

14. Universal applicability of the principle of Inversals in the other Musical Systems of the world:

It has already been mentioned earlier in Chapter 5 that, Music is nothing but the organized sounds and it employs consonance for a pleasant and bright effect. Also, that Sound being the medium of music, physical laws of harmony prevail in every aesthetic scheme of the same. Music is also a dual entity and, though an art by nature, is a science as an exigency or need. As a science Music has to follow the fundamental laws of musical sound which are the result of purely physical causes & observation and so are universally true. The development of scientific side of music had immensely widened the scope of the intellectual element in Music while the emotional side is governed by the Physical, Psychological and Cultural associations of mankind.

Though scope of the science of Music is very wide but, in reference to Indian music, but, it virtually means the science of Raagas. The 'Raaga', in simple words, is a melodic law or order. Technically, it is a Swara pattern obeying the laws of consonances & dissonances.

The principles of, being mathematical in nature, are universal in their applicability. Since the present study is based on the concept consonance & dissonance of mirror images of Swara patterns of Raagas, the concept of inversals also is equally applicable in the other systems of Music of the world like Western System, which is based on Harmony/Chords etc, Chinese and Arabian systems etc, in the same way as the Newton's laws of motion in Physics, Pythagoras theorem of right angle triangles in Geometry & Trigonometry are applicable universally in all the educational systems of the world.

Also, as explained earlier in Chapter 5, it has been observed that tones sound well together when the ratios of their frequencies can be expressed in terms of small numbers. The smaller are the numbers, the better is the consonance. The further we go away from small numbers the more we encroach into the realm of discord. Pythagoras, one the greatest mathematician, knew this fact more than 2500 years ago when he associated consonance with ratios of small numbers. The premise of Pythagorean doctrine, "all nature consists of harmony arising out of numbers", may be somewhat simplistic, but the Chinese philosophers in Confucius's time also regarded small numbers 1, 2, 3, 4 as the source of all perfection. The Swiss mathematician

‘Leonhard Euler’, however, adopted the psychological approach in declaring that the human mind takes pleasure in Law and Order, particular in natural phenomena.

The scale of the sound:

We can see that the fifty three intervals of the scale of fifths, if sung or played by ear on a non keyed instrument, are automatically transformed into simpler harmonic intervals which are very much easier to appreciate and are much more natural.

Limited to simple ratios, the acoustic intervals in use among the different human or animal races, therefore, by the very nature of things, are limited in number. All the musical scales in the world have evolved using only the simple ratios as mentioned above.

In view of the above we can say that the basis of all that what is musical, whatever may be the system of music, is the concept of consonance & dissonance of various notes either with a common prime note or amongst themselves. The first principle makes the back bone of melodic (Indian) and the second that of Harmonic music (Western). If, therefore the principles of consonance and dissonance is understood and applied, all the system of the music in the world can be understood, this being a universal principle. As mentioned the earlier chapter-5, **this universal principle is the very back bone of the present study.**

Musical Scales in different civilizations and their Inverses:

Thousands of years before Marine Messene (1636 A.D) discovered the natural law of harmonic series and law of vibrations, the Egyptian, the Sumerian, the Chinese, the Indian, the Greek, the Arabic and the Persian systems of music were arrived at solely by means of string lengths and the ear method.

All these systems were derived either from the cyclic, the equi-partitive, the auricular (pertaining to ear) or the divisive principles. They can now be tested for accuracy against the modern harmonic laws of acoustics. All these systems had obtained the same results, namely the universal basic scale.

The Indian Shruti system of Bharata was so far supposed to be a vaguely descriptive and indeterminate ear method without any ratios or measurements. Having evolved an algebraic formula, the Indian system may be called as based on Algebric method.

In China the legendary Ling Lun (C-2700 BC) is reported to have cut twelve Bamboo pipes in to a chain of ascending Fifths by cutting each successive pipe $\frac{2}{3}$ in

length of the previous one. The series of the first five positive fifths, he thus obtained consists of Sa, Pa, Re, Dha, Ga. This cycle of five fifths, arranged in scalar order, resulted in consistent Chinese tradition consisting of the practical Major-pentatonic scale corresponding to Indian Bhoop; Sa, Re, Ga, Pa Dha.

If the principles of inversive as discussed in the present study , are applied to the Chinese system , and in place of positive cycle of 5th the negative cycle of 5th is used we will get the Inverse Pentatonic Scale of the Chinese system corresponding to Indian Malkauns; Sa, ga, ma, dha,ni. Now, in any Chinese composition, if the above swaras are interchanged with the original ones we will get the inverse of that composition which, is likely to be as melodic as the original one, its aesthetic appeal, though will be totally different than the original as explained in the earlier chapters. The same will hold good for all the other prevalent systems of music world over, like Arabian, African systems etc.

Western System; Consonants being the consonants all over the world, it is no wonder if there is found a close similarity between Indian & Western scales. In Europe there are two scales Major mode and the Minor mode which form the backbone of the music of the West. The closest and the simplest relationship of tones is reached in the major mode as all its notes are but constituents of the compound tone of the tonic or its fifth, above or below. As explained in chapter-5 the major mode is built up of three major chords.

	3←-----3←-----3							
Notes	C	D	E	F	G	A	B	C (d)
Index number	24	27	30	32	36	40	45	48 (54)
of frequency	1-----→1-----→1							
	2-----→2 -----→2							

The first major chord is indicated by 1, the second by 2 and the last by 3. The arrow supplied to the figures indicates the point of start and direction of application in each case. Similarly the Minor scale consists of three minor chords.

	3<-----3<-----3							
Notes	C	D	E _b	F	G	A _b	B _b	C (d)
Index number	24	27	28.8	32	36	38.4	43.2	48 (54)
of frequency	1-----→1-----→1							
	2-----→2-----→2							

It should be remembered in both these scales that the principle of tonality is fully observed as all the tones are connected by simple relationship of the chief note, the tonic as also between themselves.

Now if we the mathematical relationship in the notes of Major & Minor Chords we find the following. In the major chord the notes C E G having frequency index as 24, 30 & 36 .The ratios between the notes of the Major chord thus is $5/4(30/24)$ between C & E and $6/5(36/30)$ between E & G. In the Minor chord the notes C Eb G are having frequency indexes as 24, 28.8 & 36. The ratios between the notes of the Minor chord thus is $6/5(28.8/24)$ between C & Eb and $5/4(36/28.8)$ between Eb & G.

Major Chord:	C	E	G
Index number	24	30	36
Ratios		(5/4)	(6/5)

Minor Chord:	C	Eb	G
Index number	24	28.8	36
Ratios		(6/5)	(5/4)

We see that the ratios between the notes of the two chords are in inverse order of each other. In mathematical terms, therefore, it can be said that Major Chord and Minor Chords are inversely related with each other in the same way as Swara 'Pa' & 'Ma' in Hindustani Music, explained already in detail. Now if, in any composition of Western Music the Major Chords are replaced with the Minor Chords & vice versa the new composition will also be as **harmonic** as the original one it also is likely to have the aesthetic appeal of the same intensity as the original one, though a different one in nature. This can be practically tried by any one proficient in the Western music and open to further exploration and validation.