis and P. Zacharopoulos [in Greek; dialogue composed c. 360 b.C.].
- Plutarch. (1865). *Περὶ Μουσικῆς* [Über die Musik]. Edited and Translated by Rudolf Westphal. Breslau: F. E. C. Leuckart. <http://archive.org/details/ploutarchouperi00westgoog>.
- Plutarch. (1900). *De la Musique*. [Περὶ Μουσικῆς]. Edited by Henri Weil and Théodore Reinach. Paris: Ernest Leroux. <http://gallica.bnf.fr/ark:/12148/bpt6k486063k>.
- Popescu-Județ, E. and Şirli, A. A., eds. (2000). *Sources of 18th Century Music: Panayiotis Chalatzoglou and Kyrillos Marmarinos' Comparative Treatises on Secular Music*. Pan Yayincılık. Istanbul: Pan.
- Ptolemy, Claudius. *Harmonics*. (1989). "Harmonic and acoustic theory". In Barker Andrew (Ed.), *Greek musical writings vol. ii: Cambridge Readings in the Literature of Music*. Cambridge University Press, 270-291.
- Raasted, Jørgen, ed. (1983). *The Hagiopolites: A Byzantine Treatise on Musical Theory*, Cahiers de l'Institut du Moyen-Âge Grec et Latin, 45, Copenhagen: Paludan | including Paris, Bibliothèque nationale de France, département des Manuscrits, grec, Ms. 360. Composite codex (Sticherarion and Menaion fragments; grammatical texts including Manuel Moschopoulos, *Schedographia*; and Hagiopolites / tractatus de musica ecclesiastica, ff. 216–237 - 14th century).
- Rameau, Jean-Philippe. (1971). *Treatise on harmony, translated, with an introduction and notes, by Philip Gossett*. Dover Publications Inc. [1st publication in French: 1722].
- Stephanos Lampadariou. (1875). *Κρήπις, ἥτοι Νέα στοιχειώδης διδασκαλία τοῦ θεωρητικοῦ καὶ πρακτικοῦ τῆς ἐκκλησιαστικῆς μουσικῆς* [Foundation, or New elementary instruction in the theory and practice of ecclesiastical music]. Constantinople: Patriarchal Printing House.
- Tannery, Paul, ed. (1940). *Quadrivium de Georges Pachymère, texte révisé et établi par R.P. Elpidios Stéphanou A.A.*, Studi e Testi 94. Città del Vaticano: Biblioteca Apostolica Vaticana [in Greek].
- Tillyard, Henry J. W. (1935). *Handbook of the Middle Byzantine Musical Notation. Monumenta Musicae Byzantinae, Subsidia 1*. Copenhagen: Levin & Munksgaard.
- Troelsgård, Christian. (2011). *Byzantine Neumes: A New Introduction to the Middle Byzantine Musical Notation. Monumenta Musicae Byzantinae, Subsidia 9*. Copenhagen: Museum Tusulanum Press.
- Weber, L. (2009). "Intellectual currents in thirteenth century Paris a translation and commentary on Jerome of Moravia's Tractatus de musica." PhD Thesis. Yale University.
- Zannos, Ioannis. (1994). *Ichos und Makam - Vergleichende Untersuchungen zum Tonsystem der griechisch-orthodoxen Kirchenmusik und der türkischen Kunstmusik. Orpheus-Schriftenreihe zu Grundfragen der Musik*. Bonn: Verlag für systematische Musikwissenschaft.
- Πατριαρχική Μουσική Ἐπιτροπή. (1888). *Στοιχειώδης διδασκαλία τῆς ἐκκλησιαστικῆς μουσικῆς ἐκπονηθεῖσα ἐπὶ τῇ βάσει τοῦ Ψαλτηρίου τῆς Μουσικῆς ἐπιτροπῆς τοῦ Οἰκουμενικοῦ Πατριαρχείου ἐν Κωνσταντινουπόλει ἐν 1883* [Elementary instruction in ecclesiastical music, composed on the basis of the Psalterion, by the Musical Committee of the Ecumenical Patriarchate in Constantinople, 1883]. Constantinople: Patriarchal Printing House.

## General Bibliography

- Adkins, Cecil. (1967). "The Technique of the Monochord." *Acta Musicologica*, 39(1/2), 34-43.
- al-'Alwajī, 'A. (1964). *Rā'id al-mūsīqā al-arabiyya* [Guide to Arab music], Baghdad.
- al-'Alwajī, 'A. (1975). *Al-murshid ilā al-nitāj al-musīqī*. Baghdad.
- Alexandrou, Maria. (1996). "Koukouzeles' Mega Ison: Ansätze einer kritischen Edition". *Cahiers de l'Institut du Moyen-Âge grec et latin* 66: 3–23.
- Alexandrou, Maria (2000). "Studie über die 'grossen Zeichen' der byzantinischen musikalischen Notation unter besonderer Berücksichtigung der Periode vom Ende des 12. bis Anfang des 19<sup>th</sup> c." PhD Thesis, 3 vols. University of Copenhagen.
- Alexandrou, Maria and Christian Troelsgård. (2013). "The Development of a Didactic Tradition – The Elements of the Papadike". *Tradition and Innovation in Late- and Postbyzantine Liturgical Chant II: Proceedings of the Congress held at Hernen Castle, the Netherlands, 30 October – 3 November 2008*. Leuven, Paris, Walpole: Bredius Foundation, Peeters. 1–57.
- Alexandrou, Maria. (2017). *Palaeography of Byzantine Music* [Undergraduate textbook]. Kallipos, Open Academic Publications. (Αλεξάνδρου, Μ., *Παλαιογραφία Βυζαντινής Μουσικής* [Προπτυχιακό εγχειρίδιο]. Κάλλιπος, Ανοικτές Ακαδημαϊκές Εκδόσεις, in Greek). <https://hdl.handle.net/11419/6487>.
- al-Faruqi, Lois Ibsen. (1985). "Music, musicians and Muslim law." *Asian Music*, 17 (1), 3–36.
- al-Naqshabandī, U. N. (1979). *Makhtūtāt al-mūsīqā wa-l-ghinā. wa-l-samā. fī maktabat almataf al-irāqī*. Baghdad.
- al-Naqshabandī, U. N. (1984). *Makhtūtāt al-mūsīqā wa-l-ghinā. al-muswwara fī qism almakhtūtāt bi-l-mu.assasa al-amma li-l-āthār wa-l-turāth*-Baḡdād., *al-Mawrid*, xiii/4, 117.26.
- Anglès, M. H. (1955). Latin chant before St. Gregory. In A. E. Hughes (Ed.), *Early medieval music, up to 1300*. London: Oxford University Press: 58-91
- Antoniou, Spyridon. (2004). *Το ειρμολόγιον και η παράδοση του μέλους του*. Μελέται 8. Αθήνα: Ίδρυμα Βυζαντινής Μουσικολογίας.
- Antonopoulos, Spyridon. (2014). *The Life and Works of Manuel Chrysaphes the Lampadarios, and the Figure of Composer in Late Byzantium*. PhD diss., City, University of London.
- Amargianakis, George (1977). *An Analysis of Stichera in the Deuterios Modes*. 2 vols. *Cahiers de l'Institut du Moyen-Âge Grec et Latin* 22–23. Copenhagen: Université de Copenhague.
- Amargianakis, George (1982). "The Chromatic Modes". *XVI. Internationaler Byzantinistenkongress: Akten II/7 = Jahrbuch der Österreichischen Byzantinistik* 32/7. Vienna: Verlag der Österreichischen Akademie der Wissenschaften. 7–17.
- Amargianakis, George (1997). "The Interpretation of the Old Sticherarion". In *Byzantine Chant: Tradition and Reform. Acts of a Meeting held at the Danish Institute at Athens in 1993*, edited by Christian Troelsgård. Athens: Danish Institute at Athens. 23–51.
- Apel, Willi. (1956). "The Central Problem of Gregorian Chant." *Journal of the American Musicological Society* 9(2), 118-127.
- Aristotle. (2017). *Politics: A new translation* (C. D. C. Reeve, Trans.). The New Hackett Aristotle. Indianapolis; Cambridge: Hackett Publishing Company
- Arvanitis, Ioannis. (1997). "A Way to the Transcription of Old Byzantine Chant by means of Written and Oral Tradition." In C. Troelsgård, ed. *Byzantine Chant — Tradition and Reform: Acts of a Meeting*, held at the Danish Institute at Athens, 1993. Monographs of the Danish Institute at Athens. Athens: Danish Institute at Athens, 123–141.
- Arvanitis, Ioannis. "A Personal Profile." In *Anáil Dé / The Breath of God: Music, Ritual and Spirituality*, edited by Helen Phelan. Limerick: Irish World Music Centre, University of Limerick, 2001. Reproduced by permission. <https://www.ivanmoody.co.uk/arvanitis.htm>
- Arvanitis, Ioannis. "Phthora and Chromaticism in Early and Late Byzantine Chant." Unpublished paper presented at the meeting of the international research group *Cantus Planus*, within the 17<sup>th</sup> International Congress of the International Musicological Society, Leuven, Belgium, August 1–8, 2002.
- Arvanitis, Ioannis (2003). "The rhythmical and metrical structure of the Byzantine heirmoi and stichera as a means to and as a result of a new rhythmical interpretation of the Byzantine chant." *Acta Musicae Byzantinae*, vol. VI: 15–29.
- Arvanitis, Ioannis. "Intervals in Medieval Byzantine Chant: A Hypothesis Formulated on Early and Later Evidence." Unpublished paper presented at the 12<sup>th</sup> Conference of the Study Group *Cantus Planus*, Lillafüred, Hungary, August 23–28, 2004.
- Arvanitis, Ioannis. (2005), "On Chrysanthos' Diatonic Scale," online article: <http://analogion.com/site/pdf/Chrysanthos-Intervals-Arvanitis-2005.doc>

- Arvanitis, Ioannis. (2011). “Ο ρυθμός των εκκλησιαστικών μελών μέσα από τη παλαιογραφική έρευνα και την εξήγηση της παλαιάς σημειογραφίας” [The Rhythm of the Ecclesiastic Chants through the Paleographic Research and the Transcription of the Old Notation]. PhD Thesis 2010, Corfu: Ionian University. Available at: <http://phdtheses.ekt.gr/eadd/handle/10442/21885> [accessed January 20, 2025].
- Arvanitis, Ioannis. (2022). “The transcriptions of the Three Teachers: an old or a new sound?”. *Epistēmēs Metron Logos*, (5). <https://doi.org/10.12681/eml.28005>
- Arvanitis, Ioannis. “On the Second Modes: History, Practice and Theory” (unpublished notes), n.d.
- Atkinson, Charles M. (1990). “From *vitium* to *tonus acquisitus*: On the Evolution of the Notational Matrix of Gregorian Chant.” In L. Dobszay (Ed.), *Cantus planus: papers read at the third meeting, Tihany, Hungary, 19-24 September 1988*. Budapest: Hungarian Academy of Sciences Institute for Musicology: 181-197.
- Atkinson, Charles M. (2001). “The other "modus:" on the theory and practice of intervals in the eleventh and twelfth centuries.” In P. Jeffery & K. Levy (Eds.), *The study of medieval chant: paths and bridges, east and west: in honor of Kenneth Levy*. Woodbridge, Suffolk: Boydell Press. 233-255.
- Atkinson, Charles M. (2009). *The Critical Nexus. Tone-System Mode and Notation in Early Medieval Music*. Oxford University Press.
- Atkinson, Charles M., co-authored with G. Wolfram (2022). “Über den Wechsel der Tonarten im östlichen und westlichen Gesang: Techniken, Texte und Rhetorik,” *Beiträge zur Gregorianik* 74: 27-85.
- Atkinson, Charles M. (2023). “On Modulation in Early Medieval Chant: The φθοραί in Byzantium and the *vitia* in the West,” *Études grégoriennes*: 35-50.
- Atkinson, Charles M. (2024). “On Modulation in Early Medieval Chant in East and West,” in *Musikkontakt und -transfer zwischen Byzanz und dem lateinischen Westen (5.-12. Jahrhundert)*, ed. Susanne Rühling und Klaus Pietschmann, *Musiktheorie* 39: 25-35.
- Atkinson, Charles M. “On Modulation in Eastern and Western Chant”: Contribution to Athens IMS Roundtable”. Translation, Transformation, and Mediation in Christian Music of the Eastern Mediterranean Region," to be published in *Plainsong and Medieval Music* [in press].
- Atkinson, Charles M. “On Modulation in Medieval Chant in Byzantium and the West: Techniques, Texts, and Rhetoric,” *The Music is the Message: Essays in Honour of James Norman Grier* [in press].
- Azar, Rosy. (2025). “Byzantine theories of scale and Arab-Byzantine chant practices: A comparative analysis proposing a new resolution to the theoretical system of Chrysanthos of Madytos.” *Yale Journal of Music & Religion* 11, no. 2: 32–53. <https://elischolar.library.yale.edu/yjmr/vol11/iss2/2/>.
- Bailey, Terence. (1983). *The Ambrosian Alleluia*. London: Unwin Brothers Ltd.
- Bailey, Terence and Paul Merkley. (1989). *The Antiphons of the Ambrosian Office*. Vol. 50. Musicological Studies. Ottawa: Institute of Mediaeval Music.
- Bailey, Terence (2001). “Ambrosian chant”. In *Grove Music Online*, ed. L. Macy. Oxford: Oxford University Press. DOI: 10.1093/gmo/9781561592630.article.00754.
- Bailey, Terence. (2008). “A Lost Ambrosian Antiphoner of Southern Italy.” *Plainsong and Medieval Music* 17: 1-22.
- Balageorgos, Demetrios. (2008). “Εκκλησιαστική μουσική στην Κωνσταντινούπολη” [Ecclesiastical Music in Constantinople], *Εγκυκλοπαίδεια Μείζονος Ελληνισμού, Κωνσταντινούπολη*: <<http://www.ehw.gr/l.aspx?id=11048>>
- Barbera, André. “Metabolē”. *Grove Music Online. Oxford Music Online*. Retrieved 21 October 2011.
- Barbour, J. M. (1951). *Tuning and temperament, a historical survey*. East Lansing: Michigan State College Press.
- Barillari, Vito (2011). “Gli sticheraria Crypt. E.α. II e Crypt. E.α. V : sulla datazione e localizzazione dei codici.” *Bollettino della Badia Greca di Grottaferrata* (Terza serie) 8 : 5–50.
- Barker, Andrew (2000). *Scientific Method in Ptolemy’s Harmonics*. Cambridge: Cambridge University Press.
- Barker, Andrew (2007). *The Science of Harmonics in Classical Greece*. Cambridge: Cambridge University Press.
- Barrett, Sam. (2008). “Reflections on music writing : coming to terms with gain and loss in early medieval Latin song.” In A. Haug & A. Dorschel (Eds.), *Vom Preis des Fortschritts: Gewinn und Verlust in der Musikgeschichte* (pp. 89-109). Wien: Universal Edition.
- Bartlett, Robert. (1993). *The making of Europe: conquest, colonization, and cultural change, 950-1350*. Princeton, N.J.: Princeton University Press.

- Baud-Bovy, Samuel. (1982). "Bourgault-Ducoudray et La Musique Grecque Ecclésiastique et Profane." *Revue de Musicologie* 68, no. 1/2 (January 1): 153–63. <https://doi.org/10.2307/928286>.
- Baud-Bovy, Samuel. (1986). "Le 'Genre Enharmonique' a-t-Il Existé ?" *Revue de Musicologie* 72, no. 1 (January 1, 1986): 5–21. <https://doi.org/10.2307/928769>.
- Bell, John L. (2005). "Divergent conceptions of the continuum in 19th and early 20th century mathematics and philosophy." *Axiomathes*, 15(1), 63-84.
- Benson, Dave J. (2007). *Music: a mathematical offering*. Cambridge: Cambridge University Press.
- Bent, I. D., Hughes, D. W., Provine, R. C., Rastall, R., Kilmer, A., Hiley, D., Chew, G. (2001). Notation (Publication no. <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/grove/music/20114>). Retrieved January 1, 2026
- Berkey, Jonathan P. (2003). *The formation of Islam: Religion and society in the Near East, 600–1800*. Cambridge: Cambridge University Press.
- Bernard, Philippe. (1996). *Du chant romain au chant grégorien (IVe-XIIIe siècle)*. Patrimoines. Christianisme. Paris: Éditions du Cerf.
- Bernhard, Michael. (1990). *Das musikalische Fachschrifttum im lateinischen Mittelalter*. Darmstadt: Wissenschaftliche Buchgesellschaft.
- Bevington, Philip R., and K. D. Robinson (2003). *Data reduction and error analysis for the physical sciences*. 3rd ed. Boston: McGraw-Hill.
- Beyhom, Amine, and Hamdi Makhoul (2009). "Fretage du 'Ūd (luth arabe) dans la théorie musicale arabe et influence sur la pratique." *The fifth Conference on Interdisciplinary Musicology (CIM09)*. <https://hal.science/hal-01446756v1>
- Beyhom, Amine. (2011), "Two common errors about the proportions of the 'Ūd," in *The 'ūd from its earliest sources to modern times, in the Near-East*, ed. Richard Dumbrill, 81–110, online, <https://hal.science/hal-01446781v1>
- Beyhom, Amine (2012). "Un lexique de la modalité." *NEMO-Online* 2 (1): 5–24. <https://hal.science/hal-01447269v1>
- Beyhom, Amine. (2015). *Théories et pratiques de l'échelle dans le chant byzantin arabe: Une approche comparative et analytique proposant une solution inédite pour le système théorique de Chrysanthos le Madyte*. Broummana (Liban): Par l'auteur.
- Beyhom, Amine. (2016). "Dossier: Hellenism as an Analytical Tool for Occidentism (in Musicology) (V2)." *Near Eastern Musicology Online* 3, no. 5 (November): 53–275. [http://nemo-online.org/wp-content/uploads/2017/02/\(V2-INTERNET\)%205-04.%20Article%20NEMO%20n%C2%B05%20Amine%20Beyhom%20170219S.pdf](http://nemo-online.org/wp-content/uploads/2017/02/(V2-INTERNET)%205-04.%20Article%20NEMO%20n%C2%B05%20Amine%20Beyhom%20170219S.pdf).
- Beyhom, Amine. (2017). "A Hypothesis for the Elaboration of Heptatonic Scales." *Near Eastern Musicology Online* 4, no. 6 (November): 5–89. <http://nemo-online.org/wp-content/uploads/2017/05/INTERNET-6-01.-Article-NEMO-no.-4-6-1-Amine-Beyhom-Hypothesis-170501.pdf>.
- Beyhom, Amine (2019). "The lost art of maqām." *NEMO-Online* 5(8): 5-64. <https://hal.science/hal-03108178v1>
- Beyhom, Amine. (2020). "Theory and Practice of Psaltiki: Why do they not coincide?" In «...έν έπιγνώσει ύμνουϊνάς Σε...»: Προϋποθέσεις και Δεξιότητες για την Ίερά Ψαλμωδία στην Όρθόδοξη Λατρεία ["...chanting consciously in praise to Thee": Prerequisites and skills for sacred chanting in Orthodox worship], [Πρακτικά] 3ο Διεθνές Μουσικολογικό και Ίεροψαλτικό Συνέδριο (Volos, 30 May–2 June 2018), 629–669. Volos: Έκδοτική Δημητριάδος.
- Beyhom, Amine. (2020). "Byzantine Chant Theory and Practice in the Light of Ancient Greek Music Theory and Occidentism." *Series Musicologica Balcanica* 1(1), 56-85. doi:<https://doi.org/10.26262/smb.v1i1.7629>
- Bohman, Philip V. (1987). "The European Discovery of Music in the Islamic World and the 'Non-Western' in 19th-Century Music History." *The Journal of Musicology* 5, no. 2 (April 1): 147–63. <http://www.jstor.org/stable/763849>.
- Bomm, Urbanus. (1929). *Der Wechsel der Modalitätbestimmung in der Tradition der Meßgesänge im IX. bis XIII. Jahrhundert und sein Einfluß auf der Tradition ihrer Melodien*. Einsiedeln.
- Boone, Graem, ed. (2023). *Music in the Carolingian World Witnesses to a Metadiscipline: Essays in Honor of Chales M. Atkinson*. Brepols.
- Boretius, Alfredus, ed. (1883). *Monumenta Germaniae Historica: Legum sectio II: Capitularia regum Francorum I*. Hannover: Hahn.
- Bourgault-Ducoudray, Louis-Albert. (1877). *Études sur la musique ecclésiastique grecque : mission musicale en Grèce et en Orient – Janvier-Mai 1875*. Paris: Hachette et Cie.

- Bourgault-Ducoudray, Louis-Albert. (1878). *Souvenirs d'une mission musicale en Grèce et en Orient*. Paris: Hachette, 1878.
- Bower, Calvin M. (1978). "Boethius and Nicomachus: An Essay Concerning the Sources of *De institutione musica*", *Vivarium* XVI/1: Leiden, 1–45.
- Bower, Calvin. M. (1984). "The Modes of Boethius." *Journal of Musicology*, 3(3), 252-263.
- Bower, Calvin M. (2002a). "'Adhuc ex parte et in enigmata cernimus...': reflections on the closing chapters of *Musica enchiridis*." In *Music in the mirror: Reflections on the history of music theory and literature for the twenty-first century*, ed. Andreas Giger and Thomas J. Mathiesen, 21–44. Lincoln: University of Nebraska Press.
- Bower, Calvin. M. (2002b) "The Transmission of Ancient Music Theory into the Middle Ages." In *The Cambridge History of Western Music Theory*. Ed. Thomas Christensen. Cambridge: Cambridge UP: 136-67.
- Burkert, Walter (1972). *Lore and science in ancient Pythagoreanism*. Cambridge, MA: Harvard University Press. Translated by Edwin L. Minar Jr.
- Burns, E. M. (1982). Intervals, scales, and tuning. In D. Deutsch (Ed.), *The Psychology of music* (pp. 215-264). New York: Academic Press.
- Cameron, Averil (2014). *Byzantine matters*. Princeton: Princeton University Press.
- Chaldaeakes, Achilleas G. (2017). "A New Reading of John Laskaris's *Explanation and Modulation of the Musical Art: Towards a Critical Edition of Laskaris's Theoretical Treatise*." In *Aspects of Christian Culture in Byzantium and Eastern Christianity: Word, Sound and Image in the Context of Liturgical and Christian Symbolism*, edited by Vesna Sara Peno and Ivan Moody, 55–84. Belgrade: Publications of the Institute of Musicology of the Serbian Academy of Sciences and Arts – Publications of the International Society for Orthodox Church Music no. 8.
- Chaldæakes, Achilleas G., Socrates Loupas, and Evangelia A. Chaldæaki. (2021). "Uses of the New Method of the Byzantine Notation: Historico-musicological testimonies from K. A. Psachos's archive." *Epistēmēs Metron Logos* 6, 1–118. <https://doi.org/10.12681/EML.27256>.
- Chalmers, John H. (1993). *Divisions of the tetrachord: A prolegomenon to the construction of musical scales*. Hanover, NH: Frog Peak Music.
- Chalmers, John H. (2016). "Harmonic scales." *The STEAM Journal* 2 (2). <https://scholarship.claremont.edu/steam/vol2/iss2/10>
- Charalabopoulos, Nikos G. (2012). *Platonic Drama and Its Ancient Reception* (Cambridge: Cambridge University Press)
- Chartier, Yves. (2001). "Hucbald of St Amand." (Publication no. <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/grove/music/13475>). Retrieved February 2, 2016, from *Oxford Music Online*. Oxford University Press.
- Chatzegiacomou, Manoles K. (1975). *Μουσικά χειρόγραφα Τουρκοκρατίας (1453–1832)* (Musical manuscripts of the Ottoman period, 1453–1832). Athens: [s.n.].
- Christensen, Thomas. S. (2002). *The Cambridge history of Western Music Theory*. Cambridge: Cambridge University Press.
- Chartophylax, Chourmouziou. (1832). *Νέον Αναστασιματάριον* [New Anastasimatáron]. Edited by Theodoros Phocaeus. Constantinople (Galata) : British Press of Isaac de Castro.
- Ciobanu, Gheorghe (1984). "Sur l'ancienneté du genre chromatique dans la musique byzantine." In *Études de musique ancienne roumaine*. Bucarest: Editura Muzicală, 93-99.
- Cohen, David. E. (2001). "Notes, Scales, and Modes in the Earlier Middle Ages". In T. S. Christensen (Ed.), *The Cambridge History of Western Music Theory*, 307-363. Cambridge: Cambridge University Press.
- Colette, Marie-Noël. (1995). "Grégorien et vieux-romain: deux différentes méthodes de collectage de mélodies traditionnelles?" In *Laborare Fratres in Unum: Festschrift Laszlo Dóbszay zum 60. Geburtstag*, ed. Janka Szendrei and David Hiley, 37–52. Spolia Berolinensia 7. Hildesheim: Weidmann.
- Conomos, Dimitri E. (1974). *Byzantine Trisagia and Cheroubika of the Fourteenth and Fifteenth Centuries*. Thessaloniki: Institute of Byzantine Musicology.
- Conomos, Dimitri E. (1985). *The Late Byzantine and Slavonic Communion Cycle : Liturgy and Music*. *Dumbarton Oaks*.
- Conomos, Dimitri E. (1990). *Studies in Eastern chant*. Vol. 5. Crestwood, NY: St Vladimir's Seminary Press.
- Constantinides, Antonios. (2011). *Θεώρηση και προσδιορισμός των «λεπτών» διαστημάτων της μιας φωνής*. Μελέται 17. Αθήνα: Ίδρυμα Βυζαντινής Μουσικολογίας.

- Constantinides, C. N. (1982). *Higher education in Byzantium in the thirteenth and early fourteenth centuries, 1204–ca. 1310*. Nicosia: Cyprus Research Centre.
- Cornford, Francis. M. (1937). *Plato's cosmology: The Timaeus of Plato*. London: Routledge & Kegan Paul.
- Crocker, Richard. L. (1963). "Pythagorean Mathematics and Music" [1]. *The Journal of Aesthetics and Art Criticism*, 22 (2), 189-198.
- Crocker, Richard. L. (1972). Hermann's Major Sixth. *Journal of the American Musicological Society*, 25(1), 19-37.
- Crocker, Richard. L. (2000). *An introduction to Gregorian chant*. New Haven, CT: Yale University Press.
- d'Angour, Armand (2018). *How the Greeks heard music: Ancient melodies and their modern realization*. Oxford : Oxford University Press.
- Dahlhaus, Carl. (1990). "Anfänge der europäischen Musik : erste Niederschriften zu einer Musikgeschichte Europas". In A. Eckhardt, R. Stephan & R. Jakoby (Eds.), *In rebus musicis: zur Musik in Geschichte, Erziehung and Kulturpolitik : Richard Jakoby zum 60. Geburtstag*. Mainz: Schott.
- Delalande, Dominique. (1949). *Vers la version authentique du Graduel grégorien: Le Graduel des Prêcheurs, Bibliothèque d'histoire Dominicaine*. Paris: Cerf.
- Delviniotis, Dimitrios (2008). "Acoustic analysis of musical intervals in modern Byzantine chant scales." *The Journal of the Acoustical Society of America* 124, no. 4.
- Desby, Frank H. (1974). "The Modes and Tuning in Neo-Byzantine Chant." PhD Thesis, University of Southern California.
- Deutsch, Diana (2013). *The psychology of music*. San Diego: Academic Press. 3rd ed.
- Deza, E. and Deza, M. M. (2012). *Figurate numbers*. New Jersey; London; Singapore: World Scientific.
- Dimitrova, Mariana. (2006). "Some Observations on the Slavic Sources for Theta Notation". *Scripta & e-Scripta* 3–4: 225–237. ISSN 1312-238X.
- Doneda, Annalisa. (2011). "Computer Applications to Byzantine Chant: A Relational Database for the Koinonika of the Asmatikon" (PDF).
- Donner, Fred M. (2010). *Muhammad and the believers: At the origins of Islam*. Cambridge, MA: Harvard University Press.
- Dostál, Antonín; Rothe, Hans; Trapp, Erich, eds. (1976–2004). *Der altrussische Kondakar' auf der Grundlage des Blagoveščenskij Nižgorodskij Kondakar'. Bausteine zur Geschichte der Literatur bei den Slawen, Editionen. Vol. 3:2–7. Giessen [Köln, Weimar, Vienna]: Wilhelm Schmitz [Böhlau since 1990]*.
- Dragoumis, Markos. (1988). *Μάρκος Βασιλείου: Ένας πρωτοπόρος τής βυζαντινής μουσικολογίας* [Markos Vassileiou: A pioneer of Byzantine musicology]. Athens: Ekpaideutikon Leitourgon tou Kollegiou Athenon. Offprint from the journal *Απόψεις* 4: 204-211.
- Duffin, Ross. W. (2007). *How equal temperament ruined harmony (and why you should care)*. New York: W.W. Norton.
- Dunsby, J. (2002). "Diatonic" (Publication no. <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/opr/t114/e1934>). Retrieved January 12, 2016, from *Oxford Music Online*. Oxford University Press.
- During, Jean (1988). *La musique traditionnelle de l'Azerbaydjan et la science des muqâms..* Paris: Geuthner.
- During, Jean. (2003). *The spirit of sounds: The unique art of Ostad Elahi*. New York: Cornwall Books.
- Dyer, Joseph H. (1981). *The Offertories of Old-Roman Chant: a Musico-liturgical Investigation*. Ann Arbor, Mich.: University Microfilms International. see also Rebecca Maloy.
- Effat, Mahmoud (2005). *Beginner's guide to the Nay*. Pitchfork Music. Translated by Jon Friesen; originally published in Arabic in 1968.
- Egger, Brigitte P. (2006). "Music." In Hubert Cancik and Helmuth Schneider, eds, Brill's New Pauly, Antiquity vols. Leiden: Brill.
- Emmanuel, Maurice. (1921). "Grèce." In *Encyclopédie de la musique et dictionnaire du conservatoire – Première partie : Histoire de la musique*, edited by Albert Lavignac, 1.1: 377–540. Paris: Delagrave. <http://gallica.bnf.fr/ark:/12148/bpt6k1237270>.
- Engberg, Sysse G. (2005). "Les lectionnaires grecs". In *Olivier Legendre; Jean-Baptiste Lebigue (eds.). Les manuscrits liturgiques, Cycle thématique de l'IRHT 2003–2004. Ædilis, Actes. Séminaires et tables rondes (in French). Vol. 9. Paris, Orléans*.
- Erickson, Raymond. (1992). "Eriugena, Boethius, and the neoplatonism of musica and scolica enchiriadis". *Musical humanism and its legacy*, 53-78.

- Erickson, R., and C. V. Palisca. (1995). *Musica enchiridis and Scolica enchiridis*. New Haven: Yale University Press.
- Erol, Merih (2015). *Greek Orthodox music in Ottoman Istanbul: nation and community in the era of reform*. Bloomington: Indiana University Press.
- Ertan, Deniz (2007). "Cycles and peripheries: An Ottoman 'Kitâb el-Edvâr.'" *Asian Music* 38(1), 31–60.
- Fales, Cornelia (2002). "The paradox of timbre". *Ethnomusicology* 46, no. 1.
- Farhat, Hormoz (1990). *The dastgâh concept in Persian music*. Cambridge: Cambridge University Press.
- Farmer, Henry G. (1925). "Clues for the Arabian Influence on European Musical Theory", *Journal of the Royal Asiatic Society* (1925), 61ff; pub'd separately as *The Arabian Influence on Musical Theory*. London.
- Farmer, Henry G. (1925). "The Influence of Music: from Arabic Sources", *PMA*, lii, Madrid, 6, 89.114.
- Farmer, Henry G. (1926). "Some Musical Manuscripts Identified", *Journal of the Royal Asiatic Society*, 91.3.
- Farmer, Henry G. (1929). "Greek Theorists of Music in Arabic Translation", *Isis*, xiii (30), 325.33.
- Farmer, Henry G. (1929). *A history of Arabian music to the XIIIth century*. London: Luzac.
- Farmer, Henry G. (1930). *Historical Facts for the Arabian Musical Influence*. London, R.
- Farmer, Henry G. (1932). "The Influence of al-Fārībī's .Ihsa. al-ulum. (*De scientiis*) on the Writers on Music in Western Europe", *Journal of the Royal Asiatic Society*, 561. 92.
- Farmer, Henry G. (1933). "A Further Arabic-Latin Writing on Music", *Journal of the Royal Asiatic Society*, 307.22
- Farmer, Henry G. (1934). *Al-Fārībī's Arabic-Latin Writings on Music*. Glasgow, R.
- Farmer, Henry G. (1940, 1965). *The Sources of Arabian Music* (Bearsden).
- Farmer, Henry G. (1945). "Ghosts: an Excursus on Arabic Musical Bibliographies", *Isis*, xxxvi (6), 123.30.
- Farmer, Henry G. (1959). "Tenth-Century Arabic Books on Music: as Contained in .Kitâb al- Fihrist. of Abu.l-Faraj Muhammad ibn al-Nadīm" , *Annual of Leeds University Oriental Society*, ii (61), 37.47.
- Feld, Steven (1984). "Communication, music, and speech about music." *Yearbook for Traditional Music* 16.
- Fétis, François-Joseph. (1869). *Histoire générale de la musique depuis les temps les plus anciens jusqu'à nos jours. Vol. 3. 5 vols.* Paris: Firmin Didot.
- Fleischer, Oskar, ed. (1904). "Die Papadike von Messina", *Die spätgriechische Tonschrift Neumen-Studien*, 3, Berlin: Georg Reimer, pp. 15–50, fig. B3-B24 [Papadike of the Codex Chrysander], retrieved 11 April 2012.
- Flierman, R. (2015). "Gens perfida or populus Christianus? Saxon (in)fidelity in Frankish historical writing". In C. Gantner, R. McKitterick & S. Meeder (Eds.), *The resources of the past in early medieval Europe* (pp. 188-205). Cambridge, United Kingdom: Cambridge University Press, 2015.
- Floros, Constantin. (1970). *Universale Neumenkunde (in German). Vol. 1, 3. Kassel-Wilhelmshöhe: Bärenreiter*.
- Floros, Constantin and Moran, Neil K. (2009). *The Origins of Russian Music: Introduction to the Kondakarian Notation. Frankfurt am Main etc.: Peter Lang*.
- Floros, Constantin. (2015). *Das mittelbyzantinische Kontaktenrepertoire. Untersuchungen und kritische Edition. Vol. 1–3. Hamburg. Archived from the original on 2015-02-05. Retrieved 2015-02-05*.
- Floros, Constantin. (2019). *The Origins of Western Notation Revised and Translated by Neil Moran, with a Report on the Reception of the "universale Neumenkunde 1970-2010"*. Originalausgabe digitale Originalausgabe ed. Peter Lang Verlag.
- Frøyshov, Stig Simeon R. (2007). "The Early Development of the Liturgical Eight-Mode System in Jerusalem." *Saint Vladimir's Theological Quarterly* 51: 139–178.
- Frøyshov, Stig Simeon R., A. Nikiforova, and N. Smelova. (2023). "Byzantine influence before Byzantinisation: The Tropologion Sinai Greek NE MΓ 56+5 compared with the Georgian and Syriac Melkite versions." *Religions* 14, no. 11: 13–63.
- Fuller, Sarah. (2008). "Interpreting Hucbald on Mode". *Journal of Music Theory*, 52(1), 13-40.
- Fuller, Sarah. (2011). "Concerning Gendered Discourse in Medieval Music Theory: Was the Semitone 'Gendered Feminine?'". *Music Theory Spectrum*, 33(1), 65-89.

- Gauntlett, Stathis (2000). "Byzantine chant: Tradition and innovation." In *The Garland Encyclopedia of World Music*, Volume 8: Europe, edited by Timothy Rice, James Porter, and Chris Goertzen. New York: Routledge.
- Gazalé, Midhat. J. (1999). *Gnomon: from pharaohs to fractals*. Princeton, N.J.: Princeton University Press.
- Giannelos, Dimitrios. (1988). "Musique byzantine : tradition orale et tradition écrite, XVIIIe-XXe siècles." *3e cycle Ethnologie*, Paris X.
- Gombosi, Otto. (1939). "Studien zur Tonartenlehre des frühen Mittelalters II". *Acta Musicologica* 11(1/2), 28-39.
- Grier, James. (2006). *The musical world of a medieval monk: Adémar de Chabannes in eleventh-century Aquitaine*. Cambridge; New York: Cambridge University Press.
- Grier, James. (2013). "Adémar de Chabannes (989-1034) and musical literacy". *Journal of the American Musicological Society*, 66(3), 605-638.
- Grisey, Gérard (1987). "Tempus ex machina: A composer's reflections on musical time." *Contemporary Music Review* 2, no. 1.
- van Groningen, Bernhard Abraham (1967). *Short manual of Greek palaeography*. 4th printing. Leiden: A. W. Sijthoff.
- Guettat, Mahmoud. (1986). *La Tradition musicale arabe*. [Paris]: Ministère de l'Éducation nationale, Centre national de documentation pédagogique.
- Gushee, Lawrence. A. (1973). "Questions of genre in Medieval treatises on music". in: *Gattungen der Musik in Einzeldarstellungen. Gedenkschrift Leo Schrade I*, Bern/München 1973, 376-404.
- Guthrie, W. K. C. (1962). *A history of Greek philosophy, Vol. I: The earlier Presocratics and the Pythagoreans*. Cambridge: Cambridge University Press.
- Haas, Max. (1997). *Mündliche Überlieferung und altrömischer Choral: Historische und analytische computergestützte Untersuchungen*. Bern: Lang.
- Hadzitheodorou, Georgios J. (1998). Βιβλιογραφία της Βυζαντινής Εκκλησιαστικής Μουσικής. Περίοδος Α' (1820-1899). [Bibliography of Byzantine ecclesiastical music. First period (1820-1899).] Thessaloniki : Patriarchal Institute for Patristic Studies.
- Hagel, Stefan. (2006). "Calculating auloi: Reconstructing the pipe from measurements." *Music in Art*, 31 (1-2), 29-47.
- Hagel, Stefan. (2010). *Ancient Greek music: a new technical history*. Cambridge: Cambridge University Press.
- Hagel, Stefan. (2023). "Al-ʿūd, pípá, Lute: An Ancient Greek Perspective on Their Prehistory." *Oriens* 51: 71-103.
- Haines, John. (2008). "The origins of the musical staff". *The Musical Quarterly*, 91(3-4), 3-4.
- Hannick, Christian. (1994). "Altslawische Musik". In *Laurenz Lütteken (ed.). MGG Online (in German). Kassel, Stuttgart, New York*.
- Hannick, Christian. (1995). "Byzantinische Musik". In *Laurenz Lütteken (ed.). MGG Online (in German). Kassel, Stuttgart, New York*.
- Harris, Simon J. M. (1999). *Communion chants of the thirteenth-century Byzantine Asmatikon*. New York: Routledge.
- Hebborn, B. (1995). *Die Dasia-Notation*. Bonn: Orpheus.
- Helmholtz, Hermann L. F. (1954). *On the sensations of tone as a physiological basis for the theory of music*, translated, revised, corrected and expanded by Ellis Alexander J. in 1885 (2nd English edition New York: Dover Publications, Inc.) [1st publication in German: 1863].
- Hiley, David. (1993). *Western plainchant: a handbook*. Oxford [England]; Oxford; New York: Clarendon Press ; Oxford University Press.
- Hodgson, Marshall G. S. (1974). *The venture of Islam, Volume 1: The classical age of Islam*. Chicago: University of Chicago Press.
- Hoppin, Richard H. (1978). *Medieval Music*. New York: W.W. Norton.
- Howson, Colin, and Peter Urbach (2006). *Scientific reasoning: the Bayesian approach*. 3rd ed. Chicago: Open Court.
- Hucke, Helmut. (1980). "Toward a New Historical View of Gregorian Chant". *Journal of the American Musicological Society*, 33(3), 437-467.
- Hucke, Helmut, and J. Dyer. (2001) "Old Roman chant." In *Grove Music Online*. Oxford: Oxford University Press. <https://doi.org/10.1093/gmo/9781561592630.article.20362>
- Huffman, Carl. (2006). "Pythagoras." In *Stanford Encyclopedia of Philosophy*. <http://plato.stanford.edu/entries/pythagoras/>.
- Huffman, Carl. (2006). "Pythagoreanism." In *Stanford Encyclopedia of Philosophy*. <http://plato.stanford.edu/entries/pythagoreanism/>.

- Hughes, David G. (1987). "Evidence for the Traditional View of the Transmission of Gregorian Chant." *Journal of the American Musicological Society*, 40 (3), 377-404.
- Huglo, Michel (1969). "L'auteur du 'Dialogue sur la musique' attribué à Odon." *Revue de musicologie* 55 (2): 119–171.
- Huglo, Michel (1971). "Der Prolog des Odo zugeschriebenen 'Dialogus de Musica'." *Archiv für Musikwissenschaft* 28 (2): 134–146.
- Huglo, Michel. (1992). "Notated performance practices in Parisian chant manuscripts of the thirteenth century". In T. F. Kelly (Ed.), *Plain-song in the age of polyphony* (pp. 32-44). Cambridge: Cambridge University Press.
- Huglo, Michel. (2010). "Psalmody in the Ambrosian Rite - Observations on Liturgy and Music." In *Ambrosiana at Harvard: New Sources of Milanese Chant*, ed. Thomas Forrest Kelly. Cambridge, Mass.: Houghton Library, 97–124.
- Huglo, Michel. (2011). "Toward a scientific palaeography of music". *The calligraphy of medieval music*, 13-22.
- Hunt, Frederick V. (1992). *Origins in acoustics: the science of sound from antiquity to the age of Newton*. New Haven: Yale University Press.
- Jacobsthal, Gustav. (1897). *Die chromatische Alteration im liturgischen Gesang der abendländischen Kirche*. Berlin: J. Springer.
- Jaynes, Edwin T. (2003). *Probability theory: The logic of science*. Cambridge: Cambridge University Press.
- Jedrzejewski, Franck. "Avicenne et le tempérament" [in French]. Available online at: <http://perso.club-internet.fr/daschour/micromegas/jedrzejewski/avicen.html> (accessed 1 June 2006)
- Jeffery, Peter. (1984). "The Introduction of Psalmody into the Roman Mass by Pope Celestine I (422-432): Reinterpreting a passage in the "Liber pontificalis" *Archiv Für Liturgiewissenschaft* 26: 147–65.
- Jeffery, Peter. (1992). *Re-Envisioning Past Musical Cultures: Ethnomusicology in the Study of Gregorian Chant*. University of Chicago Press.
- Jeffery, Peter. (2001). "The Earliest Oktōēchoi: The Role of Jerusalem and Palestine in the Beginnings of Modal Ordering". *The Study of Medieval Chant: Paths and Bridges, East and West; In Honor of Kenneth Levy*. Woodbridge, Suffolk: Boydell Press, 147–209.
- Kaldellis, Anthony (2019). *Romanland: ethnicity and empire in Byzantium*. Cambridge, MA: Harvard University Press.
- Kalogeropoulos, Takes (1998). *Τὸ Λεξικὸ τῆς Ἑλληνικῆς Μουσικῆς*, Vol. 1, Athens: Εκδόσεις Γαλλελη.
- Karas, Simon I. (1989). *Ἀρμονικά: Ἐκ συμφωνιῶν, κατ' ἄρμονικὰς μεσότητας, τὰ μελωδικὰ διαστήματα. Ἀνακοίνωσις εἰς τὸ Μουσικολογικὸν Συνέδριον τῶν Δελφῶν τῆς 28–30 Ὀκτωβρίου 1988*. Αθήνα.
- Karp, Theodore. (1998). *Aspects of orality and formularity in Gregorian chant*. Evanston, Ill.: Northwestern University Press.
- Katsanevaki, Athina (2023). "The evolutionary pentatonism in Nicomachus, the extant fragments and an ancient Greek musical praxis." *Greek and Roman Musical Studies* 11: 139–181. <https://doi.org/10.1163/22129758-bja10061>
- Katsiampoura, Gianna (2010). "The Quadrivium of 1008 and Pachymeres' Syntagma: Comparing Two Byzantine Quadrivia." In L. del Corso, & O. Pecere (Eds.), *Libri di scuola e pratiche didattiche, dall' Antichità al Rinascimento*, II (pp. 409-424). Edizioni Università di Cassino.
- Kelly, Thomas F. (1989). *The Beneventan chant*. Cambridge [England]; New York: Cambridge University Press.
- Kelly, Thomas F. (2011). *The sources of Beneventan chant*. Farnham: Ashgate Variorum.
- Kelly, Thomas F. (2015). *Capturing music: the story of notation*. New York: W. W. Norton & Company.
- Kennedy, Hugh. (1981). *The early Abbasid Caliphate: A political history*. London: Croom Helm.
- Khalil, Alexander K. (2009). "Echoes of Constantinople: oral and written tradition of the psaltes of the Ecumenical Patriarchate of Constantinople." PhD Thesis, University of California, San Diego.
- Kitsikis, Dimitri. (1985). *L'Empire ottoman*. Paris: Presses universitaires de France.
- Krüger-Wust, W. J. (1983): *Arabische Musik in europäischen Sprachen*. Wiesbaden.
- Kunz, Lucas. (1936). Die Tonartenlehre des Boethius. *Kirchenmusikalisches Jahrbuch*, 31, 5–24.
- Lachmann, R. and M. El Hefny. (1931). "Ja.qūb Ibn Ishāq al-Kindī." *Veröffentlichungen der Gesellschaft zur Erforschung der Musik des Orients*, I, Leipzig.
- Landels, J. G. (1964). "Fragments of Auloi Found in the Athenian Agora". *Hesperia: The Journal of the American School of Classical Studies at Athens*, 33(4), 392-400.

- Lawergren, Bo. (2000). "Music History i. Pre-Islamic Iran." *Encyclopaedia Iranica*.  
<https://www.iranicaonline.org/articles/music-history-i-pre-islamic-iran>
- Le Goff, Jacques. (2005). *The Birth of Europe*. Malden, MA: Blackwell.
- Leedy, Douglas (1991). "A venerable temperament rediscovered." *Perspectives of New Music* 29(2): 202–211.
- Lekkas, Demetrios E. (1995). "Η μαθηματική θεωρία της μουσικής" [The mathematical theory of music]. PhD Thesis, Athens: National University. Available at:  
<https://thesis.ekt.gr/thesisBookReader/id/33545#page/1/mode/2up>
- Lekkas, Demetrios E. (2003). "Περί αυλών τρήσεως" [On the drilling of flutes], text # 13 in the collective volume *Accompany-ing texts for the course "Arts II: Overview of Greek music and dance"* ELP 40, 1-9, (Patras, Greece: The Hellenic Open University) [in Greek].
- Lekkas, Demetrios E. (2003). "Αρχαία ελληνικά μουσικά Θεωρητικά". In κ. ά. Αγγελόπουλος Λ., ed., *Τέχνες II: Επισκόπηση Ελληνικής Μουσικής και Χορού. Ελληνική Μουσική Πράξη: Αρχαίοι και Μέσοι Χρόνοι (τ. Β', 21-54)*. Patras: Hellenic Open University.
- Lekkas, Demetrios E. (2006). "Η διατονική βάση της βυζαντινής μουσικής: συστηματική δομική προσέγγιση" [The diatonic basis of byzantine music: systemic structural approach]. *Πολυφωνία* 8, 7-35.
- Lekkas, Demetrios E. (2010). "Βυζαντινό 'μαλακό χρώμα:' συστηματική δομική προσέγγιση" [Byzantine 'soft chroma:' systemic structural approach]. *Πολυφωνία* 11. 139-165.
- Lekkas, Demetrios E. (2018). "Theorem of (upwards) Harmonic Subdivision". *Epistēmēs Metron Logos* 1, 45–69. <https://doi.org/10.12681/eml.19245>
- Lekkas, Demetrios E. (2021). "Byzantine church chant and Islamic art music on the English recorder: theory and practice". *Epistēmēs Metron Logos* 5. <https://doi.org/10.12681/eml.28941>
- Levin, Flora R. (2009). *Greek reflections on the nature of music*. Cambridge; New York: Cambridge University Press.
- Levy, Kenneth. (1970). "The Italian Neophytes' Chants." *JAMS* 23: 181–227.
- Levy, Kenneth. (1987). "Charlemagne's Archetype of Gregorian Chant." *JAMS* 40: 1–30.
- Levy, Kenneth. (2000). "A new look at Old Roman chant". *Early Music History*, 19, 81-104.
- Levy, Kenneth. (2001). "A new look at Old Roman chant – II". *Early Music History*, 20, 173-197.
- Levy, K and C. Troelsgård. (2001). "Byzantine Chant." *The New Grove Dictionary of Music and Musicians*, 2nd ed., edited by Stanley Sadie and John Tyrrell. London: Macmillan. 4: 734–56.
- Levy, Kenneth; John A. Emerson; Jane Bellingham; David Hiley; and Bennett Mitchell Zon. (2001). "Plainchant." In *Grove Music Online*. Oxford: Oxford University Press.  
<https://doi.org/10.1093/gmo/9781561592630.article.22099>
- Levy, Kenneth. (2003). "Gregorian Chant and the Romans." *JAMS* 56: 5–41.
- Levy, Kenneth. (2009). "On the Origin of Neumes." In *Early Music History - Studies in Medieval and Early Modern Music*, by Iain Fenlon. Cambridge, New York, New Rochelle, Melbourne, Sydney: Cambridge University Press, 7:59–90.
- Lindley, Mark. (2001). "Just intonation" (Publication no. <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/grove/music/14564>). Retrieved February 2, 2016
- Lindley, Mark. (2001a). "Equal temperament" (Publication no. <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/grove/music/08900>). Retrieved February 8, 2016, from *Grove Music Online*. Oxford University Press
- Lindley, Mark. (2001b). "Pythagorean intonation" (Publication no. <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/grove/music/22604>). Retrieved February 12, 2016, from *Grove Music Online*. Oxford University Press
- Lindley, Mark. (2001c). "Temperaments" (Publication no. <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/grove/music/27643>). Retrieved December 18, 2015
- Lingas, Alexander. (1991). "Byzantine Chant, Western Musicology, and the Performer", *San Francisco Early Music News* (April):3–5.
- Lingas, Alexander. (1995). "The Liturgical Place of the Kontakion in Constantinople", in ed. Constantin C. Akentiev, *Liturgy, Architecture and Art of the Byzantine World: Papers of the XVIII International Byzantine Congress (Moscow, 8–15 August 1991) and Other Essays Dedicated to the Memory of Fr. John Meyendorff*, *Byzantinorossica* 1. St. Petersburg: 50–57.
- Lingas, Alexander. (1996). "Hesychasm and Psalmody", *Mount Athos and Byzantine Monasticism*, eds. Anthony Bryer and Mary Cunningham. Aldershot: Variorum, 155–68. Romanian translation in *Acta Musicae Byzantinae* V (2003): 70–79.

- Lingas, Alexander. (1997). "Festal Cathedral Vespers in Late Byzantium", *Orientalia Christiana Periodica* 63. Rome: Pontifical Institute of Oriental Studies: 421–59.
- Lingas, Alexander. (2001). "The First Antiphon of Byzantine Cathedral Rite Matins: From Popular Psalmody to Kalophonia", In *Cantus planus: Papers read at the 9th meeting, Esztergom & Visegrád, Hungary, 1998*, edited by László Dobszay, 479–500. Budapest: Institute for Musicology of the Hungarian Academy of Sciences.
- Lingas, Alexander. (2002). "Byzantine Chant" in A. Latham, ed., *The Oxford Companion to Music*. Oxford: Oxford University Press.
- Lingas, Alexander. (2003). "Johannes Damascenos", in *Die Musik in Geschichte und Gegenwart. Personenteil* 9, cols. 1086–88.
- Lingas, Alexander. (2003). "Performance Practice and the Politics of Transcribing Byzantine Chant", in *Acta Musicae Byzantinae* 6: 56–76.
- Lingas, Alexander. (2003). "Tradition and Renewal in Greek Orthodox Psalmody", in H.W. Attridge and M.E. Fassler, eds., *The Psalms in Community: Jewish and Christian Textual, Liturgical and Artistic Traditions*. Atlanta: Society of Biblical Literature, 341–56 [hardcover edition also available from Brill].
- Lingas, Alexander. (2004). "Ancient Music in a Medieval Mirror", review of Thomas J. Mathiesen, *Apollo's Lyre: Greek Music and Music Theory in Antiquity and the Middle Ages* (Lincoln and London: University of Nebraska Press, 1999). *Journal of the Royal Musical Association*, 129 no. 2: 298–304.
- Lingas, Alexander. (2004). "Musica e liturgia nelle tradizioni ortodosse", in J.J. Nattiez, ed., *Enciclopedia della musica, 4 Storia della musica europea*. Turin: Giulio Einaudi, 68–93.
- Lingas, Alexander. (2004). "Preliminary Reflections on Studying the Liturgical Place of Byzantine and Slavonic Melismatic Chant", in Gerda Wolfram, ed., *Paleobyzantine Notations III: Acta of the Congress Held at Hernen Castle, The Netherlands, in March 2001*, Eastern Christian Studies 4. Leuven, Paris and Dudley, MA: Peeters, 147–55.
- Lingas, Alexander. (2004). "Vizantiiskaya imperiya: Tserkovnoye peniye" ("Byzantine Empire: Church Singing"), in *The Orthodox Encyclopedia*, vol. 8. Moscow: Ecclesiastical Research Centre Lingas, Alexander 'Pravoslavnaya entsiklopediya', 350–59.
- Lingas, Alexander. (2006). "Medieval Byzantine Chant and the Sound of Orthodoxy", in Andrew Louth and Augustine Casiday, eds., *Byzantine Orthodoxies, Papers from the 36th Spring Symposium of Byzantine Studies*. Aldershot: Ashgate, 131–50.
- Lingas, Alexander. (2007). "How Musical was the 'Sung Office'? Some Observations on the Ethos of the Byzantine Cathedral Rite", in Ivan Moody and Maria Takala-Rozszenko, eds., *The Traditions of Orthodox Music. Proceedings of the First International Conference on Orthodox Church Music, University of Joensuu, Finland 13–19 June 2005*. Joensuu, 217–34.
- Lingas, Alexander. (2008). "Music", Chapter III.19 in E. Jeffreys, R. Cormack and J. Haldon, eds., *The Oxford Handbook of Byzantine Studies*. Oxford: Oxford University Press, 915–935.
- Lingas, Alexander. "Bringing Byzantium to Light: A Conversation with Alexander Lingas of Cappella Romana." Interview by Steven E. Ritter. *Fanfare Magazine* (12 October 2010), reposted on *Byzantine Blog*, 15 October 2010. Accessed [date you accessed it]. <https://mybyzantine.wordpress.com/2010/10/15/bringing-byzantium-to-light-a-conversation-with-alexander-lingas-of-cappella-romana/>
- Lingas, Alexander. (2011). "Late Byzantine Cathedral Liturgy and the *Service of the Furnace*", in Sharon Gerstel and Robert Nelson, eds., *Approaching the Holy Mountain: Art and Liturgy at St Catherine's Monastery in the Sinai*. Turnhout, Belgium: Brepols, 179–230.
- Lingas, Alexander. (2012). "Chant, Liturgical", "Liturgy, Byzantine", and "Music, Byzantine", in the *Encyclopedia of Ancient History*, ed. E. Bulls. Oxford: Wiley-Blackwell.
- Lingas, Alexander. (2013). "From Earth to Heaven: The Changing Soundscape of Byzantine Liturgy", in Mark Jackson and Claire Nesbitt, eds., *Experiencing Byzantium: Papers from the 44th Spring Symposium of the Society for the Promotion of Byzantine Studies*, Aldershot: Ashgate, 311–58.
- Lingas, Alexander. (2014). *Their Psalmody Is [Still] Not Foreign': Greek And Latin Chanting In The Eastern Mediterranean 1000–1500 AD*. Paper presented at the Axion Estin Conference, New York.
- Lingas, Alexander. (2019). "Canonising Byzantine Chant as Greek Art Music," in Roderick Beaton, Katerina Levidou, Polina Tambakaki and Panos Vlagopoulos, eds., *Music, Language and Identity in Greece: Defining a National Art Music in the Nineteenth and Twentieth Centuries*, Centre for Hellenic Studies, Kings College London Publications 21. London and New York: Routledge, 31–53.

- Lingas, Alexander. "Notes." In *Kassiani* (attr.), *Tetraodion for Holy Saturday*, ed. Ioannis Arvanitis and Alexander Lingas. Portland, OR: Cappella Romana, forthcoming.
- Cappella Romana Recordings -- with liner notes by Alexander Lingas:  
*When Augustus Reigned: Orthodox Music for Christmas*, Cappella Romana (Gagliano CD 502, 2000).  
*Music of Byzantium*, Cappella Romana (The Metropolitan Museum of Art, New York: 2004).  
*Epiphany: Medieval Byzantine Chant*, Cappella Romana (Gothic G 49237, 2004).  
*The Fall of Constantinople: Byzantine and Latin Music of the Fifteenth Century*, Cappella Romana (Cappella Romana CR40-2CD, 2006).  
*Byzantium in Rome: Medieval Byzantine Chant from Grottaferrata*, Cappella Romana (Cappella Romana 403-2CD, 2007).  
*The Divine Liturgy of St John Chrysostom according to the Byzantine Tradition: A New Musical Setting in English*, Cappella Romana (CR404-2CD, 2008).  
*Byzantium 330–1453*, Cappella Romana (RRCD489/RAA, 2008).  
*Mt Sinai: Frontier of Byzantium*. Cappella Romana (CR407-CD, 2011).  
*Cappella Romana Live in Greece. From Constantinople to California*. Cappella Romana CR 409 CD, 2012.  
*Good Friday in Jerusalem, Medieval Byzantine Chant from the Church of the Holy Sepulchre*. Cappella Romana (CR413-CD, 2015).  
*Cyprus: Between Greek East and Latin West*. Cappella Romana (CR416-CD, 2015).  
*Venice in the Greek East: Renaissance Crete and Cyprus*. Cappella Romana (CR419-CD, 2019).  
*Lost Voices of Hagia Sophia: Medieval Byzantine Chant Sung in the Virtual Acoustics of Hagia Sophia. The Feast of the Exaltation of the Holy Cross in Constantinople*. Cappella Romana (CR420-CDBR, 2019).  
*Hymns of Kassiani: The Earliest Music by a Female Composer, Kassianv (Kassva) ca. 810–ca. 865* Cappella Romana (CR 422SACD, 2021).]
- Lochhead, Judy (2011). "Music theory and philosophy." In *The Routledge companion to philosophy and music*, edited by Theodore Gracyk and Andrew Kania, 506–516. London; New York: Routledge.
- Lucas, Ann E. (2019). *Music of a Thousand Years: A New History of Persian Musical Traditions*. University of California Press.
- Lynch, T. A. C., and E. Rocconi, eds. (2020). *A companion to ancient Greek and Roman music*. Hoboken, NJ: Wiley-Blackwell.
- Lynch, Tosca A. C. (2024). "Unlocking the riddles of Imperial Greek melodies: The 'Lydian' metamorphosis of the Classical harmonic system." *Greek and Roman Musical Studies* 12(1): 61–98.
- El Mahdi, Salah. (1972). *La musique arabe: structures, histoire, organologie: 39 exemples musicaux extraits du répertoire traditionnel*. Paris: Alphonse Leduc.
- Maître, Claire. (1995). *La réforme cistercienne du plain-chant: étude d'un traité théorique*. Studia et Documenta 6. Brecht: Abbaye de Nazareth.
- Makris, Eustathios. (2005). "The Chromatic Scales of the Deuterios Modes in Theory and Practice". *Plainsong and Medieval Music* 14: 1–10.
- Makris, Eustathios. (2008). "Adjustments of modality in the postbyzantine Heirmologion." In Gerda Wolfram (ed.), *Tradition and innovation in late- and postbyzantine liturgical chant: Acta of the Congress held at Hernen Castle, the Netherlands, in April 2005*. Leuven: Peeters, 37-63.
- Maloy, Rebecca. (2002). "The Roles of Notation in Frutolf of Michelsberg's Tonary". *The journal of musicology*, 19(4), 641-693.
- Maloy, Rebecca. (2007). "Problems of pitch level and modal structure in some Gregorian offertories". *The offertory and its verses*, 67-88.
- Maloy, Rebecca. (2009). "Scolica Enchiriadis and the non-diatonic plainsong tradition". *Early Music History* 28, 61-96.
- Maloy, Rebecca. (2010). *Inside the Offertory: Aspects of Chronology and Transmission*. Oxford: Oxford University Press.
- Maltezos, Constantinos (193?). *Περὶ τῶν διατονικῶν κλιμάκων τῆς Ἑλληνικῆς ἐκκλησιαστικῆς μουσικῆς* [On the Diatonic Scales of Greek Ecclesiastical Music]. *Proceedings of the Academy of Athens*. Digital item no. 7450. Ψηφιακὴ Βιβλιοθήκη Ἀκαδημίας Ἀθηνῶν. <https://digitallibrary.academyofathens.gr/archive/item/7450>
- Mango, Cyril (2002). "Byzantium: the empire of New Rome." In *The Oxford history of Byzantium*, edited by Cyril Mango, 1–16. Oxford: Oxford University Press.

- Martani, Sandra (2003). "The theory and practice of ekphonetic notation: The manuscript Sinait. gr. 213." *Plainsong & Medieval Music* 12, no. 1.
- Martani, Sandra (2021). "Modal references in the Byzantine Heirmologion : the medial signatures in the manuscript Grottaferrata E.γ.III." *Series Musicologica Balcanica* 1(2): 393–412. <https://doi.org/10.26262/smb.v1i2.7949>
- Mathiesen, Thomas J. (1983). "Aristides Quintilianus and the 'Harmonics' of Manuel Bryennius: A study in Byzantine music theory." *Journal of Music Theory* 27 (1): 31–47.
- Mathiesen, T. J. and Treitler, L. (1998). *Strunk's Source Readings in Music History. Vol. 1*. New York: Norton.
- Mathiesen, Thomas J. (1999). *Apollo's Lyre : Greek Music and Music Theory in Antiquity and the Middle Ages*. Lincoln, Neb.: University of Nebraska Press.
- Mathiesen, T. J., Conomos, D., Leotsakos, G., Chianis, S., and Brandl, R. M. (2001). "Greece" (Publication no. <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/grove/music/11694pg1>). Retrieved January 12, 2026
- Mathiesen, Thomas J. (2011). "Antiquity and the Middle Ages". In T. Gracyk & A. Kania (Eds.), *The Routledge Companion to Philosophy and Music* (pp. 257-272). London; New York.
- McAlpine, Fiona (2008). *Tonal consciousness and the medieval West*. Bern; New York: Peter Lang.
- McGee, Timothy J. (1996). "'Ornamental' neumes and early notation." *Journal of the American Musicological Society* 49 (1): 39–65.
- McGee, Timothy J. (1998). *The sound of medieval song : ornamentation and vocal style according to the treatises*. Oxford; New York: Clarendon Press; Oxford University Press.
- McKinnon, James W. (1987). "The Fourth-Century Origin of the Gradual." *Early Music History* 7: 91–106.
- McKinnon, James W. (1990). "Christian antiquity". In J. W. McKinnon (Ed.), *Antiquity and the Middle Ages: from ancient Greece to the 15th century*: 68-87.
- McKinnon, James W. (1996). "Preface to the Study of the Alleluia." *Early Music History* 15: 213–249.
- McKinnon, James W. (1998). "Compositional Planning in the Roman Mass Proper." *Studia Musicologica Academiae Scientiarum Hungaricae* 39: 241–245.
- McKinnon, James W. (2000). *The Advent Project: the Later-seventh-century Creation of the Roman Mass Proper*. Berkeley: University of California Press.
- McKinnon, J. W., and C. Thodberg. (2001). "Alleluia." In *Grove Music Online*. Oxford: Oxford University Press. <https://doi.org/10.1093/gmo/9781561592630.article.40711>
- McKinnon, James W. (2001). "Gregorian chant." In *Grove Music Online*. Oxford: Oxford University Press. <https://doi.org/10.1093/gmo/9781561592630.article.11758>
- Megremi, Athanasia, and J. Christianidis. (2014). "Georgios Pachymeres, reader of Nicomachus : The arithmetical theory of ratios as a means for solving problems" [in Greek]. *Neusis* 22: 53–85. <https://www.academia.edu/15409596/>
- Mengozi, Stefano. (2006). "Virtual segments: the hexachordal system in the late Middle Ages". *The journal of musicology*, 23(3), 426-467.
- Mengozi, Stefano. (2007). "Si quis manaus non habeat": charting non-hexachordal musical practices in the age of solmisation. *Early Music History*, 26, 181-218.
- Merlan, Philip (1953). *From Platonism to Neoplatonism*, The Hague: Martinus Nijhoff.
- Meyer, C., M. Huglo, and M. Pérès. (1991). *Aspects de la musique liturgique au moyen âge : actes des colloques de Royaumont de 1986, 1987 et 1988*, Paris.
- Meyer, C., M. Huglo, and M. Pérès. (1992). *Jérôme de Moravie: un théoricien de la musique dans le milieu intellectuel parisien du XIIIe siècle: actes du Colloque de Royaumont, 1989*, Paris.
- Moisil, Costin (2003). "Diatonic, chromatic, enarmonic. Observații privind intonația în muzica bizantină." *Acta Musicae Byzantinae* V: 51–55.
- Montagu, Jeremy. (2002). "Mean-tone temperament" (Publication no. <http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/article/opr/t114/e4312>). Retrieved January 24, 2016, from Oxford Music Online. Oxford University Press
- Monzo, Joe. "Philolaus". Available online at: <http://tonalsoft.com/enc/p/philolaus.aspx> (accessed 1 June 2006)
- Moran, Neil K. (1975). *The Ordinary Chants of the Byzantine Mass*. Verlag Der Musikalienhandlung K. D.
- Moran, Neil K. (2010). "A Second Medial Mode in Old Roman Beneventan and Frankish Sources As Related to the Question of the 'parapteres.'" *Traditions Du Plain-Chant Occidental* S. 65-77.

- Morgan, Maureen M. (1971). "The 'Three Teachers' and Their Place in the History of Greek Church Music". In *Studies in Eastern Chant*, Vol. 2, edited by Egon Wellesz and Miloš M. Velimirović, 86–99. London & others: Oxford University Press.
- Myers, Gregory, ed. (1994). *The Lavrsky-Troitsky Kondakar'. Monumenta Slavico-Byzantina Mediaevalia Europensia. Vol. 4. Sofia: Ivan Dujcev Centre for Slavo-Byzantine Studies (Heron Press).*
- Myers, Gregory. (1998). "The medieval Russian Kondakar and the choirbook from Kastoria: a palaeographic study in Byzantine and Slavic musical relations". *Plainsong and Medieval Music*. 7 (1): 21–46. doi:10.1017/S0961137100001406.
- Nelson, Janet L. (1986). *Politics and ritual in early medieval Europe*. London: Hambledon Press.
- Nelson, Janet L. (1994). "Kingship and empire in the Carolingian world". In R. McKitterick (Ed.), *Carolingian culture: emulation and innovation*, 52-87. Cambridge [England]; New York, NY, USA: Cambridge University Press.
- Neubauer, Eckhard. (1987). "Henry George Farmer on Oriental Music: an Annotated Bibliography", *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, iv (8), 219.66
- Neubauer, Eckhard. (1992). "Manuscripts de musique arabe: enregistrement et catalogue depuis le congrès du Caire", *Musique arabe: le congrès du Caire de 1932*. Cairo.
- Neubauer, Eckhard. (1998). "Die acht 'Wege' der arabischen Musiklehre und der Oktoechos – Ibn Mišğāh, al-Kindī und der syrisch-byzantinische oktōēchos", *Arabische Musiktheorie von den Anfängen bis zum 6./12. Jahrhundert: Studien, Übersetzungen und Texte in Faksimile, Publications of the Institute for the History of Arabic-Islamic Science: The science of music in Islam*, 3, Frankfurt am Main: Inst. for the History of Arab.-Islamic Science, 373–414.
- Noble, Thomas. F. X. (2013). *Western Civilization : Beyond Boundaries. Volume 2*. Belmont, Calif.; Andover: Wadsworth ; Cengage Learning [distributor].
- Noble, Thomas. F. X. (2015). "Carolingian Religion". *Church Hist Church History*, 84(02), 287-307.
- Nolan, Catherine. (2002). "Music theory and mathematics". In T. S. Christensen (Ed.), *The Cambridge history of Western Music Theory* (pp. 272-304). Cambridge: Cambridge University Press.
- Norwich, John J. (1999). *Histoire de Byzance : 330-1453*. Perrin.
- Nowacki, Edward. (1986). "Text Declamation as a Determinant of Melodic Form in the Old Roman Eighth-Mode Tracts". *Early Music History*, 6, 193-226.
- Ostrogorski, G. and Hussey, J. M. (1956). *History of the Byzantine State*. Oxford: Blackwell & Mott.
- Pachymeres, Georgios and Bacchius l' Ancien. (1847). *Notice sur divers manuscrits grecs relatifs à la musique, comprenant une traduction française et des commentaires: Extrait de la 2e partie du Tome XVI des Notices et extraits des manuscrits de la Bibliothèque du Roy ...*, editor Alexandre Joseph Hidulphe Vincent, translator Alexandre-Joseph-Hidulphe Vincent, Imprimerie royale.
- Page, Christopher. (1992). "Musicus and cantor". In T. Knighton and D. Fallows, eds., *Companion to medieval and renaissance music* (pp. 74-78). New York: Schirmer Books, an imprint of Macmillan Publishing Company: Maxwell Macmillan International.
- Page, Christopher. (2010). *The Christian West and its singers: the first thousand years*. New Haven: Yale University Press.
- Palisca, Claude V. (1985). *Theories of music in the ancient world: Science and the humanities..* Oxford: Oxford University Press.
- Palisca, Claude. V. (1990). "An Introduction to the Musica of Johannes dictus Cotto vel Affligemensis". In L. A. Dittmer, B. Gillingham and P. Merkley, eds., *Beyond the moon: festschrift Luther Dittmer* (pp. 144-162). Ottawa, Canada: Institute of Mediaeval Music.
- Palisca, C., & Bent, I. (2001). "Theory, theorists". *Grove Music Online*. Retrieved 24 Jan. 2025, from <https://www.oxfordmusiconline.com/grovemusic/view/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000044944>.
- Panteli, Maria (2013). "A quantitative comparison of Chrysanthine theory and performance practice of scale tuning, steps, and prominence of the Octoechos in Byzantine chant". *Journal of New Music Research* 42, no. 3.
- Papa Paraschos Phocaeus, Theodoros. (1847). *Μουσική Μέλισσα, περιέχουσα τὸ ἀργὸν καὶ σύντομον Ἀναστασιματάριον (Mousikē Mélissa, periechousa to argòn kai sýntomon Anastasimatáron)*. Edited by Theodoros P. P. Phocaeus. Constantinople (Galata): Castro Press.
- Papademetriou, Panagiotis D. (2014). "Ἡ διατονικὴ κλίμακα τοῦ Χρυσάνθου." [The diatonic scale of Chrysanthos]. Online PDF. (current online ed. 12 March 2014; first online ed. 12 August 2005). <http://psaltiki.gr/articles/papadimitriou/004-xrusan0os-diatonikh-papadimitriou.pdf>
- Papademetriou, Panagiotis D. (2014). "Οἱ Κλίμακες καὶ Συγκερασμοὶ τοῦ Χρυσάνθου ἐκ Μαδύτων." In «Μέθοδος Δημιουργίας Κλιμάκων». [The Scales and Temperaments of Chrysanthos of Madytos], Online PDF. Draft ed. 0.9 (15 March 2014).

- <http://psaltiki.gr/articles/papadimitriou/016g-Chrysanthos-Scales-Temperament-Papadimitriou-v0p9.pdf>
- Papageorgiou, Konstantinos. and Lekkas, D. (2018). “On the Methodology of the Analytic Method: Historical Account”, Epistemological Suggestions, Stages. *Epistēmēs Metron Logos*, (1), 70–89. <https://doi.org/10.12681/eml.19244>
- Pérès, Marcel. (1992). Chant cistercien (monodies du XIIe siècle)-Ensemble Organum/Marcel Harmonia mundi.
- Pérès, M., Homo-Lechner, C. and Le Goff, J. (1998). *La rationalisation du temps au XIIIe siècle : musique et mentalités : actes du colloque de Royaumont, 1991*, Grâne.
- Pérès, M. and Cheyronnaud, J. (2001). *Les voix du plain-chant*. Paris: Desclée de Brouwer.
- Pérès, Marcel. and Lacavalerie, X. (2002). *Le chant de la mémoire : Ensemble organum, 1982-2002*. Paris: Desclée de Brouwer.
- Petros Lampadarios, and Constantinos Protopsaltēs. (1839). *Ἀναστασιματάριον ἀργόν* (*Anastasimatáριον argón*). Edited by Constantinos and Theodoros Papa-Paraschos Phocaeus. Constantinople: Printing House of the Ignatiades Brothers.
- Petros Lampadarios. (1863). *Ἀναστασιματάριον νέον ἀργόν καὶ σύντομον* (*Anastasimatáριον néon argón kai sýntomon*). Edited by Ioannis, Protopsaltēs of the Great Church of Christ. Constantinople: Printing House Th. Dēmētzian.
- Pfisterer, Andreas. (2002). *Cantilena Romana: Untersuchungen zur Überlieferung des Gregorianischen Chorals*. Beiträge Zur Geschichte der Kirchenmusik ; 11. Paderborn: Schöningh.
- Pfisterer, Andreas. (2008). “Italian and Gallican Alleluia Psalmody.” *Plainsong and Medieval Music* 17: 55-68.
- Phillips, Nancy. (1986). “Musica and Scolica enchiriadis : the literary, theoretical, and musical sources.” PhD Thesis. New York University.
- Phillips, Nancy. (1990). “Classical and late latin sources for ninth-century treatises on music”. In A. Barbera, ed., *Music theory and its sources: antiquity and the Middle Ages* (pp. 100-135). Notre Dame, Indiana: University of Notre Dame Press.
- Phillips, Nancy. (2000). “Notationen und Notationslehren von Boethius bis zum 12. Jahrhundert”. *Die Lehre vom einstimmigen liturgischen Gesang*, 293-623.
- Pizzani, Ubaldo. (1965). *Studi sulle fonti del “De institutione musica” di Boezio*. Steenbrugge: Martinus Nijhoff.
- Plemmenos, John (2021). “Η μεταρρύθμιση του 1814 και η επίδρασή της στην εξωτερική μουσική: ρυθμικά και μελωδικά ζητήματα [The reform of 1814 and its impact on external music: Rhythmic and melodic issues].” In *H Βυζαντινή Μουσική μέσα από την Νέα Μέθοδο Γραφής 1814–2014: Πρακτικά Διεθνούς Μουσικολογικού και Ψαλτικού Συνεδρίου*: 697–717.
- Poché, Christian. (1996). *Musiques du monde arabe: écoute et découverte*, Paris.
- Poorhaydari, Kioumars. (2022). “Examination of neutral intervals and parent scales in Persian art music: A step toward the standardization of the musical system.” *Music Theory and Analysis* 9(1):28–55. <https://doi.org/10.11116/MTA.9.1.2>
- Poorhaydari, Kioumars. (2023). “Empirical evaluation of intervals and fretting systems in Persian art music.” *Analytical Approaches to World Musics* 11(2). <https://journal.iftawm.org/previous/2023-volume-11-no-2/poorhaydari>
- Poorhaydari, Kioumars. (2025). “Historical examination and theoretical analysis of Maqām Humāyūn in Persian art music.” *Music Theory Spectrum* 47(2). <https://doi.org/10.1093/mts/mtae023>
- Pulkki, Ville, and Matti Karjalainen (2015). *Communication Acoustics: An Introduction to Speech, Audio and Psychoacoustics*. Hoboken, NJ: John Wiley & Sons.
- Raasted, Jørgen (1966). *Intonation formulas and modal signatures in Byzantine musical manuscripts*. Monumenta Musicae Byzantinae, Subsidia 7. Copenhagen: Ejnar Munksgaard.
- Raasted, Jørgen. (1969). “Observations on the Manuscript Tradition of Byzantine Music, I: A List of Heirmos Call-Numbers, based on Eustratiades's Edition of the Heirmologion” (PDF). Cahiers de l'Institut du Moyen-Âge grec et latin. 1: 3–12.
- Raasted, Jørgen. (1986). “Chromaticism in Medieval Byzantine Chant.” Cahiers de l'Institut du Moyen-Âge grec et latin. 53: 15–36.
- Raasted, Jørgen (1987). “Thoughts on a revision of the transcription rules of the *Monumenta Musicae Byzantinae*.” *CIMAGL* 54: 13–38.
- Rankin, Susan. (1994). “Carolingian music”. In R. McKitterick, ed., *Carolingian culture: emulation and innovation* (pp. 274–316). Cambridge [England]; New York, NY, USA: Cambridge University Press.

- Williams, Edward V., and Christian Troelsgård. (2001). "Akolouthiai." In *The New Grove dictionary of music and musicians*. Oxford: Oxford University Press.  
<https://doi.org/10.1093/gmo/9781561592630.article.00384>
- Rankin, Susan. (2011). "On the treatment of pitch in early music writing". *Early Music History* 30, 105-175.
- Reimer, Erich. (1978). "Musicus und Cantor. Zur Sozialgeschichte eines musikalischen Lehrstücks". *Archiv für Musikwissenschaft*, 35(1), 1-32.
- Ribera y Tarragó, Julián (1975). *Historia de la música árabe medieval y su influencia en la española*. New York: AMS Press. Reprint of the edition Madrid, 1927.
- Riché, Pierre (1993). *The Carolingians : a family who forged Europe*. Philadelphia: University of Pennsylvania Press.
- Richter, Lukas. (1998). "Antike Überlieferungen in der byzantinischen Musiktheorie". *Deutsches Jahrbuch der Musikwissenschaft* 6 (1962): 75–115 *Lipsiae [Leipzig]*. Revised, updated version in *Acta musicologica* 70(2), 133-208.
- Roederer, Charlotte. D. (1974). "Can We Identify an Aquitanian Chant Style?". *Journal of the American Musicological Society* 27(1), 75-99.
- Romanou, Katy. (1990). "A new approach to the work of Chrysanthos of Madytos: The new method of musical notation in Greek church and the Μέγα Θεωρητικόν της Μουσικής." *Studies in Eastern Chant*. Vol. 5: 89–100.
- Romanou, Katy (2003). "Westernization of Greek Music." *Zbornik Matice Srpske za scenske umetnosti i muziku [Matica Srpska Journal of Stage Arts and Music]* 28–29: 93–105.
- Romanou, Katy; Thomas J. Mathiesen; Alexander Lingas; Nikolaos Maliaras; Achilleas Chaldaiakis; John Plemmenos; Panagiotis Bamichas; Konstantinos Kardamis; Sophia Kontossi; Michael Economides; Dafni Tragaki; Ioannis Tsagkarakis; Konstantinos Chardas; Manolis Seiragakis; Stefanos Chianis; and Rudolf Brandl. (2019). "Greece." In *Grove Music Online*. Oxford: Oxford University Press.  
<https://doi.org/10.1093/gmo/9781561592630.article.3000000167>
- Russell, James C. (1994). *The Germanization of early medieval Christianity : a sociohistorical approach to religious transformation*. New York; Oxford: Oxford University Press.
- Sachs, Curt. (1943). *The Rise of Music in the Ancient World: East and West*. New York: W.W. Norton.
- Sayyid, Fuad. (1964): *Fihris al-makhtūtāt al-musawwara, juz. 4: al-ma.ārif al-āmma wa-l-funūn al-mutanawwi.a*. Baghdad.
- Schlesinger, Kathleen. (1939). *The Greek aulos; a study of its mechanism and of its relation to the modal system of ancient Greek music, followed by a survey of the Greek harmoniai in survival or rebirth in folk-music*. London: Methuen & Co.
- Schutz, Herbert. (2010). *The Medieval Empire in Central Europe: Dynastic Continuity in the Post-Carolingian Frankish Realm, 900-1300*. Newcastle upon Tyne: Cambridge Scholars Publ.
- Shafiei, Sepideh. (2021). "An Analysis of Iranian Music Intervals Based on Pitch Histogram." *arXiv:2108.01283 [cs.SD]*. Submitted 3 August 2021.  
<https://doi.org/10.48550/arXiv.2108.01283>
- Sherman, Bernard D. (1997). *Inside Early Music: Conversations with Performers*. New York; Oxford: Oxford University Press.
- Shiloah, Amnon. (1962). "Réflexions sur la danse artistique musulmane au Moyen-Age", *Cahiers de civilisation médiévale*, v, 463.74.
- Shiloah, Amnon. (1979): *The Theory of Music in Arabic Writings (c. 900.1900)*. Munich.
- Shiloah, Amnon. (1995). *Music in the world of Islam: A socio-cultural study*. Detroit: Wayne State University Press.
- Shiloah, Amnon. (2007). "Anonymous arabic treatises on music: lost legacies, hidden answers". In M. Bucciarelli & B. Joncus, eds., *Music as social and cultural practice: essays in honour of Reinhard Strohm* (pp. 11-23). Woodbridge, Suffolk: Boydell Press.
- Shkolnik, Irina (1998). "Byzantine prosomoion singing, a general survey of the repertoire of the notated stichera models (automela)." In *Cantus Planus: Papers read at the 7th meeting, Sopron, Hungary 1995*, edited by László Dobszay, 521–536. Budapest: Hungarian Academy of Sciences.
- Shkolnik, Irina (1999). "Stichera-automela in Byzantine and Slavonic sources of the late 11th–late 18th centuries." In *Palaeobyzantine notations II: Acta of the congress held at Hernen Castle (The Netherlands) in October 1996*, edited by Christian Troelsgård, 81–97. Hernen: A.A. Brediusstichting.

- Skoulios, Markos (2012). *Modern theory and notation of Byzantine chanting tradition: A Near-Eastern musicological perspective*. *NEMO-Online* 1(1): 19–38.  
<https://doi.org/10.5281/zenodo.5634143>
- Skoulios, Markos (2014). “Τα ανατολικά Μακάμ και ο ‘ορθός’ τρόπος Ραστ” [Eastern makams and the ‘right’ mode Rast]. *Πολυφωνία* 25: 103–126. Athens: Κουλτούρα.
- Snyder, John. L. (1983). “Theinred of Dover on Consonance: A Chapter in the History of Harmony”. *Music Theory Spectrum Music Theory Spectrum*, 5(1), 110-120.
- Snyder, John. L. (1990). “A Road Not Taken: Theinred of Dover’s Theory of Species”. *Journal of the Royal Musical Association*, 115(2), 145-181.
- Solie, Ruth A. (1982). “Melody and the Historiography of Music.” *Journal of the History of Ideas* 43, no. 2 (April 1): 297–308. <https://doi.org/10.2307/2709205>.
- Solomon, J. and Cleonides. (1980). *Cleonides, Eisagoge armonike critical edition, translation and commentary*.
- Solomon, Jon. (1984). “Towards a History of Tonoι.” *The Journal of Musicology* 3, no. 3: 242–251.
- Spencer, Herbert. (1858). *Essays: Scientific, Political and Speculative*. London: Longman, Brown, Green, Longmans, & Roberts.
- Spyrakou, Evangelia Ch. (2008). *Οί χοροί ψαλτῶν κατὰ τὴν Βυζαντινὴ παράδοσιν* [Cantors’ choirs according to the Byzantine tradition]. (Studies, 14). Athens: Ἴδρυμα Βυζαντινῆς Μουσικολογίας.
- Stathis, Gregorios Th. (1975). *Les Manuscrits De Musique Byzantine: Mont Athos. I*. Éditeur Non Identifié Ἴδρυμα Βυζαντινῆς Μουσικολογίας.
- Stathis, Gregorios Th. (1979). “An Analysis of the Sticheron *Τὸν ἥλιον κρύψαντα* by Germanos, Bishop of New Patras [The Old ‘Synoptic’ and the New ‘Analytical’ Method of Byzantine Notation].” In *Studies in Eastern Chant*, edited by Miloš M. Velimirović. Vol. 4:177–227. London & others: Oxford Univ. Press.
- Stathis, Gregorios Th. (1987). “Ἡ Ἐξήγησις τῆς Ψαλτικῆς Τέχνης” [“The Exegesis of the Psaltic Art”]. *Θεολογία* 58: 337–371.
- Stathis, Gregorios Th. (2016). *Τὰ Πρωτόγραφα τῆς Ἐξηγήσεως εἰς τὴν Νέαν Μέθοδον Σημειογραφίας* [The archetypes of the exegesis into the New Method of notation]. Vols. A–B. Athens: Ἴδρυμα Βυζαντινῆς Μουσικολογίας.
- Strunk, Oliver. (1942). The Tonal System of Byzantine Music. *The Musical Quarterly*, 28(2), 190-204.
- Strunk, Oliver. (1950). *Source readings in music history from classical antiquity through the romantic era*. New York: W.W. Norton.
- Strunk, Oliver. (1977). *Essays on music in the Byzantine world*. New York: W. W. Norton & Company.
- Strunk, O., Treitler, L., Mathiesen, T. J., McKinnon, J. W., Tomlinson, G., Murata, M. and Morgan, R. P. (1998). *Source readings in music history*. New York: Norton.
- Tardo, Lorenzo (1938). *L’antica melurgia bizantina nella interpretazione della scuola monastica di Grottaferrata*. Roma: Scuola Tipografica Italo-Orientale San Nilo.
- Taylor, Thomas (1804). *The Timaeus of Plato: Translated, with explanatory notes*. Reprinted edition, various publishers.
- Theotokatos, Nikolaos. (n.d.). “Ο β’ ἦχος κατὰ τὸν Χρῦσανθο ἐκ Μαδύτων” [The Second mode according to Chrysanthos of Madytos]. Online PDF.  
[http://www.sholeionpsaltikis.gr/media/files/eggrafa\\_pdf/N.%20TH.%202os%20ixos%20perili%20psi.pdf](http://www.sholeionpsaltikis.gr/media/files/eggrafa_pdf/N.%20TH.%202os%20ixos%20perili%20psi.pdf)
- Thodberg, Christian. (1966). *Der byzantinische Alleluiarionzyklus: Studien im kurzen Psaltikonstil*. transl. Holger Hamann. Monumenta Musicae Byzantinae, Subsidia 8. Kopenhagen: E. Munksgaard.
- Thomas, John and A. Constantinides Hero, eds. (2000). *Byzantine Monastic Foundation Documents: A Complete Translation of the Surviving Founder’s Typika and Testaments*. *Dumbarton Oaks Studies*. Washington, D.C.: *Dumbarton Oaks Research Library and Collection*.
- Tillyard, Henry J. W. (1918) “The Modes in Byzantine Music.” *Annual of the British School at Athens* 22: 133–156. <https://doi.org/10.1017/S0068245400009898>
- Tillyard, Henry J. W. (1923) *Byzantine Music and Hymnography*, London: Faith Press; reprint, New York: AMS Press, 1970.
- Tillyard, Henry J. W. (1930–1931). “Ἐωθινὰ Ἀναστάσιμα: The Morning Hymns of the Emperor Leo, Part II.” *Annual of the British School at Athens* 30–31: 86–108.
- Tillyard, Henry J. W. (1937). “Byzantine Neumes: The Coislin Notation”. *Byzantinische Zeitschrift*. 37 (2): 345–358. doi:10.1515/byzs.1937.37.2.345.

- Tillyard, Henry J. W. (1952). "The Stages of the Early Byzantine Musical Notation". *Byzantinische Zeitschrift*. 45 (Jahresband): 29–42. doi:10.1515/byzs.1952.45.1.29.
- Touma, Habib Hassan. (1996): *The Music of the Arabs*, Portland, OR.
- Treadgold, W. (1984). *Renaissances before the Renaissance: cultural revivals of late antiquity and the Middle Ages*, Stanford, Calif.
- Treitler, Leo. (1974). "Homer and Gregory: The Transmission of Epic Poetry and Plainchant". *The Musical Quarterly*, 60 (3), 333-372.
- Treitler, Leo (1984). "Reading and singing: On the genesis of occidental music-writing." *Early Music History* 4: 135–208.
- Troelsgård, Christian (1988). "Ancient musical theory in Byzantine environments". *Cahiers de l'Institut du Moyen-Âge Grec et Latin* 56: 228–238.
- Troelsgård, Christian. (1995). "Melodic variation in the 'marginal' repertoires of Byzantine musical manuscripts, exemplified by apolytikia/kontakia and exaposteilaria anastasima." In *Cantus Planus: Papers Read at the 9th Meeting of the IMS Study Group*, Sopron, 1995, 601–609.
- Troelsgård, Christian (ed.) (1999). *Palaeobyzantine notations II: Acta of the congress held at Hernen Castle (The Netherlands) in October 1996*. Hernen: A.A. Brediusstichting.
- Troelsgård, Christian. (2000). "The repertoires of model melodies (automela) in Byzantine musical manuscripts." *Cahiers de l'Institut du Moyen-Âge Grec et Latin* 71: 3–27.
- Troelsgård, Christian (2001). "What kind of chant books were the Byzantine sticheraria?" In *Cantus planus: Papers read at the 9th meeting, Esztergom & Visegrád, Hungary, 1998*, edited by László Dobszay, 563–74. Budapest: Institute for Musicology of the Hungarian Academy of Sciences.
- Troelsgård, Christian. (2003). "A handlist of the 'Standard Abridged Version' (SAV) of the Sticherarion according to Oliver Strunk" (PDF). *Cahiers de l'Institut du Moyen-Âge grec et latin*. 74: 3–20.
- Troelsgård, Christian. (2006). "Simple psalmody in Byzantine chant." In *Cantus Planus: Papers Read at the 12th Meeting of the IMS Study Group, Lillafüred/Hungary 2004, August 23–28*, 83–92. Budapest: Institute for Musicology of the Hungarian Academy of Sciences.
- Troelsgård, Christian. (2017). "Byzantine chant notation: Written documents in an aural tradition" [In memory of Kenneth Levy (\* New York 1927 — † Princeton 2013)]. In Bissera V. Pentcheva (ed.), *Aural architecture in Byzantium: Music, acoustics, and ritual*, 52–77. London: Routledge.
- Troelsgård, C., & G. Wolfram. (2022). *Byzantine Chant, Radiation and Interaction: Proceedings of the Congress Held at Hernen Castle, the Netherlands, in December 2015*. Eastern Christian Studies 29. Louvain / Leuven: Peeters Publishers. Accessed 28 Feb. 2024.
- Trompf, G. W. (1973). "The Concept of the Carolingian Renaissance". *Journal of the History of Ideas*, 34(1), 3-26.
- Turco, Alberto. (1992). *Il canto antico di Milano: La salmodia alleluatica e antifonata nelle fonti manoscritte*. Vol. 1. Quaderni Di "Studi Gregoriani". Roma: Torre d'Orfeo.
- Ursprung, O. (1934). "Um die Frage nach dem arabischen Einfluss auf die abendländische Musik des Mittelalters", *Zeitschrift für Musikwissenschaft*, xvi, 129.41
- Uspenskiy, Boris Aleksandrovič, ed. (2006). *Типографский Устав: Устав с кондакарем конца XI — начала XII века [Tipografsky Ustav: Ustav with Kondakar' end 11th-beginning 12th c. (vol. 1: facsimile, vol. 2: edition of the texts, vol. 3: monographic essays)]. Памятники славяно-русской письменности. Новая серия. Vol. 1–3. Moscow: Языки славянских культур.*
- Vassileiou, Marcos (1906-7). "Περὶ τοῦ στενογραφικοῦ ἢ ἱερογλυφικοῦ τῆς παρασημαντικῆς τῆς ἀρχαίας ἐκκλησιαστικῆς μουσικῆς" [On the shorthand or hieroglyphic character of the notation of ancient ecclesiastical music] *Ἐκκλησιαστικὴ Ἀλήθεια* 30 (1906), 416-418, 447-448, 483-484, 645-647; cont. in vol. 31 (1907), 9-11.
- Velimirović, Miloš M., and Egon Wellesz (1966). *Studies in Eastern chant*. Vol. 1. London: Oxford University Press.
- Velimirović, Miloš (1968). "H. J. W. Tillyard, Patriarch of Byzantine Studies". *The Musical Quarterly* LIV, no. 3 (July). 341–351.
- Velimirović, Miloš, and Egon Wellesz (1973). *Studies in Eastern chant*. Vol. 3. London: Oxford University Press.
- Velimirović, Miloš, and Egon Wellesz (1979). *Studies in Eastern chant*. Vol. 4. Crestwood, NY: St Vladimir's Seminary Press.
- Velimirović, Miloš; Lozovaya, Irene; Myers, Gregory; De Carlo, Leonora. (2001). "Russian and Slavonic church music". *New Grove Music Online*. *Oxford Music Online*. Vol. 1. doi:10.1093/gmo/9781561592630.article.43458.

- Walker, Jonathan. (1996). "Intonational Injustice a Defense of Just Intonation in the Performance of Renaissance Polyphony." *Music Theory Online* <https://doi.org/10.30535/mto.2.6.3>.
- Wason, Robert. W. (2002). "Musica practica: music theory as pedagogy". In T. S. Christensen, ed., *The Cambridge History of Western Music Theory* (pp. 46-77). Cambridge: Cambridge University Press.
- Weincke, Peter (1987). "Some observations on the interpretation of signatures and accidentals in East and West." *CIMAGL* 54: 61–72.
- Wellesz, Egon (1947). *Origins of Byzantine music. Bulletin of the American Musicological Society*, no. 25, 25–26.
- Wellesz, Egon. (1954). "Gregory the Great's Letter on the Alleluia." *Annales Musicologiques* 2: 7–26.
- Wellesz, Egon. (1961). *A History of Byzantine Music and Hymnography*, 2nd, revised and enlarged ed. Oxford: Clarendon Press. First published 1949.
- Wellesz, Egon, and Miloš Velimirović (1971). *Studies in Eastern chant*. Vol. 2. London: Oxford University Press.
- Werf, Hendrik van der. (1983). *The Emergence of Gregorian Chant: A Comparative Study of Ambrosian, Roman and Gregorian Chant*. Rochester, N.Y.: H. van der Werf.
- Werner, Eric. (1959). *The Sacred Bridge: The Interdependence of Liturgy and Music in Synagogue and Church During the First Millennium*. London: Dennis Dobson.
- West, Martin L. (1992). *Ancient Greek Music*. Oxford University Press.
- Whaley, Joachim. (2012). *Germany and the Holy Roman Empire*. Oxford: Oxford University Press.
- Williams, Edward V., and Christian Troelsgård. (2001). "Akolouthiai." In *The New Grove dictionary of music and musicians*. Oxford: Oxford University Press. <https://doi.org/10.1093/gmo/9781561592630.article.00384>
- Wilson, David. F. (1990). *Music of the Middle Ages: style and structure*. New York: Schirmer.
- Winnington-Ingram, Reginald P. (1928). "The spondeion scale: Pseudo-Plutarch *De musica* 1134f–1135b and 1137b–d." *The Classical Quarterly* 22, no. 2: 83–91.
- Winnington-Ingram, Reginald P. (1984). *Aristides Quintilianus, On Music. In three books: translation, with introduction, commentary, and annotations by Thomas J. Mathiesen*. New Haven and London, Yale University Press, 1983. xiii + 217 pp. *Early Music History*, 4, 375-380.
- Wolfram, Gerda (1995). "Die *Phthorai* der paläobyzantinischen Notationen." In *Palaeobyzantine Notations: A Reconsideration of the Source Material*, edited by Jørgen Raasted and Christian Troelsgård, 119–129. Hernen: A. A. Bredius Foundation. Available online: <https://archive.org/details/palaeobyzantine-notations/Palaeobyzantine%20Notations%20I/>
- Wolfram, Gerda (2001). "Fragen der Kontinuität zwischen antiker und byzantinischer Musiktheorie." *Cantus Planus: Papers read at the ninth meeting*. Budapest: Magyar Tudományos Akadémia, 575–584.
- Wolfram, Gerda. (2001). "Stichërarion." *Grove Music Online*. Oxford University Press. Accessed [21 Dec 2025]. <https://www.oxfordmusiconline.com>
- Wolfram, Gerda and C. Troelsgård. (2008). *Tradition and Innovation in Late- and Postbyzantine Liturgical Chant: Acta of the Congress Held at Hernen Castle the Netherlands in April 2005*. Leuven: Peeters.
- Wolfram, Gerda and C. Troelsgård. (2013). *Tradition and Innovation in Late- and Postbyzantine Liturgical Chant II: Proceedings of the Congress Held at Hernen Castle the Netherlands 30 October - 3 November 2008*. Leuven: Peeters.
- Wolfram, Gerda. (2021). "The Byzantine modal system in relation to ancient Greek music theory." *Series Musicologica Balcanica* [Online], 1.2, 200–208. Accessed 23 February 2024.
- Wolfram, Gerda, and C. Troelsgård., eds. (2021). *Der Traktat des Akakios Chalkeopulos zum Byzantinischen Kirchengesang*. Turnhout: Brepols. ISBN 978-2-503-58970-1.
- Wright, Craig. M. (1989). *Music and ceremony at Notre Dame of Paris, 500-1550*. Cambridge [England]; New York: Cambridge University Press.
- Wright, Owen. (1978). *The modal system of Arab and Persian music, A.D. 1250–1300*. Oxford: Oxford University Press.