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SOUND AND MUSIC

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ABSTRACT: *The mathematical aspect of North Indian Classical music while it can hardly be claimed that all aspects of music (North Indian or otherwise) can be explained on a mathematical or a scientific basis, it stand to reasons that sound and its effect on human ears being a physical phenomenon, the origin of notes, Shrutis, Grams, Thatas and Ragas have mathematical explanation also. It is well know that sound is produced as a result of Physical vibration, whether they are directly visible or not. The vibrations have three aspect-amplitude, Frequency and the pattern. Accordingly, any sound (musical or otherwise), has three characteristics-loudness (related to the frequency or vibration which plays a pivotal role in the origin of notes, Shrutis, etc. and the determination the inter relationship of different Notes, Shrutis and also the rules for the construction of Gram, Thata and Rage. A mathematical inquiry into the structure of Classical music reveals that not only can we explain the exeact pitch or frequency of the accepted Notes and Shrutis but can also drive new Notes and Shrutis and new Grams and Ragas based on certain mathematical principal, which has resulted in a number of significant conclusions which go a long way in proving a strong mathematical basis of the system of classical music and may prove the way for inventing new pattern of music.*

KEYWORDS: Sound, Music, Mathematical, Vibration, Frequency

INTRODUCTION

One kind of Sound is distinguished from another by three qualities, namely, loudness, pitch and quality which depend on the characteristics of vibrations. The concept of frequency, wave-length, and amplitude etc, The"Swara" or a Note depends upon the frequency of vibration. This in its turn depends upon the length of the vibrations which in its turn, depends upon the length of the vibrated chord or vibrated ear column. While the frequency of vibrations distinguishes one "Note" or shruti from another, it is the quality of the sound (depending upon the pattern of vibrations) which distinguishes a musical sound from a non-musical one and also distinguishes a voice of one singer from another. Contrary to what may appeal to the common sense, a "pure tone" which has a regular shape of sine/cosine-curve shape-does not constitutes a musical note because it is not pleasant to the human ears. A "compound note" which has a irregular shape on the vibration graph consists of a series of pure notes which are suitable superimposed and give rise to harmony. The human ears are familiar with this harmony because most of the sound produced in nature consists of compound notes. This familiarity manifests as "pleasantness" in short, musical notes are compound notes rather than their" pure tones". It has been explained that the human ear perceives ratio of frequency rather than their differences. This quality is called logarithmic response.

The Ratio of the Swaras and Notes

The origin of the musical scale has been studied purely from a mathematical point of view, the special question which has been only certain frequencies produce pleasant or musical effect in combination with the base note. It must be remembered that in any interval between two notes, there are infinite musical Shrutis and infinite "non-shrutis" which are not musical. The evolution of a musical scale has been help of a theory of harmonics. Construction of musical scale has been adopting "third harmonic method" and "fifth harmonic method". Since it is not possible mathematically to construct" perfect musical scale" by adopting third harmonic or fifth harmonic method or any other method, at no stage of our construction of musical scale, do we come back to the same musical note from which we started. On account of this compromise will have to be made to close the musical scale and this has given rise to a multiplicity of system of musical scales. The different types of musical scales have been discussed including those intervals by ancient musicians. The tone tempered scale has also been established mathematically how it makes unwarranted compromise with the accuracy of notes for the sake of achieving a practical convenience. The origin of Shruti has also been discussed from the mathematical point of view. The exact frequencies of the 22 Shrutis as derived by the Veena experiment described by Bharat have been calculated and it has been established that all the shrutis are not equal. The musical property of Shadaj Gram and Madhyam Gram has been compared with respect to musical relationships between different Shrutis. Musical relationships are no longer subjective but dependent on exhibiting certain mathematical rations between the Shrutis concerned, which is a scientific basis. These ratios are called Shadaj-pancham Bhav(equivalent to the ratio of 3/2), Shadaj-Madhyam Bhav (equivalent to the ratio of 4/3), and Shadaj-Gandhar Bhav (equivalent to the ratio of 5/4), and Shadaj- Komal Gandhar Bhav (equivalent to the ratio of 6/5), respectively. The shrutis separated by these ratios are bound to be musical, Apart from Shadaj-Madhyam Gram, a third gram, namely Gandhar Gram has also been discuses. Although no accounts of Gandhar Gram are available in any ancient literature. The notes and Shrutis of this Gram have been derived on mathematical principles which can be said. The Shrutis of the Gandhar Gram turn out to be such that a very large number of them exhibit Shadaj-Gandhar Bhav (either equivalent to the ratio of 5/4). Since Gandhar Gram is altogether new to the field of Indian Classical music, this opens up a new vista of Ragas arising out of Gandhar Gram. One such has been constructed by research work on mathematical principles taking care to maximizing the number of notes exhibiting relationship with each other.

The general mathematical theory of Grams in which Shrutis have been derived purely from mathematical considerations and also taking into account the requirement of maximizing musical relationship and elimination those notes which are musically inconsistent with the others. Starting from these numbers, the different Grams have been constructed on theoretical basis and it has been shown that although only 3 Grams have been mentioned in the ancient literature out of which only have been described (Shadaj amd Madyham Gram), many more Grams can be constructed on theoretical basis which are musically as rich as two Grams in the ancient literature. If we discard the requirement of musical relationship (unthinkable in any system of music), the number of Gram which can be constructed out of 22 Shadaj is more then 12 crore, but of course, all these Grams are not musical. When different conditions are imposed on the location of Shadaj in order to make them musical, the number comes down drastically. Still, there is 60 Gram which is as musical as the two or three ancient Grams, at least in terms of consecutive note-rations. When other requirements of musical relationship are taken care of, we are left with still 22 Grams which are at least as rich in musical

relationship as the Shadaj Gram. Thus as against only 3 Grams mentioned in the ancient literature (out of which only 2 have been described), there are 22 Grams which merit attention, on the basis of their musical properties. Notes and Shrutis----First, the question have been tackled as to how many notes should form octave. It has been calculated that a musical scale may have either 7 notes 12 notes and both systems have their advantages and disadvantages detail. Coming to Shrutis, the different claims made by musicians regarding the exact location of 12 notes as described by Bharat. However the Indian classical music cannot be limited by 12 notes or even 22 by Shrutis and, infect shrutis more than employed in Indian classical music, consciously or unconsciously.

No musician calculates this relationship and very few even realize which note or Shrutis being played or sung, but owing to the sense with which every musician is equipped the right note or shruti crops up to fit in with the requirements of the mood and the rules of the melody.

That's have employed what is the fundamental different between the concept of a Gram are employed using a different note as the same Gram. The number Thatas as derived mathematically from 12 note system and each Thata has been established that each Thata has a number of variation in which notes are slightly different (differing by a Shruti) which pertains to different Gram all these variations are employed in practice according to the requirement of the melody in question. In the process, different version of thata comes to light which are not obvious. In any literature and which can be revealed only when all possible alternatives are discussed keeping the requirements of musical relationship intact.

The ragas or melodies have been defined and derived. The definition of ragas is the same as adopted in the ancient literature but the properties of the Ragas have been discussed for the point of view of the mathematical requirements or musical relationship and it has been established that different shrutis of the constructed from the Ghandhar Gram. The raga is a frame work of notes arising out of Thata bund by a set of rules in the nature of certain conditions or restrictions leaving a lot of scope for composition of tones. How ever, apart from the general set of rules, a raga has its own special characteristics which are difficult to define but easy to demonstrate. In order to construct a Raga from Thatas, an important step is to select Aaroh and Avaroh in such a way that makes possible a number of musical relationships which are exploited.

The basic conclusion in Indian classical music and their combination into Gram, Thatas and Ragas, the condition necessary for certain combinations of musical notes have a pleasant and musical defect on the ears and the method that evaluates musical richness of a particular scale on mathematical basis, A musical note has to be a compound note has thus been established, those notes appear musically related to this note which have a predominant frequency equal to its 3^{rd} , 4^{th} ,5^{th} and 6^{th} tharmonics. These harmonics give rise to Shadaj-pancham Bhav(Frequency ratio of 3/2) and Shadaj-shuddha Gandhar Bhav(frequency ratio 5/4).

From shadaj-pancham Bhav, another relationship know as shadaji-madhyam Bhav (Frequency ratio 4/3) can be derived by rising a lower note by an octave or by lowering a higher note by an octave. Similarly, by raising the lower note by a frequency ratio of 3/2, or by oowering a higher note by the same ratio, Shadaj-shuddha Ghandhar Bhav is converted into dhadaj-komal Ghandhar Bhav(6/5). Thaus four fundamental musical relationship were derived having frequency ratio 3/2,4/3,5/4 and 6/5.Idealy, in the musical scale containing

seven note, notes separated by three notes(Sa-pa,re-da etc) are expected to exhibit sa-pa type relationship, notes separated by two notes(sa-ga,re-ma)are expected to exhibit one of the shadaj-Gandhar type relationship.However, theoretically it is impossible for any musical scale to exhibilt these relationship in all possible pairs. At least one pair would fail to exhibit the relationship it is expected to. The ideal method of construction of musical scale could be to fellow the successive third harmonic of fifth harmonic method. However, it is mathematically impossible for either of these sequences to close at any stage, although the successive third harmonic methos gives 12 notes before coming to note 13^{th} , Fairly close to the stating note. Since a perfect musical scale is impossible in this sense, there has been a multiplicity of scales which have their own advantage and disadvantages.

The Grams(seven-note scales) defined by Bharat were constructed on very sound scientific basis Although a full description of Gandhar Gram is not available, it has made a conjunction of its notes and Shrutis and how rich it is in terms of shadaj-Gandhar relationships.

The musical richness of a in terms of the number of airs which exhibit the relationship they are expected to, has been defined, When we proceed in this manner, we get 22 Grams as against 3 mentioned in ancient literature. In fact,if we admit certain un-usual frequency ratios between successive notes, we get 17 more Grams.

It has been established that although shrutis are infinite, it is possible to derive 88 order shrutis on theoretical consideration as against 22 Grams as against 3 mentioned in ancient literature. In fact, if we admit certain un-usual frequency ratios between successive notes, we get 17 more Grams

It has been established that although shrutis are infinite, it is possible to derive 88 order shrutis on theoretical consideration as against 22 traditional shrutis.Many of these 88 ehrutis are in use consciously or unconsciously.

Thatas are seven-note scales in which the notes are in particular order (in a Gram, only cyclic order of the note important). The number of mathematically possible Thatas and the number of thatas which are musically rich on the basis of yardstick developed. Also musically richness and the prevalent that's has its own variation Somthimes by varying a note slightly (by a shruti), we move into diggerent Gram although, thata appeats to be unchanged. As compared to Gandhar, a Tata is a more crude system of defining a musical scale. The development of nurchhana,Taans and jatis (prototype of Ragas from ancient Frams have been discussed). It has been explained how various Shrutis are emplyed in different Ragas or out of the same Raga in order to highlight a particular musical relationships.

CONCLUSION

However, when two notes having almost (but not exactly) similar frequencies are sounded simultaneously, the ear perceives the difference of these frequencies which gives rise to the phenomenon of beats. It is this phenomenon of beats which is utilized by musicians to tune their musical instruments. First, the two notes to be tuned to each other are sounded separately, when the ratio of their frequencies is observed and two notes are adjusted until they have sounded simultaneously and re-adjusted until the beats disappear. The phenomenon of Resource has also been explained in this chapter which arises when two or more notes

having exactly the same are frequency are sounded together this chapter, therefore, lays down the foundation of a mathematical analysis into the structure of classical music.

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