Microtone (Sruti)

In Indian classical music, there are only 12 notes per octave but in practice we have more than 12 notes. In an octave there are no of frequencies, which are known as Sruti or Microtone. Main purpose of my research is to find out different microtone and its existence.

'With newer mathematics, and newer equipment, experimental work on sruti is an absolute necessity. It is an area where the least experimental work has been done. We do not know which sruti occur in which raga: neither do we know the extent of pitch variation of note in a raga.'[66]

'Bharatmuni and Sarang Dev Indicates 'Sruti Sthapan' on the basis of minute experience but both the scholars did not take help of math.'[67]

MUSICAL SOUND (NADA)

Origin & Classification

Bhartmuni believes in three origin of swar i.e. Body,Veena,Venu.

'Sage Bharata defines 'Music' as the confluence or combination of Swara, Tala, & Pada - all in harmonious blend. Sage Matanga defines 'Raga' as a combination of musical notes that gives delight, a melody arrangement to project a definite mood, emotion or feeling.

Brahma was the origin of music inspired by Sama Veda. From one note, music progressed to three, then five & crystallized in seven notes, the Sapta Swaras. Sapta Swaras are Shadja, Rishabha, Gandhara, Madyama, Panchama, Daivata & Nishada. Swara is a musical note.

Swaras are reputed to have been inspired by sounds of birds & animals such as: '[68]

'Sarang Dev also wrote about this.'[69]

Shadja --	Peacock
Rishabha --	Ox
Gandhara --	Goat
Madyama --	Krouncha bird
Panchama --	Cuckoo
Daivata --	Horse
Nishada --	Elephant

The Editor of the book "Sagitraja' Respected Dr.Premlata Sharma, who is a great scholar of Classical music and who established Musicology in the field of Music Education wrote that 'In the formation of 'Raga', 'Svarbheda' is always not necessary but the difference

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[66] The Music Of India: A Scientific Study by B.Chaitanya Dava, P.13
[67] Sangit Shshtra Tatha Raga Mala by Pandit Bhola Dutt Joshi,P.21
[68] http://www.saigan.com/heritage/music/mus1.htm
[69] Sangit Ratnakar by Sarang Dev,Kalanidhi Tika,Sholaka 46-47

in 'Bhava' or 'Vasana' goes to make one Raga different from another. 'Bhava' alone gives a specific nature to an object.' [70]

'If the element of 'Pathya' becomes predominant in 'Gita' the balance tilts in favour of kavya and when the beauty of 'Dhvani' predominates over the element of 'Pathya', the balance may turn in favour of Gita.' [71]

Swaras

What they mean

'Each swara is associated with one of the seven chakras of the body. Just as the swaras ascend through the saptak, so they are mapped onto the chakras in the body in ascending order. Komal notes are associated with the left side of each chakra; the left channel, Ida Nadi, is the side of emotion and intuition. Shuddha and tivra notes are associated with the right side; the right channel, Pingala Nadi, is the side of logic. Ragas, therefore, have more or less of an effect on a given chakra depending on the notes they contain.'[72]

Swara	Chakra
Sa	mūlādhāra (anus)
Ri	svādhiṣṭhāna (genitals)
Ga	maṇipūra (solar plexus and stomach)
Ma	anāhata (heart and lungs)
Pa	viśuddha (throat)
Da	ājñā (third eye)
Ni	

Vat, Pit and Kuf also affects the voice as described by Sagang Dev in his book Sangit Ratnakar.

'The Nada is primordial sound and is the very essence of music. The nada manifests letters, letters constitute the word, and the words make a sentence, so the entire business of life is carried on, through language and, therefore, whole phenomena I.e. the world is based on the Nada.'[73]

'The Musical Sound is known as Nada. Nada gives pleasure to the listener. It is the root cause of music. All Srutis, Swara and Raga are based on this Nada.

Nada is made of Nada (Dhatu) i.e. Na and Da. Na means vital air and Da means Vital heat. Thus it appears that Nada is the result of the united action of the vital air and vital heat of the body of course. Indians did not know the longitudinal wave motion of sound but they did connect the production of sound in air in some way to fire. Fire causes expansion of air and sound is generated in air.

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[70] Sangitaraja by MahaRana Kumbha Editor Dr.Premlata Sharma,P.129,130
[71] Ibid, P.78
[72] www.wikipedia.org
[73] Music Therapy by Manorma Sharma, P..6

A Nada is of two kinds:

Ahata Nada:

Ahata Nada is caused by physical impact. It is called struck sound. It can be perceived through ears. Music is concerned with Ahata Nada.

Anahat Nada:

It is not produced by physical impact. It is called unstruck sound. It is ever present and unchanging. It is experienced by yogis. Yogis hear this sound from their inner self. They achieve this after many years of meditation and discipline in yoga.'[74]

Western Music

'Today's system developed over many centuries. The note shapes are derived from neumes, handwritten signs that were placed over the words of medieval chant. At first neumes gave only a vague indication of melodic directions and patterns. Gradually the shapes became more precise and, about ad1000, staff lines were added: first one, then two, then four and five. By about 1200, the notation was reasonably exact as to pitch, but quite vague regarding duration.'[75]

Note

'Notes evolved in the 13th century from neumes (q.v.), signs indicating relative or absolute pitch and nuancebut not necessarily rhythm. The earliest notes were the longa, and brevis, ˘; and their derivatives, the maxima, and semibrevis. In modern notation the brevis and semibrevis correspond to the double whole note, and the whole note. Other modern notes, in diminishing time value, are the half note, quarter note, eighth note, sixteenth note, thirty-second note, and sixty-fourth note.

"Note" may also refer to a tone, the sound either produced by a singer or musical instrument or represented by a pitch name (such as G, or sol), a neume, or a written note. The term is also used in describing the French lai form.'[76]

The Indian Musical Scale

'The basis of scale in the Indian musical system has to be considered in terms of relation between successive sounds. There is need to examine the Indian musical scale, which is primarily based on 'Srutis'.

The building up of a musical scale is based on two assumptions about the human hearing process:

The ear is sensitive to ratios of frequencies (pitches) rather than to differences in establishing musical intervals.'[77]

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[74] Fundamental of music by Swatantra Sharma,P.9

[75] Microsoft ® Encarta ® Encyclopedia 2003. © 1993-2002 Microsoft Corporation

[76] Britanica Encyclopedia CD, 2004

'There were 3 main scales in Indian Music: Shadaj Gram, Madyan Gram & Gandhar Gram.

Today, in Indian Classical Music there are two scales in use. One is C Scale or Shadaj Gram and the other is F Scale or Madhyam Gram. Most of the Indian Musicians prefer the C Scale. Whereas, there are a few who do not rule out the F Scale altogether.'[78]

Indian Musician Scale thus is composed of 12 notes, 7 pure, 4 flat and 1 sharp as shown below:

There are 12 notes in an octave. Indians call an octave Saptak. As per voice Register, Indian Musicians have recognized three Saptaks. These are called Mandra Spatak, the lower octave, and Madhya Saptak, the middle octave, and Tar Saptak, the higher octave. These three saptaks were prevalent in the time of Sangeet Ratnakar.

Westerns Scale is based or the ratio of frequencies which they call "Interval", whereas the Indian Scale is based on microtonal distance, which Indian call as Shruti-antar.

SHRUTI (MICROTONES)

'A very long period of development of Indian music (over 4 millennia) gave rise to unique scale based on large number of basic Intervals called srutis. Thus a musician can choose any of the shrutis, which supports the interval when he is required to use a swar.

According to the ancient definition,sruti is perceived as an interval of sound.sruti may be defined as the separately identifiable interval of pleasing sounds. The swar is understood by the expression created in the mind of the listener through the resonance of a perceived sruti.

It is impossible to sing a complete scale of shrutis in succession but they are claimed to be sung with perfect accuracy when they are embodied in expressive scale.

The usage of srutis is very dependent on the modes (ragas) in the practice of Indian music.'[79]

'Different aspects of grammar defines position of swars through body. Bharatmuni in his book 'Natyashashtra' and Maharshi Patanjali in his book 'Taitriya Pratishakhya' wrote about 'Aaytatva' and 'Mrudutav'. Bharatmuni wrote in connection with 'Darvi Veena' and Patanjali wrote in connection with voice.'[80]

'Aayam,Darunya and Anuta increases the note while Anvavasarg,Mardav and Uruta decreases the note.'[81]

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[77] Ninad:Journal of ITC Sangeet Research Academy,Vol.19,2005,P.14
[78] Sangit Ratnakar by Sharang Dev,P29 and Natyashashtra by Bharatmuni,P.14,Shloka 24
[79] Ninad:Journal of ITC Sangeet Research Academy,Vol.19,2005,P.14
[80] Bharat Ka Sangit Siddhant by Shri Kailashchandra Brihaspati, P.18
[81] Ibid,P.19

'In some of the ragas certain notes are treated slightly differently from the standard notes.'[82]

'The division of the tone into several intervals is necessary for accurate playing and, although it is very easy for a well-trained ear to discern whether an interval is accurate or not, yet it is extremely difficult, if not impossible, to find out, without special instrument, in what proportion an interval is bigger or smaller than another.This is why Greek musicians, appreciating interval by ear, and noticing that they were utilizing two or three intermediary positions in the tone, may, like the Hindus, Have considered them, in practice.'[83]

'The srutis are represented by their characteristic notes, but they are, theoretically, region of the octave. Within the limits of each sruti several positions may be possible, allowing and adjustment of the tuning of the notes according to modes or ragas.As long as the notes do not trespass the limits of the sruti their expression keeps the same characteristics. This expression will only be the clearer and stronger if, within the limits of the sruti, that not is utilized which forms, with the tonic, the most rational and simple ratio.'[84]

'Basic difference between the Western and the Indian classical music system, we noted that in Indian music it is not enough to produce just twelve or even twenty two 'tones' in an octave. One ought to produce even the intermediate frequencies. These intermediate frequencies, which do not have any keys to produce them, are called 'microtones'. The Indian word for the 'microtone' is 'gamakam'. (of course, 'gamak' in hindi) Whereas, to make Indian music, twelve keys are not enough in an octave.'[85]

'The earliest mention appears to have been made in Bharat muni's Natyashastr (about 500 B.C.). Later references include Narada of Shiksha (1st century A.D.), Kohala (quoted in Brihaddeshi) Dattila's Brihaddeshi, and several later works. "samvaditaa" (consonance) is defined in terms of sruti-s like this: The distances of 23, 13, and 9 sruti-s imply perfect consonances. The distance of 23 sruti-s indicates the same note, but in the higher octave. The 13-shruti distance shows the distance of the fifth, called shadja-panchama bhaava. The 9-sruti distance means the distance of the fourth, called shadja-madhyama bhaava.

The sruti-s may be grouped according to two scale types, or grama-s, namely shadja grama, and madhyama grama:

Shadja grama: S 4 R 3 G 2 m 4P 4 D 3 N 2
Madhyama grama: S 4 R3 G 4 m 2 P 4 D3 N 2

Shruti is a part of tonal concept. Talented singers use them, regularly and unknowingly, as part of their musical repertoire. Quite often, even the raga-s have their notes established on sruit-s, rather than the usual notes. For example, the "komal Re" (Db, if Cis the tonic) of the

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[82] Nad by Sandeep Bagchee P.23
[83] Introduction to the study of Musical Sacles by Alain Danielou P.134
[84] Introduction to the study of Musical Sacles by Alain Danielou P.132
[85] http://www.khazana.com/et/music/gentle1.asp?mscssid=D289BVSM4MTN9K9FLEQV4HB0QTDN6QLC

raga Todi, is really a microtone, lower than the usual location of "komal Re" in the Indian scale. Singing correct microtones comes naturally to the voice of a talented singer.'[86]

'Sangita darpan gives following characteristics of shrutis:- they are fixed(in relation to each other),useful for the purposes of singing, distinguishable(from the adjacent ones) and in good concordant relation with other notes.'[87]

"Shruyate iti shruti hi"

'Sruti is a minute sound capable of being heard by the ear. Musical sound has been divided according to their use into 22 small divisions and they are known as "Srutis", Srutis are thus the microtonal interval of sound and play a very important role in our classical music. The use of these Srutis when combined with the many kinds of grace notes and embellishments produce the characteristic quality of Indian Music.

The simplest arrangement that one can think of is to divide an octave into 22 equal parts and level each part from 0 to 22. This way each part will be one Sruti a part.

This arrangement is shown as :
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
|1|1|1|1|1|1|1|1|1|1|1| 1|1|1| 1|1|1|1| 1|1| 1| 1|
Such an arrangement in modern terms is said to be a tempered scale with 22 intervals. This scale perhaps may not sound sweet and one may try the next possibility:
0 2 4 6 8 10 12 14 16 18 20 22
|2|2|2|2|2|2|2|2|2|2|2|
This is also tempered one with 11intervals. There is no reason to believe that this scale sound sweeter and we pass on to the next one:
0 3 6 9 12 15 18 21 22
|3|3|3|3|3|3|3|1| 1
The arrangement of seven equal intervals of 3 Srutis each and one interval of one sruti is an odd one and leads us to keep 4 srutis between 18 and 22 instead of 3 and 1.
|3|3|3|3|3|3|4| 2
Arrangement can be done in several other ways.
|4|3|3|3|3|3|3|
and 3
|3|3|3|4|3|3|3|
Out of three arrangements 1, 2, 3 only the last one is symmetrical and aesthetically satisfying. We make one more symmetrical change in (3).
|4|3|2|4|4|3|2| - 4

This is the arrangement which has received the firm approval of the great Sarang Dev. He wrote that we associate 4 Srutis each to Shadja, Madhyan and Pancham Swaras. 2 Srutis to Nishad and Gandhar and 3 Srutis to Rishabh and Dhaiwat.'[88]

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[86] http://www.soundofindia.com/articles.asp
[87] Theory of Indian music by Rai Bahadur Bishan Swarup,P.23

'Shadja of present days has been fixed at first sruti instead of fourth, the change must have takes place very recently, for none of the old Sanskrit books on music recognize this.' [89]

Review about Microtone

'Traditional eastern music is strictly monophonic, which means that it uses only melodies, and it can easily support the inclusion of intensely dissonant microtonal intervals. Western music is mostly polyphonic, which means it also uses chords. Generally, western polyphonic music avoids the inclusion of microtones because of the effect they would have on the harmony of the chords.

Even without microtones there can be considerable dissonance among the 12 most consonant intervals, but if polyphonic music were to include intervals other than the 12 most consonant, it would be very hard to listen to.

The power of music that includes microtones depends not only on playing the melody with the correct intonation, but also on the musician's intent. Played unintentionally, a microtone will just sound out of tune. Played intentionally, the same microtone will have an entirely different effect on the listener.

When two tones of a strongly dissonant interval are played simultaneously, the sound may seem harsh and if sustained, difficult to listen to. When the same two dissonant tones are played sequentially, the harshness is neutralized. Time-intervals are needed between the tones of melodies that include microtones so we can be open to their energy and feel the finer vibrations reverberate on our inner octaves.'[90]

'The srutis are convenient steps of pitch analogous to note. We say that Bhup has five notes. It does not mean that we use only five perfectly steady frequencies. It means we recognize five points where we can conveniently stand and measure the pitch. If we try to measure all the minds,gamakss used in singing or playing Bhup, the pitch would be infinite.

If we carefully try the experiment on swarmandal we can get many more than 22 srutis in an octave.

Also, by modern experiments with pure tone, it has been found that a normal ear can discern a difference of nearly 3 cps to 5 cps in pitch. That is, if there is a tone of 240 cps and another of 243 cps or 237 cps, the latter will be heard as different in pitch. But if the other tone is say 241cps or 239 cps the ear can not distinguish between this and 240 cps

For instance, when some one asks," How far is the post office from here?" we may say "oh! Just pass by five lamp-posts and you will reach it." We definitely do not mean that the lampposts are at equal distance from one another. The lamppost is only a numerical indicative

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[88] Shruti and Swar ,The Basis of Indian Music by Jashbhai Patel,P.33
[89] Theory of Indian music by Rai Bahadur Bishan Swarup,P.13
[90] http://www.gurdjieff.org/werbock1.htm, Gurdjieff International Review

The sruti then may be considered as ordinal number. It shows the position of sound on a scale of 22. The actual ratio is a cardinal number, which shows correct relation between two pitches. We may compare the srutis to the position of a student in the class. This is his sruti number. The actual mark he gets in the examination is like the pitch ratios.

Srutis are equal when they indicate a position in the octave but unequal when we express them as ratios.In other words, srutis are both equal and unequal in so far as they indicate a position in as octave (as ordinal number), they are equal. In the capacity they do not measure but show only a position in a series of pitches. But each position or sruti may have many close ratios which we measure. In this capacity they are unequal. '[91]

'All srutis are not equal, but their division suffices to allow the classification of all the notes which have a distinct significance and which are utilized in the definition of Hindu modes(ragas).In reality, the division into twenty two is the minimum division which allows a clear definition of the expression of intervals.'[92]

Usage of Micortone in Moderen Classical music:

[93]Indian Classical Music is based on Ragas.Perfect singing of notes is very important in Raga.We use komal gandharin Ragas like Malkauns,Darbari,Todi,Mulstani but in all these Ragas Komal Gandhar is different from one another. due to that tradition of 22 srutis is still in practice.

Late Pt.Vishnu Digamber Paluskar believed in scientific aspects of music and therefore emphasized different usage of vikrut swar. Where as Late.Pt.Bhatkhande emphasized more importance to practical aspects (Vyahavari paksh) and therefore did not give much importance to different usage of vikrut swar.

In so many Ragas position of 12 notes are always not fixed it deviates up or down according to 'Swar kagavar' of that particular Raga.

Also in 'Gamak' there is a deviation of note form its original position. Even there is a difference if we use one swar in fast tempo and the same swar in slow tempo.

Pt.Vishnu Digamber Paluskar believed in 12 notes per saptak but also believed in 19 notes in Practical music. This proves usage of 'Sruti' in Indian classical music.

'In some raga composition, a couple of notes called srutis will not tally with the Piano or organ keys. So the musical notes used in our ragas have their respective frequencies in relation to the tonics.'[94]

'The great maestro of music Respected Sangit Martand Pt.Omkarnath Thakur wrote in his book 'Pranav Bharati' That notes used in different ragas are slightly higher or lower from

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[91] Music of India -A scientific study by B.Chitanya Deva.P.97, 98,102
[92] Introduction to the study of Musical Scales by Alain Danielou P.133
[93]'Pravin Pravah' By Prof.Harishchandta Shrivastava, 1985,P.121, Translated in English
[94] Indian classical music by Prof.Sunil Bose,P.42

its original position, the reason being their internal correlation, 'Ragang' and 'Kiryang.used in that particular raga.

Pt.Vishnu Digambar Paluskar tried to make us know this difference by indicating the difference in different raga which is shown in detail in the book 'Pranav Bharati' on page no. 209-213. '[95]

'Following table shows distribution of 19 notes of Pt.Vishnu Digamber Paluskar & 22 notes of Shri Asarekar amongst 22 srutis.'[96]

Shruti No	Pt.Vishnu Digamber Paluskar's Swar	Shri Asarekar's Swar	Swar used in particular Raga
1	Sa	Sa	-
2	Aati aati kamal re	Aati kamal re	Bhairav
3	Aati kamal re	Komal re	Bhairavi
4	Komal re	Shuddha re	Bibhas
5	Shuddha re	Tivra re	Yaman Kalyan
6	Aati komal ga	Aati komal ga	Todi
7	Komal ga	Komal ga	Bhairavi
8	Shuddha ga	Madhya ga	Malkauns
9	-	Tivra ga	Yaman Kalyan
10	Shuddha ma	Komal ma	Bhairavi
11	Tivra ma	Madhya ma	Purvi
12	Tivratar ma	Tivra ma	Yaman Kalyan
13	Tivratam ma	Tivratar ma	Puriya
14	Pa	Shuddha pa	-
15	-	Aati komal dha	Bhairav
16	Aati komal dha	Komal dha	Bhairavi
17	Komal dha	Shuddha dha	Bibhas,Malkauns
18	Dha	Tivra dha	Yaman Kalyan
19	Aati koma; ni	Aati komal ni	Gaud Malhar
20	Komal ni	Komal ni	Bhairavi
21	Shuddha ni	Madhya ni	Malkauns
22	-	Tivra ni	Yaman Kalyan

[95] Pranav Bharati By Pt.Omkarnath Thakur,P.209
[96] Sangit Shshtra Tatha Raga Mala by Pandit Bhola Dutt Joshi,P.34