Ravikiran's Concept of Melharmony: An Inquiry into Harmony in South Indian Ragas

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While most internationally known Indian musicians have ventured into fusion, many have felt limitations, for indigenous musical values and principles tend to be altered or ignored in spirit of collaboration. Chitravina N. Ravikiran has proposed a concept called *melharmony* to help guide the use of harmony in South Indian classical music. Melharmony suggests that voice leading should be derived from the melodic and combinational structure of the raga. To this end, we study ragas to reveal the harmonic potential of their melodic structure. We consider the combinational potential of ragas and their scales, their networks of pitch classes, their hierarchy of salient tones, and the chords derivable from them.

Keywords: Carnatic Music, Indian Music, Harmony, Set Theory, Arranging

INTRODUCTION

"World-music," "world-beat," and "fusion" are names for a new form of international music in which master musicians from different musical traditions play together. Among the first instances of this trend were the 1970s collaborations of the North Indian sitarist Ravi Shankar with Western musicians. While most internationally-known Indian musicians have ventured into fusion with varying degrees of success, many have felt limitations, for indigenous musical values and principles tend to be altered or ignored in spirit of collaboration. One of us, Chitravina N. Ravikiran, has proposed a concept called *melharmony* to help guide the use of harmony in modal musics. In this essay we apply melharmony to Carnatic, or South Indian, classical music. Melharmony can be "roughly understood as melody with harmony and chords that conform to the modal/scalar, sequential and ornamental principles of highly evolved melodic systems . . . The concept dictates that a composition based on a well-defined scale such as the raga not only features chords and harmonies drawn only from notes permitted in the raga, but also highlights the sequence and typical ornamentation that bestow the raga its unique individuality and identity."[1] Melharmony therefore suggests that voice leading should be derived from the melodic and combinational structure of the raga. Nevertheless, it should be noted that only certain melodic combinations will be palatable when rendered simultaneously, which makes melharmony all the more challenging. Before we go further, we shall provide a brief sketch of the essentials of Carnatic music.

Carnatic music is one of the most colorful, complete, and highly evolved melodic systems of the world. It has four basic characteristics: it focuses on melody (permutations of successive notes) as opposed to harmony (simultaneous combinations of notes such as chords); it gives equal importance

1 Ravikiran 2000.

to melody, rhythm, and lyrics; it places equal emphasis on composition and improvisation; and it combines grace and force in adequate proportions. Melody, in the context of Carnatic music, may be defined as any musical tone or succession of tones with an inherent capacity to please, whether rendered independently or in conjunction with rhythm. Carnatic music, like several other major musical systems in the world, primarily uses seven notes, with twelve chromatic intervals within an octave.[2] However, as we will see, some of these overlap, giving Carnatic music a 16-note system.

The essential melodic concept and form of Indian music is the *raga*. A raga may be partially understood as a melodic scale or formula, created by using some of the 16 notes in a *specific combination and permutation* in both ascent and descent. While most classical ragas are heptatonic, hexatonic, or pentatonic, a few contain just three or four tones.[3] Carnatic music has 72 seven-tone scales, known as parent scales (often called melakarta ragas[4], or simply *melas*). Most ragas are said to be derived from the mela scales. For Indian musicians, a raga is a living entity, capable of evoking or communicating emotions.

In order to practice melharmony, one needs to study a raga with an eye to the harmonic potential of its melodic structure. Indian music theory provides schemes for classifying ragas that help identify their similarities and differences. Each raga's melodic potential is based on at least five resources: (1) the parent scale, the *mela*; (2) various specified melodic motion using the notes of the scale, summarized in a specific ascending and descending scale pattern; (3) the hierarchization of the notes of the raga; (4) melodic ornamentation; and (5) typical and significant melodic phrases. Ragas may share or differ in any of these characteristics. Let us now examine each of these resources.

(1) A raga is based on one of the 72 melakarta scales from which its tonal material is derived through inclusion and permutation. The mela system was invented by Venkatamakhin in the early 17th century to classify ragas of that time. Melas are constructed from two disjoint tetrachords. Each tetrachord has six forms. This gives 36 melas; the remaining 36 are derived by sharping the fourth degree of the first 36. In this paper, we refer to the melas by their ordinal number, although Indian musicians will more often use their names. See Examples 1 and 2.

(2) A raga's defined ascending and descending motion often involves skips and changes of direction; ragas may take all or some of a mela's notes in ascent and/or descent, in order, or in permutation.[5] It is important to note that not all of the scales that are subsets and permutations of a mela are part of the repertoire of ragas. Some melas define many ragas, others few. However, rare ragas are sometimes popularized and new ragas are created, often with the mela scheme as a guiding light. The ragas in Example 3 that we will study later, Hamsadwani, Janaranjini and Kadanakutoohalam, belong to the 29th mela, called Dhirashankarabharana, which is equivalent to the Western major scale.

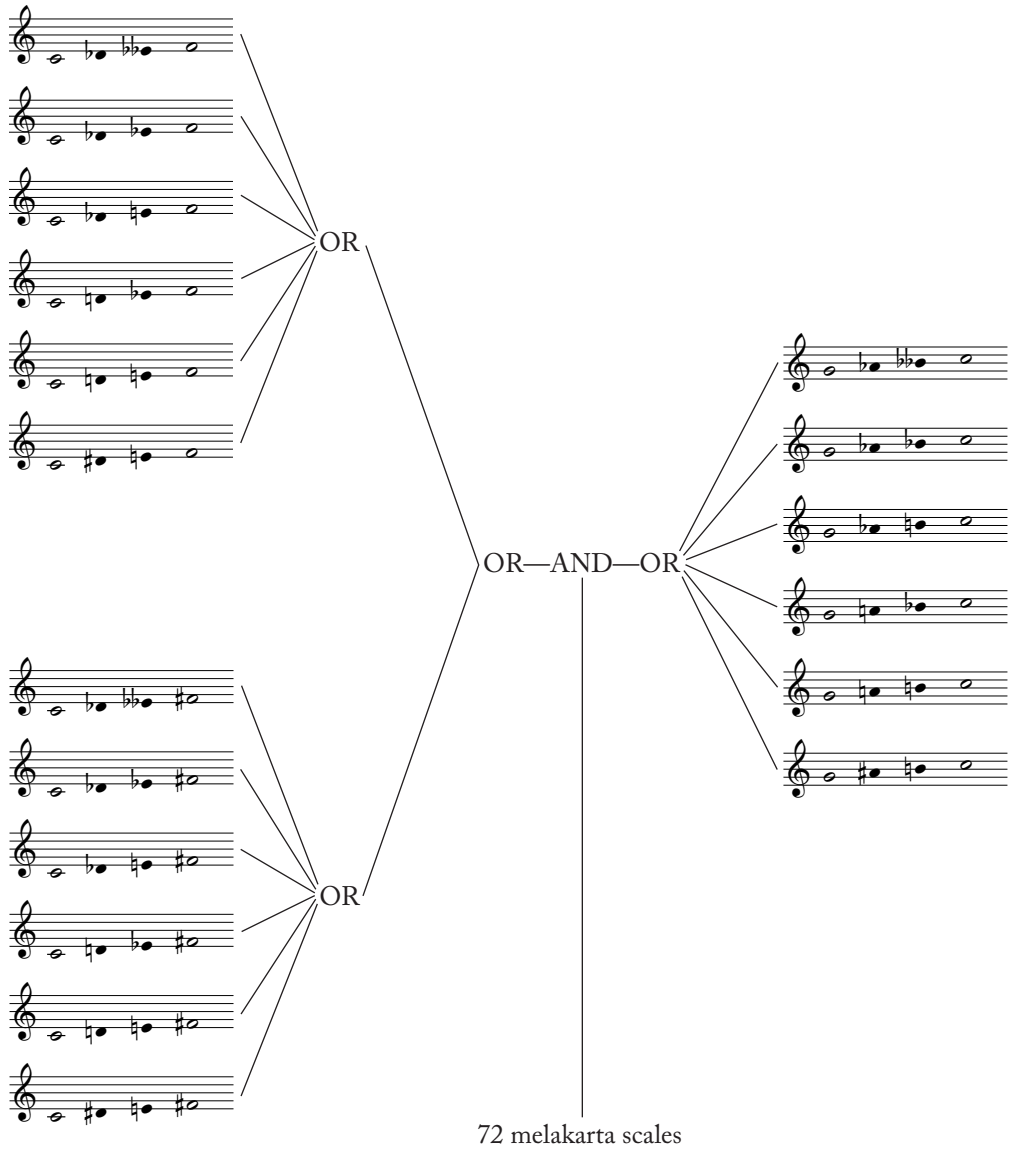
(3) Ragas have a hierarchy of beginning, ending, "reciting," and rare notes. Later in the paper we briefly refer to these tones in the raga Kharaharapriya. In Kharaharapriya, phrases can begin on all the notes except the third degree. Phrases can end on all notes except the

2 The chromatic notes are not equally tempered, as in the West, but are tuned according to 22 microtones, called sruti.

3 For instance, the raga Sankari has four tones (C, E, G, and B) and the raga Svambusvara has three (C, E, and G).

4 Note that the term raga when associated with the term melakarta simply means scale. The "melakarta ragas" are therefore not ragas, because in a raga, not only are the notes important, but their sequence is as well. Further confusion of scale with raga is possible since many of the mela scales have the same names as the ragas derived from them.

5 However, some important ragas have more than seven distinct tones, including extra, bhashanga notes, so they do not fit the mela scheme well.



EXAMPLE 1. *Flow chart for generating the 72 melakarta scales of Carnatic music.*

Melakarta scale	Pitch classes	Set-class	Mela	Mela name
C D♭ E𝄫 F G A♭ B𝄫 C	0125789	7-20I	1	Kanakangi
C D♭ E𝄫 F G A♭ B♭ C	012578A	7-29I	2	Ratnangi
C D♭ E𝄫 F G A♭ B C	012578B	7-19I	3	Ganamurti
C D♭ E𝄫 F G A B♭ C	012579A	7-27I	4	Vanaspati
C D♭ E𝄫 F G A B C	012579B	7-24I	5	Manavati
C D♭ E𝄫 F G A♯ B C	01257AB	7-12	6	Tanarupi
C D♭ E♭ F G A♭ B𝄫 C	0135789	7-30I	7	Senavati
C D♭ E♭ F G A♭ B♭ C	013578A	7-35	8	Hanumattodi
C D♭ E♭ F G A♭ B C	013578B	7-30	9	Dhenuka
C D♭ E♭ F G A B♭ C	013579A	7-34	10	Natakapriya
C D♭ E♭ F G A B C	013579B	7-33	11	Kokilapriya
C D♭ E♭ F G A♯ B C	01357AB	7-24	12	Rupavati
C D♭ E F G A♭ B𝄫 C	0145789	7-21I	13	Gayakapriya
C D♭ E F G A♭ B♭ C	014578A	7-32	14	Vakulabharanam
C D♭ E F G A♭ B C	014578B	7-22	15	Mayamalavagaula
C D♭ E F G A B♭ C	014579A	7-32I	16	Chakravakam
C D♭ E F G A B C	014579B	7-30I	17	Suryakantam
C D♭ E F G A♯ B C	01457AB	7-19	18	Hatakambari
C D E♭ F G A♭ B𝄫 C	0235789	7-29I	19	Jhankaradhvani
C D E♭ F G A♭ B♭ C	023578A	7-35	20	Natabhairavi
C D E♭ F G A♭ B C	023578B	7-32	21	Kiravani
C D E♭ F G A B♭ C	023579A	7-35	22	Kharaharapriya
C D E♭ F G A B C	023579B	7-34	23	Gaurimanohari
C D E♭ F G A♯ B C	02357AB	7-27	24	Varunapriya
C D E F G A♭ B𝄫 C	0245789	7-27I	25	Mararanjani
C D E F G A♭ B♭ C	024578A	7-34	26	Charukeshi
C D E F G A♭ B C	024578B	7-32I	27	Sarasangi
C D E F G A B♭ C	024579A	7-35	28	Harikhamboji
C D E F G A B C	024579B	7-35	29	Dhirasankarabharana
C D E F G A♯ B C	02457AB	7-29	30	Naganadini

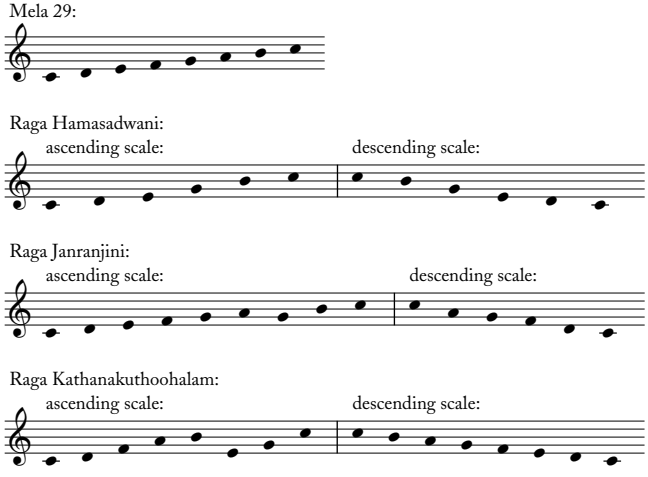
EXAMPLE 2. *The 72 Melakarta scales of Carnatic Music. (Set-class labels are appended with "I" when the mela is a transposition of the inversion of the normal form of the set class.)*

Melakarta scale	Pitch classes	Set-class	Mela	Mela name
C D♯ E F G A♭ B𝄫 C	0345789	7-17	31	Yagapriya
C D♯ E F G A♭ B♭ C	034578A	7-27	32	Ragavardhani
C D♯ E F G A♭ B C	034578B	7-21	33	Gangeyabhusani
C D♯ E F G A B♭ C	034579A	7-29	34	Vagadhibhusani
C D♯ E F G A B C	034579B	7-30	35	Sulini
C D♯ E F G A♯ B C	03457AB	7-20	36	Chalanata
C D♭ E𝄫 F♯ G A♭ B𝄫 C	0126789	7-7	37	Salagam
C D♭ E𝄫 F♯ G A♭ B♭ C	012678A	7-15	38	Jalarnavam
C D♭ E𝄫 F♯ G A♭ B C	012678B	7-7I	39	Jhalavarali
C D♭ E𝄫 F♯ G A B♭ C	012679A	7-38I	40	Navanitam
C D♭ E𝄫 F♯ G A B C	012679B	7-14I	41	Pavani
C D♭ E𝄫 F♯ G A♯ B C	01267AB	7-6I	42	Raghupriya
C D♭ E♭ F♯ G A♭ B𝄫 C	0136789	7-19	43	Gavambhodi
C D♭ E♭ F♯ G A♭ B♭ C	013678A	7-29	44	Bhavapriya
C D♭ E♭ F♯ G A♭ B C	013678B	7-20	45	Subhapantuvarali
C D♭ E♭ F♯ G A B♭ C	013679A	7-31	46	Sadvidhamatgini
C D♭ E♭ F♯ G A B C	013679B	7-28	47	Suvarnangi
C D♭ E♭ F♯ G A♯ B C	01367AB	7-18	48	Dvyamani
C D♭ E F♯ G A♭ B𝄫 C	0146789	7-18I	49	Dhavalambari
C D♭ E F♯ G A♭ B♭ C	014678A	7-28I	50	Namanarayani
C D♭ E F♯ G A♭ B C	014678B	7-20I	51	Kamavardhani
C D♭ E F♯ G A B♭ C	014679A	7-31I	52	Ramapriya
C D♭ E F♯ G A B C	014679B	7-29I	53	Gamanasrama
C D♭ E F♯ G A♭ B C	01467AB	7-19I	54	Visvambari
C D E♭ F♯ G A♭ B𝄫 C	0236789	7-19I	55	Syamalangi
C D E♭ F♯ G A♭ B♭ C	023678A	7-30	56	Sanmukhapriya
C D E♭ F♯ G A♭ B C	023678B	7-22	57	Simhendramadhyama
C D E♭ F♯ G A B♭ C	023679A	7-32	58	Hemavati
C D E♭ F♯ G A B C	023679B	7-32I	59	Dharmavati
C D E♭ F♯ G A♯ B C	02367AB	7-21	60	Nitimati
D E F♯ G A♭ B𝄫 C	0246789	7-24I	61	Kantamani
C D E F♯ G A♭ B♭ C	024678A	7-33	62	Risabhapriya
C D E F♯ G A♭ B C	024678B	7-30I	63	Lantangi
C D E F♯ G A B♭ C	024679A	7-34	64	Vachaspati
C D E F♯ G A B C	024679B	7-35	65	Mechakalyani
C D E F♯ G A♯ B C	02467AB	7-30	66	Chitrambari

EXAMPLE 2. [*continued*]

Melakarta scale	Pitch classes	Set-class	Mela	Mela name
C D♯ E F♯ G A♭ B𝄫 C	0346789	7-16I	67	Sucharitra
C D♯ E F♯ G A♭ B♭ C	034678A	7-26	68	Jyotisvarupini
C D♯ E F♯ G A♭ B C	034678B	7-21I	69	Dhatuvardhani
C D♯ E F♯ G A B♭ C	034679A	7-31	70	Nasikabhusani
C D♯ E F♯ G A B C	034679B	7-32	71	Kosalam
C D♯ E F♯ G A♯ B C	03467AB	7-22	72	Rasikapriya

EXAMPLE 2. [*continued*]

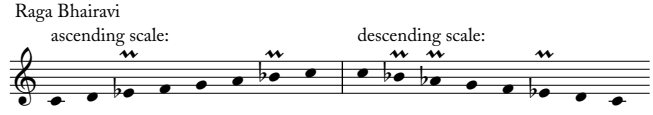


EXAMPLE 3. *Three ragas derived from mela 29, Dhirashankarabharana.*

third and seventh degrees, and the second, fourth, and sixth degrees can be emphasized.

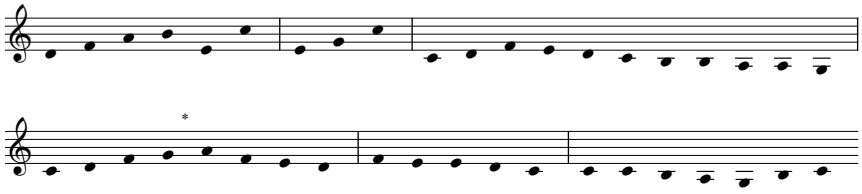
(4) A raga has a set of required and typical ornamentations. Example 4 shows the notes that frequently take ornamentation in the raga Bhairavi. The third and seventh can be oscillated while the second and natural sixth are always rendered plain. The fourth and flatted-sixth (used mostly in descent) can be rendered either way, depending on context. Oscillation is a very important type of ornamentation in Carnatic music. It is well defined and rendered in a precise manner involving amplitude, speed and frequency. Certain Carnatic ragas, like Sahana, Ahiri, and Mukhari, may never be performed without their characteristic ornamentations, while others such as Keeravani (the harmonic minor scale) sound well with or without ornaments. Still others, such as Hindolam, are rendered with minimal ornamentation.

(5) A raga has a set of key phrases called *sancharis* (singular *sanchari*) that help immediately identify it. Example 5 shows some sancharis for the raga Kadanakutoohalam, These phrases are essential to bring out the identity and spirit of the raga. The grasp of these essential phrases



Mordent signs show ornamented tones. The 3rd and 7th can be oscillated while the 2nd natural 6th are always rendered plain.

EXAMPLE 4. *Ornamentation in ragas.*



*The move from scale-degrees 4 to 6 via 5 is given as a sanchari phrase in Bhagyalehshmi, 1990. This motion is not part of the ascending scale of the raga.

EXAMPLE 5. *Sancharis of Raga Kathanakuthoolaham.*

determine the very caliber of an artist or composer. Perceiving and rendering ragas as mere permutation and combination of notes is considered to be the most elementary stage in Carnatic music.

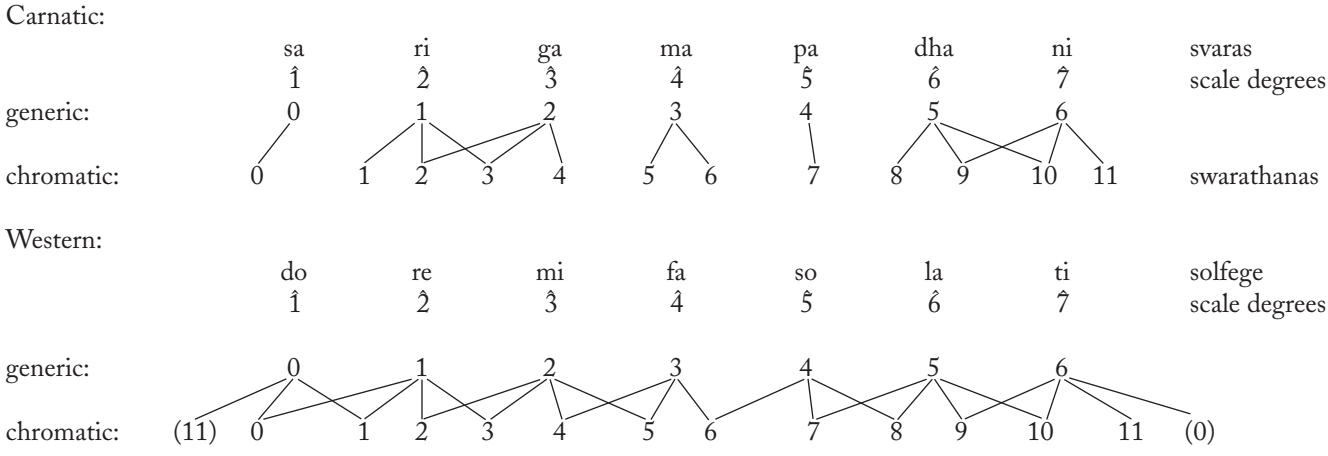
These five features and others can help reveal a particular raga's harmonic potential. Here, we are interested in discovering and/or constructing a given raga's melharmonic features.[6] In the following discussion, it will be useful to conceptualize the notes of ragas in either generic or chromatic cyclic pitch-class spaces, or both at once. This follows from both Indian and Western music theory. In Indian music, the seven notes of a scale are called *svaras*: sa, ri, ga, ma, pa, dha, and ni. The svaras correspond to the Western solfege of do, re, mi, fa, sol, la, ti, or scale-degrees 1, 2, 3, 4, 5, 6, and 7. Svaras and scale degrees are what scale theorists such as Clough and Myerson call the *generic* pitch classes of a scale.[7] Indian and Western music also incorporate the familiar 12 chromatic pitch classes, as shown in Example 6. The mapping of chromatic pitch classes to generic pitch classes is many to one. In Western common-practice tonality in equal temperament, scale-degrees 2, 3, 4, and 7 have four values (diminished, minor, major, and augmented), and scale-degrees 1, 4, and 5 have three values (diminished, perfect, and augmented). Carnatic music postulates multiple chromatic values, called *svarasthana*s (singular *svarasthana*) for scale-degrees 2, 3, 4, 6, and 7, while scale-degrees 1 and 5 are fixed. Scale-degrees 2 and 6 have three values each (flat, natural, and sharped); scale-degrees 3 and 7 also have three (double-flat, flat, or natural); and scale degree 4 can be natural or sharped.

We use integers to model the generic and chromatic space classes of pitch classes and intervals of scales. We define the first scale degree as generic pitch-class 0 (not 1) and the first chromatic note as 0 (not 1). Thus the generic notes vary from 0 to 6 and the chromatic from 0 to 11. We also fix C-natural as chromatic pitch-class 0.[8]

6 By conflating discovery and construction, we mean to imply that a raga's melharmonic features are not arbitrarily manufactured, but depend on the raga's melodic features. In the process, we may discover that a particular raga forges new relationships between melody and harmony.

7 Clough and Myerson 1985.

8 While we will not formalize intervals in this paper, we would like to show how this can be done with a binomial, as in Brinkman 1986. This practice models the Western nomenclature for intervals and is of importance for advanced work in melharmony. For instance, the minor sixth stands for an interval that is of 6 generic scales steps and 8 chromatic semitones; thus we need two integers—6 and 8—to model a minor sixth. Notes are also denoted by binomials. A given note can be shown by the binomial (*x*,*y*). Thus, C♮ is given by (0,0); C♯ is (1,0); D♭ is (1,1); E♭ = (3,2); E-natural = (4,2), E♯ = (5,2), etc. We can calculate intervals between binomials by subtracting the respective values in the first binomial from those in the second. Thus, the interval from C to E♭ is the binomial (3,2), that is, (3,2) - (0,0); this can be read as the interval of three chromatic steps and two scale steps. Such an interval is



EXAMPLE 6. *Mapping of chromatic to generic pitch classes in Carnatic and Western music.*

We use traditional names of pitches and intervals except in calculations and matrices. By convention, we represent unisons by the label 0, and traditionally-defined intervals of size n as *n-1*. (Thus, thirds are now identified by the generic interval 2.)

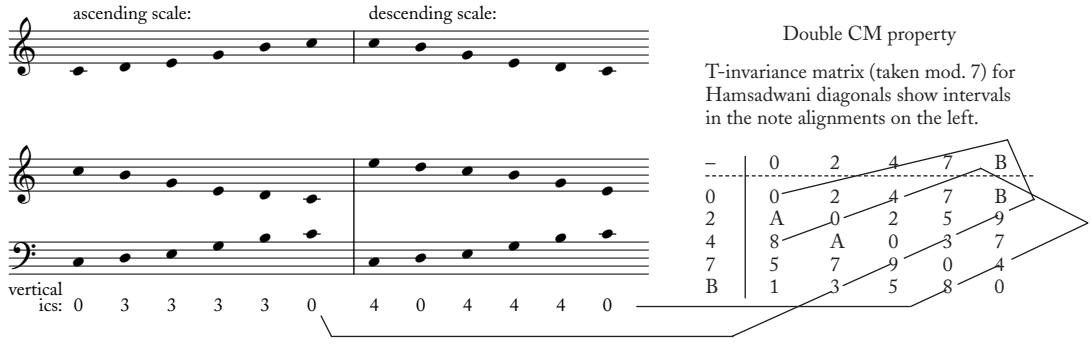
MELHARMONY AND TWO-VOICE COUNTERPOINT

To start our inspection of the melharmonic features of ragas, let us consider the use of the notes of a raga to construct Western common-practice, two-voice counterpoint. This is an important step toward harmonizing ragas since most Western harmony is based on a framework of a bass and treble voice. Here we are interested in ragas that permit passages in contrary motion with verticals of only thirds, sixths, and unisons, because these intervals are consonant and invert into each other. The *audava*,[9] or five-tone raga Hamsadwani is a prime example. As can be seen in Example 7, Hamsadwani omits scale degrees four and seven of its mela, number 29. Its ascending and descending scales are identical under retrograde. We construct a T-invariance matrix from the ascending notes using the chromatic note names.[10] The T-matrix shows that there are two contrary

traditionally called an ascending minor third. The interval from F♯ to E♭ is (6,3) – (3,2), or (3,1). The interval is called a descending diminished third, or down by 3 chromatic steps and 1 scale step. In this article, we use chromatic intervals rather than binomials.

9 Ragas are classified according to the number of distinct tones in their ascending and descending scales. A raga that is of five tones up and down should therefore be called audava-audava, but this is shortened to audava with the proviso that the notes in the ascent and descent are the same.

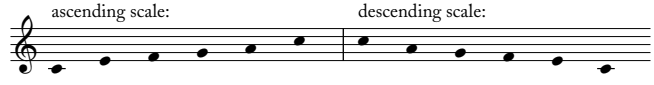
10 The T-matrix is constructed for two sets of tones and displays the intervals from one set to the other. Given sets *A* and *B*, the interval *n* for a note *a* in *A* to a note *b* in *B* (that is, $n = b - a$) is in the a^{th} row and b^{th} column of the matrix. In our work, the two sets *A* and *B* are identical. Thus the interval in the matrix *n* is within the set *A*. Given two intervals in the matrix, *c* and *d*, if *c* is higher and to the left of *d*, *c* comes first in the set *A*; if *c* is lower and to the right of *d*, then *d* comes before *c* in A.



EXAMPLE 7. *Raga Hamsadwani.*

motion alignments that produce unisons, thirds, and sixths. This raga therefore has much potential for voice leading involving contrary motion. Moreover, the alignments are differentiated by interval class[11]: one alignment forms chromatic intervals 0, 3, and 9, that is, interval-classes 0 and 3; the other alignment has chromatic intervals of 0 and 4 and 8, interval-classes 0 and 4. One might ask: do other ragas have the same voice-leading potential? Example 8 shows the raga Nagasvaravali, which is the same as Hamsadwani but with a modal shift of a fourth. Thus these two ragas have the same voice-leading potential under transposition. Indian musicians have noted that many ragas are related by modal shift (called *svara bheda*); all ragas related in this way have the same combinational potential. However, in the case of Hamsadwani, the other three modal shifts produce scales of non-existent or very rare ragas.

We can generalize the preservation of thirds under contrary motion to other five-tone ragas by considering the generic



Modal Shift: raga Hamsadwani is transposed up a fourth so that its fifth becomes Nagaswaravali's tonic.

EXAMPLE 8. *Raga Nagasvaravali.*

intervals in Hamsadhwani. To this end, we build a T-matrix out of Hamsadwani's generic intervals. This is given in Example 9. Observe that two distinct diagonals on the matrix contain intervals 0, 2, and 5. This means that there are two ways that the notes of the raga can be put in contrary motion so as to preserve unisons, thirds, and sixths. We shall call this property the *double CM property*. This matrix is derivable from any five-tone subset that omits scale-degrees four and six of a mela. Since there are 72 melas, there are 72 potential ragas with the double CM property.[12] However, only a few

11 An interval class is a pair of inversionally-related generic or chromatic intervals. An interval is turned into its inversion by reversing the order of its notes, either by octave displacement or temporal order. The inverse of an interval i is j, where $i + j = 0$.

12 However, some of these potential ragas will have augmented and/or diminished thirds and/or sixths, which are enharmonically equivalent to seconds, fourths, fifths, and sevenths.

	0	1	2	4	6
0	0	1	2	4	6
1	6	0	1	3	5
2	5	6	0	2	4
4	3	4	5	0	2
6	1	2	3	5	0

Double CM property:

The first SW–NE diagonal: 0 2 5 2 5 (generic thirds, sixths, and unisons)
The third SW–NE diagonal: 5 0 2 5 2 (generic thirds, sixths, and unisons)

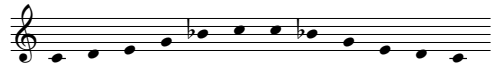
EXAMPLE 9. *Generic Hamsadwani T-Matrix.*

of these possible ragas are found in the Carnatic music repertoire. One of these is a rare raga called Vinavadini, which is derived from the 28th mela; it is given in Example 10. This raga is equivalent to the Western Mixolydian mode, omitting the fourth and sixth degrees (F and A).

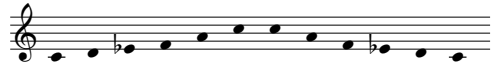
We can produce more candidates for five-tone ragas with the double CM property by allowing the modal shift to be generic rather than chromatic. Such ragas would be gapped melas, where the two notes extracted from a mela are separated by one tone. This generalization includes some well-known ragas such as Abhogi, shown in Example 11. Abhogi is derived from mela 22, the Western Dorian mode, omitting scale-degrees five and seven.

Other potential audava ragas besdies Hamsadwani and its modal shifts have the double CM property and allow contrary motion differentiated by interval-class 3 and 4. We could simply invert Hamsadwani in chromatic space and reverse the ascending and descending scales, as shown in Example 12. However, neither this raga nor any of its modal shifts is found in the Carnatic repertoire.

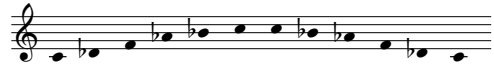
We can generalize even further when we realize that there are only three species of five-tone ragas derived from seven-



EXAMPLE 10. *Raga Vinavadini.*



EXAMPLE 11. *Raga Abhogi.*



EXAMPLE 12. *Chromatic inversion of the raga Hamsadwani.*

tone melas. Species I includes melas with two-note extractions that are one note apart; species II includes melas with two-note extractions two notes apart[13]; and species III contains melas with one gap of two extracted notes. Example 13 identifies some well-known audava ragas in each species. Example 14 presents T-matrices of the three species of five-note ragas. Species I contains Hamsadwani.[14] Species II contains many more ragas, however, including Mohanam, which is equivalent to the Western pentatonic mode. Species III contains only a few popular ragas.

13 A two-note extraction three notes apart is equivalent to two-note extractions two notes apart.

14 The generic T-matrix of species I differs from the generic T-matrix of Hamsadwani in Example 1.3 since the sequence of generic notes that generates the former matrix is a modal shift of the generic notes in Hamsadwani.

Ragas in Species I	Ragas in Species II	Ragas in Species III
Abhogi	Amritavarshini	Megharanjani
Hamsadwani	Bhupalam	Niroshta
Nagasvaravali	Suddha Severi	Kuntalavarali
Valaji	Gambhiranattai	
	Hindolam	
	Karnataka Suddha Severi	
	Madhyamavati	
	Mohanam	
	Revagupti	
	Revati	
	Udayaravichandrika	

EXAMPLE 13. *Ragas in each species.*

Species I (mod. 7)

	0	1	2	3	5
0	0	1	2	3	5
1	6	0	1	2	4
2	5	6	0	1	3
3	4	5	6	0	2
5	2	3	4	5	0

Species II

	0	1	2	4	5
0	0	1	2	4	5
1	6	0	1	3	4
2	5	6	0	2	3
4	3	4	5	0	1
5	2	3	4	6	0

Species III

	0	1	2	3	4
0	0	1	2	3	4
1	6	0	1	2	3
2	5	6	0	1	2
3	4	5	6	0	1
4	3	4	5	6	0

EXAMPLE 14. *The three basic pentatonic generic T-matrices.*

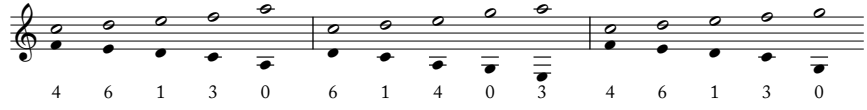
Example 15 lists the SW–NE diagonals of the generic T-matrices for each species. These diagonals fall into four sets of contrary-motion intervals, labeled *a* through *d*. We call these *CM-sets*. Each of the four CM-sets has a different collection of generic intervals. For example, CM-set *a* has one unison (0), a second and seventh (1 and 6), and a fourth and a fifth (3 and 4). Since CM-set *a* occurs in diagonals in all three species, any audava raga can produce these five intervals in contrary motion. Example 16 shows an instance of each species. Subscripts on the CM-set names partition some of the interval sets into two cases, with members of a case being related by identity or rotation. CM-set *b*, *which* is unique to species 1, allows the double CM property. It interested us because it contains no dissonant intervals. CM-set *c*, which is found twice in species II and once in species III, contains a unison (0), a third and sixth (2 and 5), and a fourth and fifth (3 and 4). It contains only one dissonance, the fourth. However, if the fourth is not perfect, or if the

Species I					
a_1	0	3	6	1	4
a_1	6	1	4	0	3
b	5	0	2	5	2
a_2	4	6	1	3	0
b	2	5	0	2	5

Species II					
c_1	0	3	5	2	4
a_1	6	1	4	0	3
d	5	0	2	6	1
a_1	3	6	1	4	0
c_1	2	4	0	3	5

Species III					
a_2	0	4	6	1	3
d	6	1	5	0	2
d	5	0	2	6	1
a_2	4	6	1	3	0
c_2	3	5	0	2	4

EXAMPLE 15. *Contrary motion interval sets derived from the SW–NE diagonals of the above T-matrices (interval sequence for contrary motion).*



EXAMPLE 16. *Generic ragas from each species displaying contrary motion verticals from CM-set a.*

fourth is inverted into a fifth by voice-exchange, or if there are more than two voices in a musical passage, CM-set *c* can support Western common-practice, contrary motion voice leading. Since species II has two members of CM-set c_1, species II has a special case of the double CM property—providing that the combination of voices avoids the use of the perfect fourth, as shown in Example 17.[15]

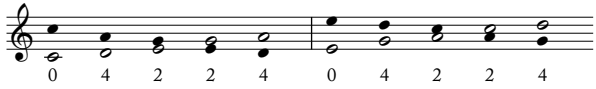
Let us finish this section on two-voice counterpoint by noting three things. First, we may generalize the CM property to *sadava*, or six-tone ragas, but there is only one species of generic sadava ragas—one extracts a tone from a mela. Consider Example 18, in which the raga Malayamarutam produces only consonant intervals in contrary motion. Here the contrary motion interval set is <2, 0, 5, 2, 0, 5>.[16] There is no instance of the CM property in a seven-tone raga (a mela); its CM-sets are rotations of <0, 5, 3, 1, 6, 4, 2>. However, seven-tone ragas have the double direct motion property, or *double DM*. This means that the ragas can produce consonant intervals by direct motion by thirds or by sixths. Since no raga of less than seven tones has even the single DM property, it should be apparent why contrary motion, rather than direct motion, is the basis for two-voice raga counterpoint.

Second, the single or double CM properties need not be confined to audava and sadava ragas. They can be used to produce contrary motion among some of the tones of ragas with greater than five tones together with passing (or other non-harmonic) tones. Example 19 shows the double CM property of a Species I audava raga in the context of a seven-tone raga; the gap in the audava raga is filled in by passing tones. Example 20 shows a contrapuntal passage that divides a seven-tone raga into three sections of contrary motion.

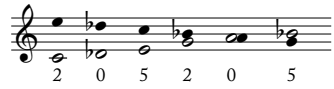
Finally, there is, of course, no need to confine the vertical combination of raga notes to the rules of Western common

15 Species III has only one CM-set, labeled c_2.

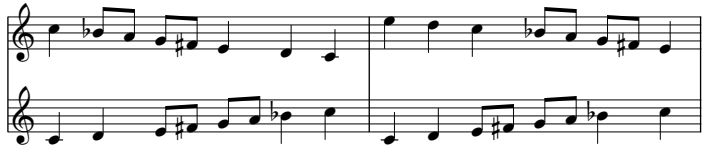
16 The other three contrary motion interval sets for a sadava (six-tone) raga are <0, 3, 5, 0, 2 ,4>, <6, 1, 4, 6, 1, 3>, and <2, 4, 0, 1, 3, 5>.



EXAMPLE 17. *Double CM property in a species II generic raga with CM set* c_1 *(03524) with 3 (fourth) inverted into 4 (fifth), and 5 (sixth) inverted into 2 (third).*

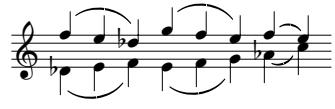


EXAMPLE 18. *Single CM-property in the sadava raga Malayamarutam.*



EXAMPLE 19. *Double CM property imported into a seven-tone raga, Vachaspati.*

practice counterpoint. Any interval can be considered consonant, dissonant, or without designation, and be deployed according to any number of arbitrary rules of voice leading. The contrary motion alignments illustrated above in Example 15 would then be permissible. Nevertheless, the collection of generic intervals given by the CM-sets of any raga is limited to eight distinct collections.[17]

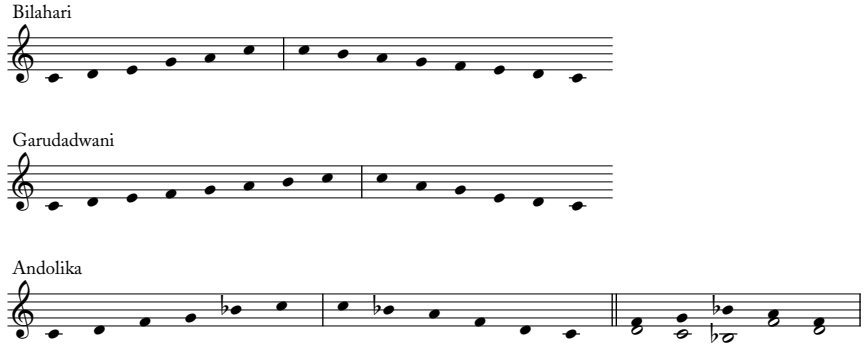


EXAMPLE 20. *Free contrary motion in the seven-tone raga, Mayamalavagaula.*

MELODIC FEATURES OF RAGAS THAT INFLUENCE MELHARMONY

The ordering of tones in a raga is often complex. This has implications for melharmony, which requires counterpoint and harmony to highlight a raga's sequence and typical ornamentation. Ragas often have different ascending and descending scales, where notes in one are missing in the other. Example 21 first shows two ragas derived from mela 29 that are complete in ascent and pentatonic (audava) in descent, and vice versa. Thus, in the ragas Bilahari and Garudadwani, the notes B and F are only allowed in ascent or descent so that, for instance, the "resolution" of the interval B–F by contrary motion would not be permitted. Other ragas may have an interval of the fourth filled in differently in ascent from

17 These are the *a*, *b*, *c*, *d* collections for audava ragas, and the four collections for sadava ragas given in the previous footnote. The number of direct motion interval sets is also limited.



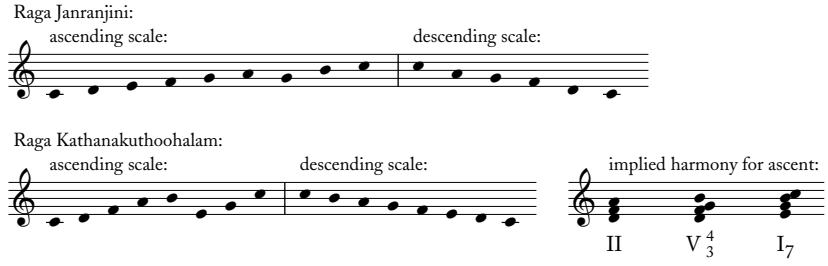
EXAMPLE 21. *Ragas with different ascending and descending scales.*

descent. Raga Andolika, also given in Example 21, shows this feature: the interval between F and B♭ is filled in by G in ascent and A in descent. This means G and A have to be treated specially in voice leading, as shown in the example.

Example 22 shows two other ragas derived from mela 29, Janarangini and Kadanakutoohalam. These have zigzag or crooked (*vakra*) ascents. The details of Janaranjini's melodic complexity are shown in Example 23 by the network that is constructed from its ascending and descending scale. Such networks are useful in defining the partially-ordered sets that characterize a given raga. A more complex network can be constructed from a raga's sanchari phrases. Example 23 also displays a sanchari network for Kadanakutoohalam.[18] The voice leading of harmony based on such ragas would have to obey the ordering given by each network; thus, in Kadanakutoohalam, scale-degree 7 cannot move directly to 8, but only via scale-degrees 3 and 5. Example 22 shows a possible jazz harmonization.

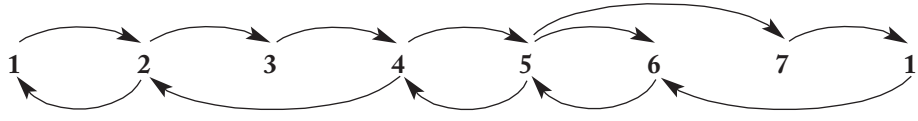
18 This raga was composed in the mid 19th century to imitate popular British music of the time.

T-matrices can help guide two-voice counterpoint in ragas with complex melodic progressions. We make the matrix out of the raga's entire ascending and descending scale. Example 24 offers a T-matrix that models the counterpoint derived from the melodic sequences in the raga Janaranjini. We can read the ascending and descending scales of the raga from left to right as the column heads of the matrix, or down from top to bottom as the row heads. Solid lines in the matrix divide the raga at the change from ascent to descent. The columns and rows of the notes that are context sensitive in Janaragini are shaded and treated in a special way. These context sensitive notes are the chromatic pitch-classes 4 and 11, which occur only in ascent. The upper-neighbor note 9 in the ascent does not need to be shaded because the sequence <9, 7> occurs in both ascent and decent. The cells of the matrix give all the intervals between pairs of notes in the ragas ascending and descending scales. If an interval *n* occurs at an instant of time in the two-voice counterpoint based on Janarangini, we locate that interval on the matrix and look at the row and column heads to see what notes produce it. The row heads give the notes of the lower voice and the column heads give the notes of the upper voice. If an interval on the matrix is negative, then the lower voice has crossed above the

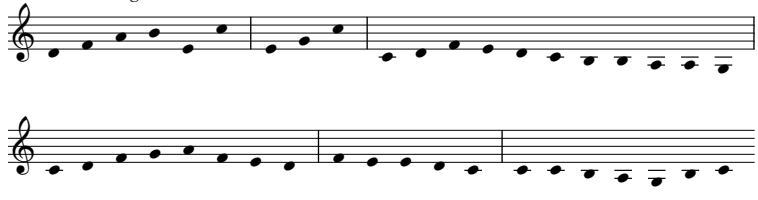


EXAMPLE 22. *Two ragas with vakra orderings.*

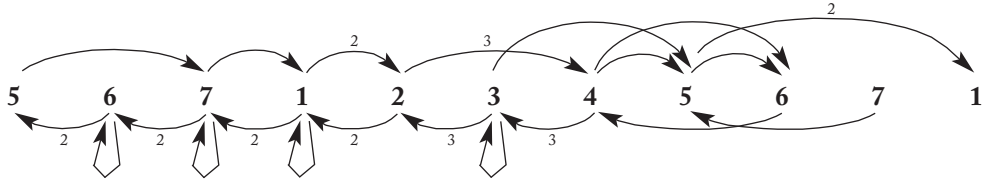
Network derived from ascending and descending scales of Raga Janaranjini.



Sancharis of Raga Kathanakuthoolaham:



Weighted network derived from sancharis of Raga Janaranjini.



EXAMPLE 23. *Raga networks.*

	0	**2**	**4**	**5**	**7**	**9**	**7**	**11**	**12**	**12**	**9**	**7**	**5**	**2**	**0**
0	0	2	4	5	**7**	**9**	**7**	11	12	12	9	7	5	2	0
2	-2	0	2	3	5	7	5	**9**	10	10	7	5	3	0	-2
4	-4	-2	0	1	3	5	3	7	**8**	**8**	5	3	1	-2	-4
5	-5	-3	-1	0	2	4	2	6	7	7	**4**	2	0	-3	-5
7	-7	-5	-3	-2	0	2	0	4	5	5	2	**0**	-2	-5	-7
9	-9	-7	-5	-4	-2	0	-2	2	3	3	0	-2	-4	-7	-9
7	-7	-5	-3	-2	0	2	0	4	5	5	2	0	**-2**	-5	-7
11	-11	-9	-7	-6	-4	-2	-4	0	1	1	-2	-4	-6	**-9**	-11
12	-12	-10	-8	-7	-5	-3	-5	-1	0	0	-3	-5	-7	-10	**-12**
12	-12	-10	-8	-7	-5	-3	-5	-1	0	0	-3	-5	-7	-10	**-12**
9	-9	-7	-5	-4	-2	0	-2	2	3	3	0	-2	-4	-7	-9
7	-7	-5	-3	-2	0	2	0	4	5	5	2	0	-2	-5	-7
5	-5	-3	-1	0	2	4	2	6	7	7	4	2	0	-3	-5
2	-2	0	2	3	5	7	5	9	10	10	7	5	3	0	-2
0	0	2	4	5	7	9	7	11	12	12	9	7	5	2	0

Explanation: The row heads of a cell indicate the note of the bottom voice of the counterpoint; the column heads of a cell indicate the note of the top voice. The number in the cell indicates the interval from the bottom voice to the top voice. If the cell number is negative, the bottom voice has crossed above the top voice.

Rules:

1(a). Move from cell to cell from top to bottom or left to right or both. The matrix wraps around so a move off the right side reappears on the left; the same from bottom to top.

1(b). On a move, do not cross the vertical and horizontal lines in the matrix, except if the two cells share the same number.

2(a). If a cell is in a dark column, then move zero or one position (adjacently) to the right, but any number of positions down.

2(b). If a cell is in a dark row, then move zero or one position (adjacently) to down, but any number of positions to the right.

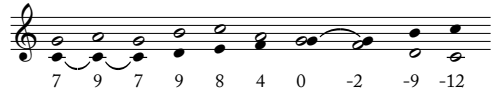
2(c). If a cell is in a dark column and a dark row, move zero or one position down and to the right (adjacently).

3. Only move to cells whose number is among the set of permitted intervals in the counterpoint.

EXAMPLE 24. *T-matrix for the raga Janaranjani.*

upper voice. The melodic motion in the lower voice is from top to bottom on the matrix; melodic motion in the top voice is from right to left. Therefore, the matrix captures the motion of both voices by a sequence of moves from cell to cell down and to the right. We can then make moves from cell to cell on the matrix that will generate the sequence of notes in counterpoint. When we decide only to use certain intervals, we only move to and from cells that contain the number of these intervals. Example 24 provides detailed information on the rules for navigating the T-matrix.

The bold-faced entries in the Janaranjini T-matrix produce the counterpoint in Example 25. The permitted intervals are consonant in the Western common practice period with the exception of –2, which is permitted in certain contexts; here it is a non-harmonic escape tone, helping to outline a V7 chord.



EXAMPLE 25. *Counterpoint in the raga Janarajani derived from path on T-matrix in Example 24.*

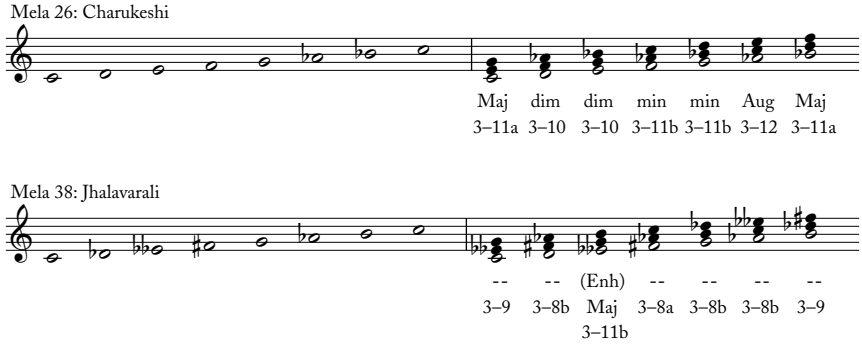
TERTIAN CHORDS IN MELAS

Another approach to raga-based harmony is to determine which chords (set classes) are produced by generic third superimposition within various ragas. We call these *tertian chords*. We are familiar with the tertian chord types available in the major and minor scales, which correspond to the melas 20 (natural minor), 21 (harmonic minor), 29 (major), and 32 (ascending melodic minor). The same tertian chord types occur in these melas' modal shifts (under rotation).[19] Example 26 shows chord types in the melas Charukeshi and Jhalavarali.[20] Note that Charukeshi is a modal shift of the ascending melodic minor scale. These chords might be used to form harmonic progressions. However, Jhalavarali—designated as *vivadi* (a mela that involves double sharps or flats)—has only one major (but enharmonic) chord by third superimposition. The other chords all fall into two set classes, which could provide a harmonic field for this mela.

The chart in Example 27 shows the set classes of the tertian chords in each *mela-class*. A mela-class is the set of melas related by chromatic modal shift (transposition) and/or inversion. On the chart, each class is represented by the mela with the lowest number in the left column; the right column gives any other melas in the class. The triad set class column gives the series of tertian chord types of the mela representative. The other melas in a mela-class have the same chords types but under modal-shift (chromatic transposition) and/or chromatic inversion. It is of interest to find that 25 of the 38 septachordal set-classes, and 7 of the 12 trichordal set-classes are represented by mela-classes. Each

19 Here are the correspondences: mela 8 is the Phrygian mode; mela 20 is the Aeolian mode or natural minor scale; mela 21 is the harmonic minor scale, and has melas 16, 21, 27, 58, 59, and 71 as modal shifts; mela 22 is the Dorian mode; mela 23 is the ascending melodic minor scale with 26 and 64 as modal shifts; mela 28 is the Mixolydian mode; mela 29 is the Ionian mode or major scale; and mela 65 is the Lydian mode. The Locrian mode is not a mela.

20 The names of set classes use the standard Forte labels appended with an *a* or *b* if the set-class members do not have inversional invariance. Therefore, *a* stands for sets that are T_n transformations of the normal form representative of the set class, and *b* for the sets that are T_nI transformations of the normal form representative. For example, 3-11a stands for minor chords, 3-11b for major chords; 3-12 stands for any augmented chords (with no *a* or *b* since augmented chords are invariant under T_nI).



EXAMPLE 26. *Tertian chord types in two melas.*

mela-class has at least one 3–11[037] tertian chord. The least frequent tertian chord is 3–6[036], which occurs in only two mela-classes. The diversity of tertian chords in mela-classes ranges from two different chord types in two mela-classes to five different chords types in seven mela-classes.

Basing harmonic practice on only the tertian chord types within the mela of a given raga may not always be desirable for a number of reasons. First of all, the chart does not list all three-note subsets of the mela, only the tertian chords built by third superimposition. For instance, in mela 39 of Example 26, the notes E𝄫, F♯, and B are enharmonically equivalent to a B-minor chord, however, the scale degrees involved, 3, 4, and 7, do not form a tertian chord.

A second reason against directly developing the harmonic practice from the tertian chords of a raga's mela is that a raga may only use a subset of the mela (janya). So in the case of Hamsadwani, as shown in Example 28, the chords on degrees 2, 4, 6, and 7 of its parent raga cannot be used to harmonize the raga because only the notes of a melodic mode may be used to harmonize it. But if we construct tertian chords on the five notes of this raga, some new tertian chord types come into play, the first of which is not found within any of the mela-classes.

If ragas that are subsets of melas inhibit direct use of the mela's tertian chords types, so do ragas that are supersets. These ragas involve the use of foreign (bhashanga) notes outside the mela.[21] Many of the most important Carnatic ragas have these notes. An extreme case of this phenomenon is the popular light raga Sindubhairavi, shown in Example 29. Sindubhairavi can be classified as a member of the eighth mela, but it actually contains all twelve tones of the chromatic scale. The example includes a "Romantic" harmonization of the descending scale since the sequence of the notes suggests some typical Western chromatic voice-leading patterns. It is interesting to note that many of the ragas with one bhashanga note can be reordered as an eight-note series of perfect fifths. The scales of some ragas of this type are given in Example 30.

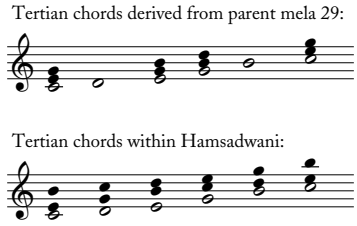
21 However, there are bhashanga ragas with less than seven tones. For instance the raga Tilang has the scale <C, E, F, G, B, C; C, B♭, G, F, E, C>. This raga could have been placed with the 30th mela, and respelled with an A♯ for the B♭. But it originated in North Indian (Hindustani) music, in which there are only ten basic seven-tone scales; the ragas there are considered to be built out of portions of more than one of these scales and employ many bhashanga tones.

mela	Pitch classes	Set class	triad set classes	other melas
1	0 1 2 5 7 8 9	7–20	9 11 9 11 8 8 12	36 45 51
2	0 1 2 5 7 8 A	7–29	9 11 11 11 10 8 11	19 30 34 44 53
3	0 1 2 5 7 8 B	7–19	9 11 11 11 8 8 8	18 43 54 55
4	0 1 2 5 7 9 A	7–27	9 12 11 11 10 7 11	24 25 32
5	0 1 2 5 7 9 B	7–24	9 12 11 11 8 7 8	12 61 68
6	0 1 2 5 7 A B	7–12	9 11 11 9 8 6 8	
7	0 1 3 5 7 8 9	7–30	11 11 8 11 8 11 12	9 17 35 56 63 66
8	0 1 3 5 7 8 A	7–35	11 11 11 11 10 11 11	20 22 28 29 65
10	0 1 3 5 7 9 A	7–34	11 12 11 11 10 10 11	23 26 64
11	0 1 3 5 7 9 B	7–33	11 12 12 11 8 10 8	62
12	0 1 3 5 7 A B	7–24	11 11 12 9 8 7 8	
13	0 1 4 5 7 8 9	7–21	11 11 7 11 8 12 12	33 60 69
14	0 1 4 5 7 8 A	7–32	11 11 10 11 10 12 11	16 21 27 58 59 71
15	0 1 4 5 7 8 B	7–22	11 11 11 11 8 12 8	57 72
31	0 3 4 5 7 8 9	7–17	11 7 7 11 8 12 8	
37	0 1 2 6 7 8 9	7–7	9 9 9 8 8 8 11	39
38	0 1 2 6 7 8 A	7–15	9 9 9 11 8 10 11	
40	0 1 2 6 7 9 A	7–38	9 11 11 10 10 7 11	
41	0 1 2 6 7 9 B	7–14	9 11 11 10 8 7 9	
42	0 1 2 6 7 A B	7–6	9 11 11 8 8 6 9	
46	0 1 3 6 7 9 A	7–31	11 11 11 10 10 10 11	52 70
47	0 1 3 6 7 9 B	7–28	11 11 12 10 8 10 9	50
48	0 1 3 6 7 A B	7–18	11 11 12 8 8 7 9	49
67	0 3 4 6 7 8 9	7–16	11 7 7 8 8 12 10	
68	0 3 4 6 7 8 A	7–26	11 7 10 8 11 12 11	

*A mela class is the set of melas related by chromatic modal shift (transposition) and/or inversion.

trichord number	Set class	tonal interpretation
3–6	[024]	incomplete M^9 chord
3–7	[025]	incomplete M^6 or m^7 chord
3–8	[026]	incomplete dom^7 or half-dim chord
3–9	[027]	sus-4 chord
3–10	[036]	diminished chord
3–11	[037]	major or minor chord
3–12	[048]	augmented chord

EXAMPLE 27. *Mela-classes and their tertian subsets.*



EXAMPLE 28. *Tertian chord types in the raga Hamsadwani.*

Carnatic ornamentation can also inhibit the use of certain tertian chords. Ornamentation is, of course, a feature of ragas, not melas. For instance, while the scale of the bhashanga raga Bhairavi seems clear enough, as illustrated earlier in Example 4, the third, sixth, and seventh degrees may employ an ornament that oscillates around, not on, the basic pitch representative of each of these pitch classes. These ornamentations will not allow chords to be asserted stably.

Finally, the important tones in a raga will also hierarchize the chords available from its notes. For instance, Example 31 gives the raga Kharaharapriya, whose salient notes are scale-degrees 1, 2, 4, 5, and 6. As a result the chord on the second degree should have prominence over the chord on the raga tonic. Example 31 also gives the raga Natta, having degrees 4 and 5 as stable tones so its "basic chord" is a member of set-class 3–9[027]. Such a chord is not based on thirds, but is equivalent to the "sus-4" chord of rock music.[22]

These considerations mean that a given raga might not be harmonized with a major or minor chord on its tonic degree. Even if this were possible, that chord may not represent the raga's "tonality" or even some form of harmonic or cadential resolution. In short, most ragas are neither equivalent nor reducible to Western common practice keys or modes.

22 To a Western ear, this raga evokes a connection with blues if one hears the sharp second as a flat third.

CONCLUSION

We have touched on only a few topics in the use of melharmony in Carnatic music. Nevertheless, it should be clear that issues of Western counterpoint and voice leading are intrinsic to melharmonic practice since Western music's harmony grew out of the modal monophony of the Middle Ages and the progression of chords and their hierarchies are still based on melodic principles. Although we have shown how principles in one raga can be generalized to others, the practice of melharmony remains highly context sensitive. Basing the harmonic vocabulary and syntax of a raga on the chords in its mela can work in many cases, but the features of the raga itself are the better guide.[23]

In sum, melharmony is not about imposing harmony on modal music, but about preserving and enhancing a mode's melodic identity in its harmonization. It is hoped that some new cross-cultural music will be created and appreciated in this way.

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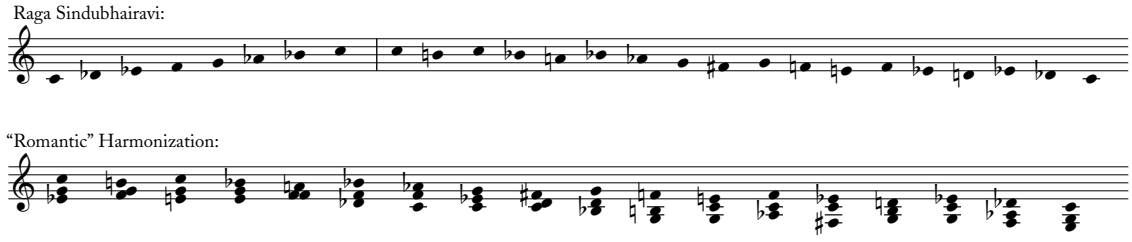
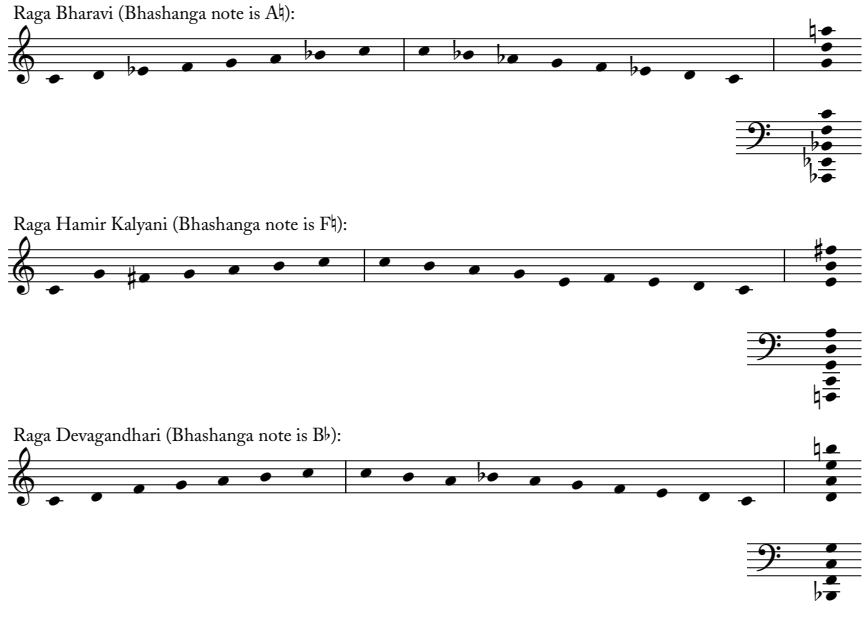
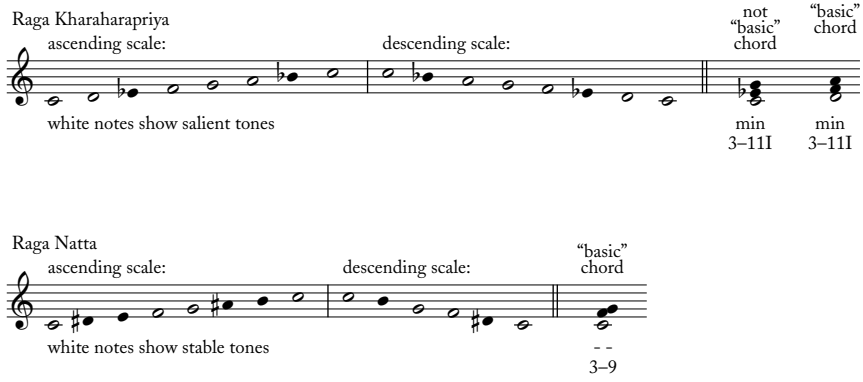
23 Moreover, for purely melodic reasons alone, some Carnatic musicians criticize the classifying of Carnatic ragas according to the scheme of 72 melas as often arbitrary and insensitive.



EXAMPLE 29. *Mixed ragas.*



EXAMPLE 30. *Bhasanga ragas based on stacked fifths.*



EXAMPLE 31. *Salient tones in ragas.*

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