Towards a Model of Gravitonicity

Towards a Model of Gravitonicity:

Distance in Harmony

By

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Yet there—in fields of space—is where she shines,
Ring-mistress of the circus of the stars,
Their prancing carousels, their ferris wheels
Lit brilliant in celebration. Thanks to her
All's gala in the galaxy.

A stanza from "Gravity" (1990, 13) by John Frederick Nims.

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PREFACE

This book develops a model of the "gravitation" in Music that is hoped to benefit practitioners, analysts, and educators from many musical backgrounds. In the literature on the "gravitational" properties of melody and harmony, two sub-metaphors are apparent: "distance" (the focus here) and "motion". Gravitation and Music's "gravitation" are, therefore, fundamentally separate categories. To benefit from the metaphor without equating the experience of the two, Music's "gravitation" is designated as "Gravitonicity".

The model is developed from three research questions: "What is Gravitonicity?"; "How and to what extent is it possible to derive a model of Gravitonicity from the "neutral level" (Nattiez, 1990, 12)?" (e.g., music theory); and "How does the listener construct the meaning (Nattiez's "esthesic dimension") of Gravitonicity and to what extent can this lead to a subjective experience?".

Conceptual metaphor theory (Lakoff and Johnson, 1980; 1999) is used to reason that the "distance" is metaphorically shaped by our embodied understanding of physical distance. Steve Larson (2012) uses the same approach to explain the "motion" alongside music-theoretic explanations. Together, these accounts form an understanding of what Gravitonicity "is".

Music-theoretic explanations of the "distance" have been historically sporadic and with little consistency in approach–an important exception being a twentieth-century lineage with interest in the harmonic series. Addressing this lacuna, audio spectrum analysis is undertaken in conjunction with Chord Scale Theory (Nettles and Graf, 1997) to reveal "Gravi-Tone Series'" ("GS'"): specific mappings of twelve "distance" ("*g*") values onto all twelve pitch classes ("gravi-tones"). It is argued that the GS' are attributed by a psychological process entitled "Gravi-Tone Series Filtering" (GSF) which accounts for present tone(s), their harmonic spectra, memory traces of preceding tone(s), and a mysterious unified time dimension.

In response to the third research question, John Shepherd and Peter Wicke's "Semiological Model" (1997, 173) is used to extrapolate meaning construction and illustrate how Gravitonicity may be negotiable for "different individuals and in the same individual at different times" (175). With a potentially unifying perspective on all types of scales, harmony, and functionality, Gravitonicity could belong to the general theory of music.

This project would not have been possible without the help of many others. Firstly, I would like to express sincere gratitude to Miroslav Spasov. In addition to unwavering professional and personal support, his influence is felt in these pages through encouragement of original thinking and practical value. I am also profoundly grateful that my musical creativity was actively stimulated in the time of writing by Ilija Pejovski.

Two guitar tutors deserve special mentions for the pivotal roles they played in my development. Chris Connelly was the first person who made music feel available to me. His advice that a great musician should master *all* the modes has been a guiding light. I also owe a debt to Brian Chell for introducing me to the jazz guitar repertoire.

I have been uncommonly blessed with a family who have offered unconditional love, patience, and a willingness to listen. My canine friends, Leo and Skye, have also brought their own indispensable brand of support. Finally, without Lauren, I would not have reached this point: Gravitonicity was realised through our love, laughter, and happiness.

Staffordshire, England
September 2025 ***J.S.***

CHAPTER 1

INTRODUCTION

A gravitational perspective on harmony can lead to a revitalised understanding of its morphology, aesthetics, and syntactical relations. This connection was first made by Jean-Philippe Rameau in *Génération harmonique* (1737), published only half a century after Sir Isaac Newton's Universal Law of Gravitation in *Philosophiæ Naturalis Principia Mathematica* (1687) ("The Mathematical Principles of Natural Philosophy"). Although Rameau was the first to use the metaphor, discourse on the "gravitational" properties of music can be traced back to the Ancient Greeks; not unlike the pre-Newtonian recognition of gravitation by figures such as Aristotle (384-322 BCE) and Galileo Galilei (1564-1642 CE)

However, whereas the study of gravitation has enjoyed the breakthroughs of Newton, Albert Einstein (1920), (arguably) string theory, and LIGO's detection of gravitational waves (2016), there have been no analogous milestones for the study of Music's "gravitation". The literature for the latter has been historically sporadic and with little consistency in approach–an important exception being a twentieth-century lineage with interest in the harmonic series.

Moreover, whilst there have been some significant individual contributions, no single work or theorist has produced a "complete", systematic model of Music's "gravitation" that offers a perspective on the existing literature and addresses the lacunae. That is the gap that motivated this book which, in response to the following research questions, aims to decipher what Music's "gravitation" is, model it, and account for the listener's subjective experience. "Gravitonicity" and Jean-Jacques Nattiez's terms are discussed further down the page.

RQ1: What is Gravitonicity?

RQ2: How and to what extent is it possible to derive a model of Gravitonicity from the "neutral level" (Nattiez, 1990, 12)?

RQ3: How does the listener construct the meaning (Nattiez's "esthesic dimension") of Gravitonicity and to what extent can this lead to a subjective experience?

Other metaphors for Music's "gravitation" have been used since Ancient Greece (Rothfarb, 2002) e.g., "*dynameis*" (Aristoxenus, 1990, 180–first documented ca.330 BCE), "germination and growth" (Rothfarb, 2002, 933–attributed to Adolf Bernhard Marx, 1795-1866), "kinetic" and "potential energy" (940–Ernst Kurth, 1886-1946) etc. However, the gravitation metaphor was selected for five reasons: its frequent historical and contemporary usage; the omnipresence of physical gravity means that its properties are intuitively understood at a universal level; several of the key figures in the field and their contributions tend to be common knowledge (e.g., Newton and the apocryphal apple); the research into physical gravity brings an effective array of terminology and detail to the metaphor; and the two types of gravitation share a similar all-encompassing nature.

Despite some metaphorical correlation, however, it is not a 1:1 relationship. The following paragraphs will begin to illustrate that Music's "gravitation" is experienced as "distance" (the focus here) and "motion". From this point on, Music's "gravitation" will be referred to as "Gravitonicity". This name retains the essence of the gravitation metaphor without equating the experience of the two and will receive additional justification in the coming pages.

Lee Rothfarb's *Energetics* (2002) offers a historiography of the "motion": "what moves in music?" and "what constitutes movement in music?" (928). "In a melody", he writes, "a tone of some frequency is replaced by a new one of a different frequency" as "two distinct tones (pitch plateaus)" without "continuous transition" (929). Rothfarb points to an "impelling force […] that induces the changes perceived as musical motion" and proceeds to assemble a chronology of theorists who have identified and described the "impelling force".

Post-dating Rothfarb's article, Steve Larson's posthumously published *Musical Forces* (2012) offers a detailed perspective on "motion" that seemingly subsumes similar earlier literature through a systematic review (e.g., Narmour, 1990; Bharucha, 1996; Lerdahl, 2001; Margulis, 2003 etc). Larson identifies and defines "three melodic forces" (2012, 2) e.g., "'melodic magnetism' is the tendency of unstable notes to move to the closest stable pitch, a tendency that grows stronger as the goal pitch is closer".

The "distance" of Gravitonicity goes unobserved in Rothfarb's historiography. However, in covering harmony treatises from the eighteenth and early nineteenth centuries, Rothfarb quotes François-Joseph Fétis' (1784-1871) "theory of energy-laden tones operating in a dynamic force field" (Rothfarb, 2002, 934). Victor Zuckerkandl has similarly argued that "Motion […] always implies something that does not move or that moves

differently–a frame, a background, against which the motion appears as motion" (1956, 95). This distinction between "motion" and a "frame" / "background" / "force field" (Rothfarb, 2002, 934)–all evocative of the "distance" metaphor–is of central importance. To understand how the "motion appears as motion" (Zuckerkandl 1956, 95), there must first be an understanding of the field it inhabits.

The distinction between the RQ2 and RQ3 accounts of Gravitonicity is based on Jean Molino's "Semiological Tripartition" (Nattiez, 1990, 10), as adopted by Jean-Jacques Nattiez. Molino and Nattiez propose three dimensions of symbolic phenomena in music:

> (1) "The poietic dimension" (11), which is concerned with the "process of creation" and the factors which influence it e.g., historical, political, social etc.
> (2) "The esthesic dimension" (12), involving the reception of symbolic phenomena by the "receivers" and their attribution of meaning(s) to it/them. However, Nattiez notes that "'receiver'' is [...] a bit misleading. [...] we do not ''receive'' a message's meaning (since the producer intended none) but rather construct meaning".
> (3) The "neutral level", which is the physical and material embodiment of the "symbolic form" (e.g., the musical text), typified by Nattiez as a "trace" and by Molino as the "niveau neutre [neutral level] or niveau matériel [material level]". Nattiez states that "an objective description of the neutral level can always be proposed–in other words, an analysis of its immanent and recurrent properties". Such an "objective description" requires the "poietic and esthesic dimensions of the object" to be ""neutralized"" (13) and for the analytical tools to be "systematically exploited".

The model produced in response to RQ2 will "neutralize" the "poietic" (11) and "esthesic" (12) dimensions to provide "an objective description" of Gravitonicity at the "neutral level". The "neutral level" model identifies pitches–metaphorically styled as "gravi-tone(s)"–as the mediators of Gravitonicity ("distance" and "motion"). Their "distance" is attributed by a psychological "filtering" process–styled as "Gravi-Tone Series Filtering"–which accounts for present tone(s), their harmonic spectra, memory traces of preceding tone(s), and a mysterious unified time dimension. Steve Larson's (2012) conception of "motion" will be positioned as a separable component of the "neutral level" (Nattiez, 1990, 12) model.

However, because we "construct meaning" in the "esthesic dimension", it cannot be completely "neutralized" (13) by the "neutral level" (12) model. Instead, the model offers a music-theoretic description of how "the musical text" gives rise to meaning construction through our experiential application of the distance and motion metaphors. It is argued in Chapter 4 that the

application of these metaphors may have a significant cultural reach. It is also acknowledged that some cultures may use other metaphors or experience music without meaning.

The purpose of RQ3 is to build upon the "neutral level" (Nattiez, 1990, 12) model of Gravitonicity by extrapolating how meaning is constructed in the "esthesic dimension". This is achieved by drawing upon the "Semiological model" (1997, 173) from John Shepherd and Peter Wicke's *Music and Cultural Theory*. Their work is used to frame and weave a semiological strand through the "neutral level" (Nattiez, 1990, 12) model and its metaphors. This creates space for a "SLIPPAGE" (Shepherd and Wicke, 1997, 173) or "Negotiation" (174) of meaning "in different individuals and in the same individual at different times" (175).

Together, the "neutral level" (Nattiez, 1990, 12) model and the extrapolated "esthesic dimension" form the full model of Gravitonicity. Molino and Nattiez's "poietic dimension" (11) is not addressed because it would shed no further light on how Gravitonicity works or is experienced. Moreover, perhaps because Gravitonicity has been an unsystematised property of music, creators' accounts of it can be difficult to trace–particularly for individual pieces and bodies of work. In future research, however, such accounts could provide interesting access points from which the analyst proceeds to apply the model assembled here. The model aims to be of value to practitioners, analysts, and educators from many musical backgrounds.

1.1: Dimensions of Gravitonicity

The "neutral level" (Nattiez, 1990, 12) of Gravitonicity will be observed, analysed, and systematised within a framework of dimensions that is mentally assembled in the act of listening. To an extent, these dimensions are graphically represented by the axes of music notation. Where they are not, they will be illuminated in Chapter 3. The dimensions / axes include: the monophonic succession of pitch events (X axis); multilayered superimposed pitch events (Y axis); a unified time dimension that conveys the interrelationships between harmony and rhythm (Z axis); time (T axis); and a set of further dimensions that each house a different kind of "motion".

Fig. 1.1a illustrates the X axis with the isolated melody voice of Wes Montgomery's (1961) introduction to the jazz standard *Angel Eyes* (Dennis and Brent, 1946).

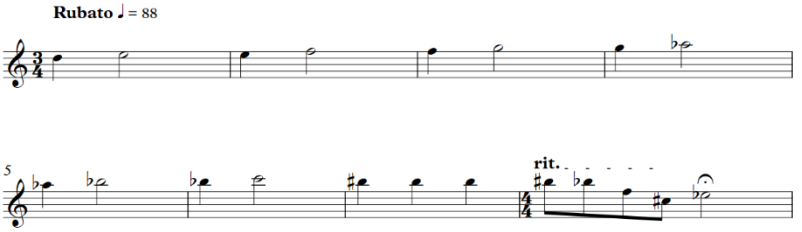

Fig. 1.1a: The melody (X axis) of Montgomery's introduction to *Angel Eyes* (1961).

In discussions of melody and harmony, it is common to see this axis referred to as "horizontal". This label is not used in this research because, whilst the monophonic line undoubtedly moves horizontally across the stave, there is also a verticality in the ascents/descents of pitch. Fig. 1.1b illustrates the Y axis with the chord Montgomery uses to harmonise the first melody note of *Angel Eyes* (1961).

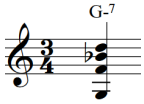

Fig. 1.1b: Montgomery's harmonisation (Y axis) of the first melody note of *Angel Eyes* (1961).

In a similar fashion to the X axis and the "horizontal" label, it is common to find the Y axis being referred to as "vertical". This is as equally problematic as the "horizontal" / X because any example of multilayered superimposed pitch events possesses a duration and is thus not a strictly vertical or "frozen" phenomenon. The duration necessitates the inclusion of the time (T) axis. Moreover, each of the tones in the chord may function as melody voices i.e., individual X axes.

Music can exist in three combinations of the four dimensions named thus far. The first "combination" is a lone T axis which may be characterised by silence, such as John Cage's *4'33''* (1952), or music in which there is an absence of discernible pitch to populate an X or X and Y axes. The second combination is realised when the passage of time (T) is decorated with a monophonic succession of pitches (X), which may also enable the unified time dimension (Z): X/Z/T. Finally, the third dimensional combination (X/Y/Z/T) introduces the multilayered superimposed pitch events (Y)

which, once unified with the other axes / dimensions, opens the door to the remaining homophonic, heterophonic, and polyphonic textures.

Because properties of harmony and melody will be the focus of this research, the first dimensional combination will only be addressed in the context of memory i.e., the "empty" space following pitch content. Similarly, whilst dimensional combination two will be found and discussed in the analyses, the general presence of the Y axis in most music throughout history and from all over the world–including the superimposition of a melody and drone–means that dimensional combination three will predominate.

Fig. 1.1c shows this combination of the X/Y/Z/T dimensions through a rearrangement (Shufflebotham, 2020a) of Montgomery's introduction to *Angel Eyes* (1961). The combination of X and Y can be understood as the Y axis building harmony into the monophonic line (X), or the X axis enabling successions of the multilayered superimposed pitch events (Y). Whilst the time (T) dimension is discernible from the tempo marking and rhythmic values, both it and the unified time dimension (Z) will receive additional explanation and analytical strategies in Chapter 3. The "motion" dimensions will be discussed shortly after.

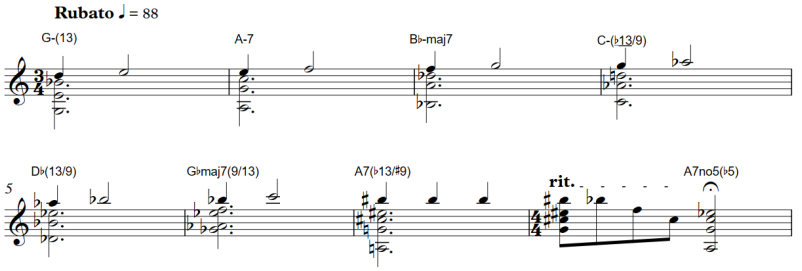

Fig. 1.1c: A rearrangement (Shufflebotham, 2020a) of Montgomery's introduction to *Angel Eyes* (1961), demonstrating the X/Y/Z/T axes. The approach to chord symbols will be explained deeper into the text.

1.2: The Evolution of Harmony in Western Music

This section will provide an historical account of how harmony has evolved in Western music. The major evolutionary stages of this account will be cross-referenced as Gravitonicity is modelled. Unless specified otherwise, the dates and historical records which follow have largely been drawn from *A History of Western Music* (Burkholder et al., 2014).

The earliest historical records of Western music are the Babylonian writings (ca.1800 BCE) which indicate knowledge of intervals and a seven-note diatonic scale with a corresponding modal system. Either directly or indirectly, these theoretical components influenced the theorising and practice of the Ancient Greeks: Pythagoras (ca.580–ca.500 BCE) is credited with the relation of concordant intervals to ratios; Aristoxenus' *Elementa Harmonica, Book II* (1990–first documented ca.330 BCE) distinguished between melodies, intervals, and scales; and Cleonides (dates uncertain) is recognised for documenting the modes, relating them to their "ancient" (Burkholder et al., 2014, 16) names and/or "styles of music practiced in different regions of the Greek world" (17) e.g., Dorian, Phrygian, Lydian etc.

The modes can be traced into the first millennia CE through the early Christian Church and the eight modes or echos (pl. echoi) of Byzantine chant, which "served as a model for the eight modes of the Western Church" (28). However, the Church modes would retain none of their Greek names (instead being numbered as "Mode 1", "Mode 2" etc.)–despite the Roman scholar Boethius (ca.480-ca.524) re-exploring the teachings of Ancient Greece–and gained additional functions e.g., authentic/plagal versions, finals, and reciting tones.

Boethius' work was ultimately acknowledged in the ninth century as writers began to apply the Greek names to the Church modes. However, the writings were misread, and the modes were labelled incorrectly. As a result, there is no connection between the Greek and Church versions of, for example, the Lydian mode.

The next significant development occurred ca.850–ca.900 with the documentation of the Y axis in the anonymous theoretical text "*Musica enchiriadis* (Music Handbook) and an accompanying dialogue, *Scolica enchiriadis* (Comments on the Handbook)" (Burkholder et al., 2014, 39). These works use the term "organum": "two or more voices singing different notes in agreeable combinations according to given rules" (85). Although organum "was apparently already an old practice" by the time these works were published and the use of a drone can be traced back to "antiquity or even prehistoric times", this might be recognised as the "official" signposting of a general historical shift from dimensional combination two (X/Z/T) to three (X/Y/Z/T).

The practice of organum would evolve through a series of stages until the thirteenth century: the earliest forms of organum are documented by "*Musica Enchiridias*" (39) and later by Guido of Arezzo's "*Micrologus* (ca.1025-28)" (86); "note-against-note organum" (88) is documented by "*Ad organum faciendum* (On Making Organum, ca.1100)"; Aquitanian

polyphony (early twelfth century) is preserved primarily in music manuscripts; and the two leading figures of Notre Dame Polyphony (late twelfth and early thirteenth centuries), Leoninus and Perotinus, are well-documented in the treatise "Anonymous IV" (93) written in "about 1285".

In all stages of its evolution, organum is characterised by a respect towards Pythagoras' concordant intervals (fifths, fourths, and unisons / octaves), particularly at points of resolution. However, the hold of these intervals was weakened with each evolutionary stage. In the Notre Dame style, for example, there is an inclination towards third and sixth intervals. Influenced by the French, the English would go further by using these intervals as consonances, as documented by Gerald of Wales in "about 1200" (107). The emphasis on these intervals foreshadows the arrival of triadic harmony, the phasing in of the tonal system, and the subsequent phasing out of modality.

The latter stages of organum are not the first evidence of denouncing the modes. In the use of the church modes, for example, it was common for the note B of "modes 1, 2, 4, 5, and 6" (Burkholder et al., 2014, 41) to be replaced with Bb. The effect of this change on mode 1 (Dorian), which had the final D, would be a conversion to the Aeolian mode. Likewise, the effect for mode 5 (Lydian), which had the final F, would be a conversion to the Ionian mode.

Because the Ionian and Aeolian modes represent the major and natural minor scales, respectively, it can be understood that the seeds of tonal dominion were begun to be sewn prior to the thirds and sixths of the Notre Dame and English styles of organum. Later, in the fourteenth through sixteenth centuries, a similar seed known as musica ficta ("feigned music") would be sewn. This involved semitone adjustments of scale degrees to enable smoother (more tonal) cadences, thereby undermining the purity of a mode.

The third and sixth intervals became more prominent in the fourteenth century through the French Ars Nova style, best demonstrated in the music of Guillaume de Machaut (ca.1300-1377), and the Italian Trecento music, as in the works of Francesco Landini (ca.1325-1397). In both traditions, these intervals still required resolutions to the stronger Pythagorean consonances. Moving into the Renaissance, however, the third and sixths joined the consonances and no longer required resolutions, as documented by Johannes Tinctoris' "*Liber de arte contrapuncti* (A Book on the Art of Counterpoint, 1477)" (154).

A concurrent change in harmonic approach was recorded by theorist Pietro Aaron's "*Toscanello in musica* (Venice 1524)" (156), which states that composers began to consider the individual contrapuntal lines "all

together". In other words, harmony eased away from being a "coincidence" of multiple superimposed X axis lines and drew closer to the Y axis phenomenon it is generally understood as today. These changes in the harmonic conception are clear in a type of improvised English polyphony called faburden, evidenced in the music of John Dunstable (ca.1390-1453), which inspired a similar French technique known as fauxbordon, demonstrated in the work of Guillaume Du Fay (ca.1397-1474).

The new harmonic consonances posed challenges to the existing systems of tuning. In Pythagorean intonation ("the tuning system used throughout the Middle Ages" (157), the thirds and sixths have dissonant, complex ratios e.g., the major third ratio is 81:64. Just intonation, on the other hand, "which performers had probably been using forms of […] for many years", makes these intervals consonant by simplifying their ratios (e.g., major third = 5:4) at the expense of detuning other intervals.

The common solution was to use compromise tuning systems called temperaments. Mean-tone temperament, which compromises the fifths to improve the thirds, was first adopted by keyboard players in the sixteenth century and would continue to be used in different forms alongside other modified temperaments "through the late nineteenth century" (158).

Equal temperament, in which the semitones are spaced evenly and was "first described by theorists in the late 1500s", is the tuning system that is most used today–although many exist. In the interests of being widely accessible, the "neutral level" (Nattiez, 1990, 12) model of Gravitonicity produced in Chapters 2 and 3 will be based on equal temperament. However, it will become clear that the principles are applicable to any tuning system.

The Renaissance was also a time of renewed interest in Greek theory. Franchino Gaffurio (1451-1522), for example, "revived the Greek names" (Nettles and Graf, 1997, 12) of the modes in his ""Practica musice" (Milan, 1496)". In the "*Dodekachordon* (The Twelve-String Lyre, 1547)" (Burkholder et al., 2014, 159), Heinrich Glareanus (1488-1563) introduced the Aeolian and Ionian modes with the finals on A and C, respectively, forming the basis of relative major-minor harmony; reflecting an increasing awareness of tonality. According to *The Chord Scale Theory & Jazz Harmony* (Nettles and Graf, 1997), a text which will play a valuable role in this research, "the essential concept of modal scales and their names used today traces back to Glarean" (12). Lastly, Gioseffo Zarlino's ""*Le Institutioni Harmoniche*" (Venice, 1558)" (Nettles and Graf, 1997, 12) would discuss the differences between the "modern modes" and the Greek modes in how the former "rely only on melodic and harmonic factors" and not cultural, geographic, affective qualities etc. Zarlino's work also

"classified all chords as major and minor" (14), thus laying the foundations of triadic harmony.

In addition to the new consonances, throughout the Renaissance there emerged a more sophisticated attitude towards dissonance and its potential expressive qualities. This can be traced through: the application of suspensions by the Franco-Flemish composers (1450-1520) and their more frequent but discreet use by Giovanni Pierluigi da Palestrina (1525/1526-1594); the use of direct chromatic motion (not seen since the music of Ancient Greece) in the Italian madrigals of Cipriano de Rore (1516-1565) and Nicola Vincentino (1511-ca.1576); and the unprepared and traditionally incorrectly resolved dissonances in the "seconda practica" (Burkholder et al., 2014, 298) of Claudio Monteverdi (1567-1643).

The harmony of the Baroque period is distinguished from that of the Renaissance by the rise of a Y axis-oriented, chord-based approach. In particular, the change was marked by a new harmonic interdependency where each Y axis structure belongs to a clear harmonic succession– something that was previously only manifested in cadences. This new harmonic conception is evidenced by a notation system called thoroughbass, in which the melody and bass parts are composed whilst the inner voices are provided by an accompanist's interpretation of chord symbols (known as figured bass). According to *A History of Western Music*, "musicians in the early seventeenth century" (306) still considered themselves to be composing modal music, but music being written "by the last third of the century" was clearly tonal. The modes became "subordinated to the imperial power of the tonal system" (Vieru, 1993, 16).

Like modality, the evolution of the tonal system would be gradual. Three of the key composers responsible for its initial development include: Jean-Baptiste Lully (1632-1687), whose cadential evasions depend "on the listener's expectations for tonal music" (Burkholder et al., 2014, 361); Alessandro Scarlatti (1685-1757), who integrated chromaticism and diminished seventh chords into the tonal system; and Arcangelo Corelli (1653-1713) who used suspensions, secondary dominants, diminished sevenths and Neapolitan sixth chords, and the later standardised modulations to the relative major / minor and dominant keys.

Corelli's broad tonal language was used in Jean-Philippe Rameau's landmark publication "*Traité de l'harmonie* (Treatise on Harmony, 1722)" (425) which "founded the theory of tonal music". Amongst other significant contributions, Rameau's treatise introduced the labels of tonic, dominant, and subdominant. Later, in *Harmony Simplified or the Theory of the Tonal Functions of Chords* (1893), the renowned theorist Hugo Riemann would

develop Rameau's ideas and designate these labels as "function(s)", having "borrowed the word from mathematics" (Hyer, 2002, 736).

It will be shown that Gravitonicity operates through functionality and can thus be limited when analysing music which overtly denies functional categorisation. The concept of functional harmony is neatly summarised in the following passage from *The Chord Scale Theory & Jazz Harmony* (Nettles and Graf, 1997, 30):

> Every chord has a function or tonal responsibility. When we hear a chord progression we match each chord sound to a function. How is the chord working to make the music progress forward? Our subconscious instantly justifies the chord's function as it passes our mind's ear even if it is a chord one had previously not expected to hear. Perception of function occurs in a split second. The more experienced the listener, the better the understanding of how each event relates to the total picture.

Post-Rameau's treatise, the tonal system was "completely crystallized" (Vieru, 1993, 16) in the works of J.S. Bach (1680-1750): "the peak from which one can look down on the past of European music, but also on its future". *The Well-Tempered Clavier, BWV 846-893* (1722 and 1742), for example, demonstrated the complete freedom of modulation (enabled by the tempered tuning systems) to all twenty-four major and minor keys.

Bach's harmonic language represents a tonal line in the sand that would persist throughout the Classic period and only begin to be caught by the tide in the Romantic foreshadowing of Joseph Haydn's late works. For example, *A History of Western Music* (Burkholder et al., 2014) highlights "the six quartets of Op. 76 (ca.1796-97)" (535) and cites Haydn's use of "chromatic progressions, chromatic chords, enharmonic changes, and fanciful tonal shifts".

The tonal system was increasingly challenged and exerted to its limits by the harmonic pioneers of the Romantic period: the music of Franz Schubert (1797-1828) shows a proclivity for tonic major / minor key relationships and modulation by a third instead of a fifth; Fryderyk Chopin (1810-1849) regularly used harmonies with "nonfunctional relationships" (Nettles and Graf, 1997, 162) and chromaticism; Franz Liszt (1811-1886) utilised symmetrical divisions of the octave such as the whole-tone and octatonic scales, and the third intervals in diminished seventh chords and augmented triads; and Richard Wagner (1813-1883) exploited the outer reaches of tonality with denied resolutions, resolutions to dissonances, chromatic alterations, and restless key changes.

Anatol Vieru writes that "When any sound could be included in any tonality, the tonal system was, logically speaking, "consumed"" (1993, 16).

This did not mean its "putting out of use", but rather the supplanting of its "imperial role" by a bifurcation into two harmonic approaches which continue alongside tonality to the present: (1) atonality and the later twelve-tone technique (dodecaphony), and (2) a reawakened interest in modality which is labelled by Vieru as "the new modalism".

The seeds of the former are evident in the harmony of late Romanticism, would germinate when Arnold Schoenberg (1874-1951) began to compose the first atonal pieces in 1908, and flourished with Schoenberg's invention and application of the twelve-tone technique in the 1920s. The twelve-tone technique has a lineage through Schoenberg's students Alban Berg (1885-1935) and Anton Webern (1883-1945), and would later give rise to total/integral serialism in the works of Milton Babbitt (1916-2011), Karlheinz Stockhausen (1928-2007), and Pierre Boulez (1925-2016).

As noted above, Gravitonicity operates through functionality. An example in Chapter 3 will illustrate that, whilst functionality can be found to varying degrees in atonal, twelve-tone, and serial music, the tendency of these styles to deny functional categorisation means that Gravitonicity's role may be severely limited.

The second branch of the bifurcation, "the new modalism" (Vieru, 1993, 16), also emerged in the latter half of the Romantic period. It can be traced through composers (to name only a few) such as Modest Mussorgsky (1839-1881), Nikolay Rimsky-Korsakov (1844-1908), Claude Debussy (1862-1918), Alexander Scriabin (1872-1915), and Olivier Messiaen (1908-1992), and became foregrounded in jazz through the release of Miles Davis' *Kind of Blue* (1959a).

Unlike the atonality / twelve-tone / serialism branch, "the new modalism" has not witnessed a Schoenbergian figure or clear lineage and was only theoretically explored in the late twentieth century by Vieru's *The Book of Modes* (1993). Whilst this neglect can be attributed to the historic dominion of tonality, Vieru alludes to another reason in terms of "modal density" (50). He considers the twelve-tone method as a mode that is "condemned to density 12" (17) (e.g., containing all notes of the chromatic scale) and, because of this, "the premises and theoretical conclusions were obvious from the beginning".

If the twelve-tone method is considered as a single mode of "the new modalism" (16), then all the remaining densities (number of pitch classes)– and the vast number of pitch collections and modal permutations for each– remains particularly fertile ground. Moreover, each of these modes can be combined successively to create new functional relationships. This is an area where the findings of Gravitonicity could potentially offer clues to the future evolutionary stages of harmony.

CHAPTER 2

THEORISING "DISTANCE"

This section will establish a theoretical framework for modelling "distance". Once the framework is in place, it will be used to consider the approaches of Arnold Schoenberg (1978, originally published in 1911), Paul Hindemith (1941), and George Russell (1953/2001). Their terminology is drawn upon in this section to make the distance metaphor more clearly apparent.

The equation shown in Fig. 2a, which first featured in *Philosophiæ Naturalis Principia Mathematica* (transl. The Mathematical Principles of Natural Philosophy) in 1687, is Sir Isaac Newton's Universal Law of Gravitation. Although it has been superseded by Albert Einstein's Theory of General Relativity (1920) (and gravitation in general remains a negotiable category), Newton's Law offers a clear illustration of how the force fundamentally works.

$$F_g = G\frac{m_1 m_2}{r^2}$$

Fig. 2a: Newton's Universal Law of Gravitation (1687). "F_g" is the gravitational force, "G" is the "constant", and the masses ("m_1" and "m_2") are inversely proportional to the square of the distance ("r^2") between them.

Gravitonicity only requires one component from Newton's equation: that the mass of an object determines its gravitational pull. The parallel for Gravitonicity is that each pitch embodies a "mass". It is important to note that pitches do not have a literal physical mass, rather they each embody a context-specific significance. This "mass" / significance is determined by "distance" and "motion". As stated, the former is the focus of this book.

Pitches will be referred to as "gravi-tone(s)". This is an appropriation of the term "graviton" (Rothman and Boughn, 2008) (the hypothetical quantum of gravity) from the field of physics. The "distance" of the gravi-tones will be measured by a "gravi-tone value(s)", or "g". Because this work aims to offer practical tools that are widely accessible to practitioners,

analysts, and educators from many musical backgrounds, the gravi-tones and their *g* values will be based upon twelve-tone equal temperament. In accordance with the twelve-part organisation of equal temperament, the *g* values will be rated on a scale of 1-12.

The gravi-tone that contextually embodies *g*1 acts as the "progenitor tone" (Hindemith, 1941, 54) / "sun" (57) / "central star" / "'Sun Absolute'" (Russell, 2001, 3), whilst the gravi-tones that contextually embody *g*2-*g*12 represent a "close to distant relationship" / "diminishing degree of relationship" (Hindemith, 1941, 56) from *g*1 e.g., *g*2 is the most "closely related" (Schoenberg, 1978, 24), then *g*3, and the most "distant" is *g*12.

Two factors make the gravi-tones and their *g* values specific to equal temperament. Firstly, Chord Scale Theory (hereby CST) will play an important part in the methodology. CST only makes two references to tuning, stating that equal temperament "allows one to transpose and play music in all keys" (Nettles and Graf, 1997, 12) and means that "modes can be transposed" (13). This emphasis on equal temperament suggests that CST may be uniquely challenged to varying degrees by other tuning systems.

Secondly, spectral analysis will be undertaken to discern the *g* values. The observed harmonic spectra correspond to various equally tempered tone combinations, meaning that the spectra are also influenced by the tempering. As a result, the derived *g* values are specific to equal temperament. Nevertheless, in future research, the same methodology could be employed for other tuning systems by analysing the spectra of appropriately tuned pitches. Depending on the tuning system, changes to CST may be required or an alternative system of harmonic organisation in its place. For tuning systems with more / fewer tones, the number of *g* values may be increased / decreased. Alternatively, if *g*12 is understood as the most "distant" (perhaps even across tuning systems), then decimals could be used between *g*1 and *g*12. In the quarter tone system, for example, ".5" values could be interspersed between the twelve values e.g., *g*1, *g*1.5, *g*2 etc.

In this present work, the gravi-tones will be represented by a scale degree numbering system that attributes names to intervals across two octaves for all scales and modes. This system (shown in Fig. 2b) has been borrowed from CST (Nettles and Graf, 1997). With C as 1/*g*1, each scale degree is shown with a representative pitch class. It is always the case that the gravi-tone acting as scale degree 1 will embody *g*1. The remaining *g* values (*g*2-*g*12) can embody any of the other scale degrees / pitch classes.

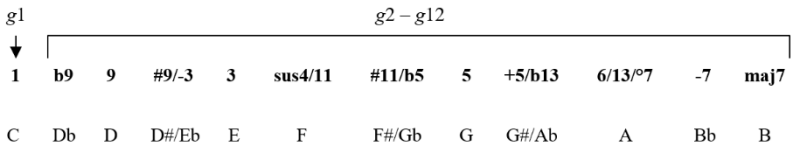

Fig. 2b: CST scale degree numbering with corresponding *g* values.

Because the gravi-tones are based on equal temperament, they could have been represented using pitch class numbering e.g., C = 0, C#/Db = 1 etc. However, similarly to equal temperament, the CST scale degree numbering system was chosen for practicality and accessibility. There is a convenient interchangeability in the terminology used for intervals, scale degrees, and (in some cases) chord names e.g., an augmented fifth chord contains an augmented fifth interval in which, if the root of the chord is scale degree 1, the upper note is the +5 scale degree.

In analogy to Newton’s Law (Fig. 2a), the gravi-tones have become the objects and their “distance” (“mass” / significance) is represented by a gravi-tone value (*g*). However, in place of the “F_g” (the gravitation itself) a name still needs to be placed for Music’s “gravitation”. The term “tonicity” has been used lightly in the music theory and analysis literature (Butler, 1983, 251; Tagg, 2014, 426; Nikolsky, 2015, 8) to generally mean the extent to which a pitch sounds as a tonic. Any of the twelve gravi-tones have the potential to be embodying *g*1 and their relative “distances” can be considered as representing degrees of tonicity. The gravi-tones, with their relative degrees of tonicity, are the mediators of *Gravitonicity*–as expressed by Fig. 2c.

$$\boldsymbol{F_G = 1_g \mid b9_g \mid 9_g \mid \#9/-3_g \mid 3_g \mid sus4/11_g \mid \#11/b5_g \mid 5_g \mid +5/b13_g \mid 6/13/°7_g \mid -7_g \mid maj7_g}$$

Fig. 2c: The distance equation of Gravitonicity: “$\boldsymbol{F_G}$” is Gravitonicity; this is comprised of the twelve gravi-tones (shown as scale degrees); and each of the twelve gravi-tones has a corresponding *g* value.

2.1: Schoenberg, Hindemith, and Russell

In his *Theory of Harmony* (1978), Arnold Schoenberg argues that a single tone (C) can be “taken as the midpoint” with “reference to two forces, one of which pulls downward, toward F, the other upward, toward G” (23). Then, by treating each tone as the fundamental of its own harmonic series,

he finds that their most "closely related" (24) harmonics / "nearest relatives" collectively form a C major scale. There is not a clear order here that mirrors the twelve *g* values of Gravitonicity. Nevertheless, the distance metaphor evoked by "nearest relatives", "closely related", and "more distant", suggests that Schoenberg conceived of the major scale as a "field" (Rothfarb, 2002, 934) or "frame" (Zuckerkandl, 1956, 95).

If it is possible to conceive of the major scale as a "distance" framework through the harmonic series, it follows logically that it can be joined by other scales, modes, and chords. However, the historical evolution of harmony was different to that offered by the natural blueprint of the harmonic series. As Schoenberg writes:

> To explain the constitution of the major triads we may cite the prototype in the overtone series. Even if we accept, however, the inversion of the idea of the triad and the undertones as an explanation of the minor triads, all such reasoning becomes inapplicable when we think of diminished and augmented triads and sevenths chords, all such combinations that are [nevertheless] recognised as chords. These and the triads that are [satisfactorily] explained have nothing more in common than the superimposed thirds of their structure; and such is surely inadequate [as explanation]. (1978, 312)

History "tells only in what order and by what route those harmonies broke into music" (315) with no "unambiguous explanation" (314) for how they did so. Schoenberg postulates that these structures may have emerged from part-writing, as natural creations of the human mind, and/or from continued tonal and functionally independent usage that has conditioned our ears. Whatever the reason(s) for our acceptance of these structures, Schoenberg recognises the introduction of tempered tuning systems as when "the burning urgency to search" the harmonic series was "tempered". However, as will be argued in the coming pages, the search for meaning continued (and continues) in the spectra of the tones played.

Paul Hindemith undertakes a more extensive analysis of the harmonic series in *The Craft of Musical Composition* (1941). The product of the analysis is a "ranking" (54) of "the twelve tones of the chromatic scale" (56) by a "diminishing degree of relationship" to a single "progenitor tone" (54) / "sun" (57) / "central star": "Series 1" (56). This is shown in Fig. 2.1a with C as the "progenitor tone" and the "degree of relationship" increasingly "diminishing" towards the right e.g., G is "closer" to C than F, A is more "distant" than F, then E etc. The corresponding *g* values of Gravitonicity are shown below each pitch class.