

Pitch

Pitch is directly related to frequency and my analysis of ragas is based on frequency so it is very important to understand this term before I proceed to analyze raga.

‘It is the frequency of vibration that determines the pitch of the Sound. If there is no clearly defined frequency there is no clearly defined pitch, because the sound is no longer musical.’¹⁰¹

‘It must be kept in mind that whereas the western system conceives of an absolute pitch for each note, this is not the case with Indian music. Absolute pitch means that there is a fixed frequency for each note.

In Indian music, it is the relative pitch which is considered and this is the relation to the tonic. The actual relationship is given by the interval, that is, the ratio between the frequencies of the note taken as the tonic and the other note.’¹⁰²

Pitch (music)

‘In music, pitch is the perception of the frequency of a note. For example, the A above middle C is nowadays set at 440 Hz (often written as "A = 440 Hz", and known as concert pitch), although this has not always been the case. Pitch is often cited as one of the fundamental aspects of music.

A slight change in frequency need not lead to a perceived change in pitch, but a change in pitch implies a change in frequency.

Pitches may be described in various ways, including high or low, as discrete or indistinct, and as determinate or indeterminate. Pitch is often measured by frequency or wavelength, but is most often discussed either through notation and the accompanying letter labels (C#).

Varying Pitch

Musically the frequency of specific pitches is not as important as their relationships to other frequencies - the difference between two pitches can be expressed by a ratio or measured in cents. The relative pitches of individual notes in a scale may be determined by one of a number of tuning systems. In the west, the twelve-note chromatic scale is the most common method of organization, with equal temperament now the most widely used method of tuning that scale. In it, the pitch ratio between any two successive notes of the scale is exactly the twelfth root of two. In well-tempered systems, different methods of musical tuning were used. Almost all of these systems have one interval in common, the octave, where the pitch of one note is double the frequency of another.’¹⁰³

¹⁰¹ Science and Music by Sir James Jeans P. 23,24

¹⁰² Nad by Sandeep Bagchee P.25

¹⁰³ [http://en.wikipedia.org/wiki/Pitch_\(music\)](http://en.wikipedia.org/wiki/Pitch_(music))

Historical Pitch standards

‘The old Indian music makers also thought of standardizing the main notes, but it was not possible at the time;¹⁰⁴

‘As well as various systems of musical tuning being used to determine the relative frequency of notes in a scale, various pitch standards have been used historically to fix the absolute position of the scale. In 1955, the International Organization for Standardization fixed the frequency of the A above middle C at 440 Hz, but in the past, various frequencies have been used.

Until the 19th century, there was no concerted effort to standardize musical pitch and the levels across Europe varied widely. Pitch levels did not just vary from place to place, or over time - pitch levels could vary even within the same city. The pitch used for an English cathedral organ in the 17th century for example, could be as much as five semitones lower than that used for a domestic keyboard instrument in the same city. Helmholtz writes: 'On the sensation of tone'. The need to standardize pitch levels, at least within one city or country,

There was a tendency towards the end of the 18th century for the frequency of the A above middle C to be in the range of 400 to 450 Hz.

Throughout the first half of the 19th century, there was a tendency for the pitch used by orchestras to rise. This was probably largely due to orchestras competing with each other,

The rise in pitch at this time can be seen reflected in tuning forks. A 1815 tuning fork from the Dresden opera house gives A = 423.2 Hz, while one of eleven years later from the same opera house gives A = 435 Hz.

The most vocal opponents of the upward tendency in pitch were singers, who complained that it was putting a strain on their voices. Largely due to their protestations, the French government passed a law on February 16, 1859 which set the A above middle C at 435 Hz. This was the first attempt to standardize pitch on such a scale, and was known as the diapason normal. It became quite a popular pitch standard outside of France as well.

An alternative pitch standard known as philosophical or scientific pitch, which fixed middle C at exactly 256 Hz (that is, 2^8 Hz), gained some popularity due to its mathematical convenience (the frequencies of all the Cs being a power of two). In 1939, an international conference recommended that the A above middle C be tuned to 440 Hz. This standard was taken up by the International Organization for Standardization in 1955 (and was reaffirmed by them in 1975) as ISO 16.

Despite such confusion, A = 440 Hz is now used virtually world wide, at least in theory. In practice, as orchestras still tune to a note given out by the oboe, rather than to an electronic tuning device (which would be more reliable), and as the oboist himself may not

¹⁰⁴ Theory of Indian music by Rai Bahadur Bishan Swarup, P.31

have used such a device to tune in the first place, there is still some variance in the exact pitch used. Solo instruments such as the piano (which an orchestra may tune to if they are playing together) are also not universally tuned to A = 440 Hz.¹⁰⁵

'The first suggestion for a standard had been made about 1700 by French physicist Joseph Sauveur, who proposed C equals 256, a convenient standard for mathematical purposes. German physicist Johann Heinrich Scheibler made the first accurate determination of pitch corresponding to frequency and proposed the standard A equals 440 in 1834. In 1859, the French government decreed that the standard should be A equals 435, based on the research of French physicist Jules Antoine Lissajous. This standard was accepted in many parts of the world, including the United States, until well into the 20th century.'¹⁰⁶

'A reference tone is required - a "standard of pitch." For most western music "A4," the fourth A from the bottom of the piano keyboard is set to 440 Hz.

With A4 at 440 Hz, the frequencies of three notes of a major chord are shown in the table below. The frequencies of the three tunings are quite close. So close that the largest differences are barely perceptible to the human ear.¹⁰⁷

Tuning	C4	E4	G4
Just	264	330	396
Pythagorean	260.741	330	391.11
Equal Temperament	261.625	329.63	392.00

'In 1939, an international conference met in London and agreed on A = 440 as a new standard universal use, at least in broadcasting. With this standard the frequencies of tones being determined, are given below in the Table.'¹⁰⁸

Tone	Standard frequency	Indian frequency
C(Sa)	261.6	240
C(Re komal)	277.2	256
d(Re)	293.6	270
d(Ga kamal)	311.1	288
e(Ga)	329.6	300
f(Ma)	349.2	320
f#(Ma tivra)	370.0	337 ^{1/2}
g(Pa)	392.0	360
G#(Dha komal)	415.3	384
a(Dha)	440.0	405
A#(Ni kamal)	466.2	432
b(Ni)	493.9	450
c(Sa Upper octave)	523.2	480

¹⁰⁵ [http://en.wikipedia.org/wiki/Pitch_\(music\)](http://en.wikipedia.org/wiki/Pitch_(music))

¹⁰⁶ Microsoft ® Encarta ® Encyclopedia 2003. © 1993-2002 Microsoft Corporation.

¹⁰⁷ <http://www.abasoft.com/music/teory03.html>

¹⁰⁸ Science and Music by Sir James Jeans.p.23,24

'If there is no clearly defined frequency there is no clearly defined pitch, because the sound is no longer musical'.¹⁰⁹

Changing the pitch of a vibrating string

'There are four ways to change the pitch of a vibrating string. String instruments are tuned by varying the strings' tension because adjusting length or diameter is impractical.

Length

Pitch can be adjusted by varying the length of the string. A longer string will result in a lower pitch. A shorter string will result in a higher pitch. The change in pitch is inversely proportional to the change in length:

$$f \propto \frac{1}{l}$$

A string twice as long will produce a tone half the pitch.

Diameter

Pitch can be adjusted by varying the diameter of the string. A thicker string will result in a lower pitch. A thinner string will result in a higher pitch. The change in pitch is inversely proportional to the change in diameter:

$$f \propto \frac{1}{d}$$

Tension

Pitch can be adjusted by varying the tension of the string. A string with less tension (looser) will result in a lower pitch, while a string with greater tension (tighter) will result in a higher pitch. The change in pitch is proportional to the square root of the change in tension:

$$f \propto \sqrt{T}$$

Density

The pitch of a string can also be varied by changing the density of the string. The change in pitch is inversely proportional to the square root of the change in density:¹¹⁰

$$f \propto \frac{1}{\sqrt{\rho}}$$

¹⁰⁹ Ibid p.22, taken from book Sitar as I know by Ravi Sharma

¹¹⁰ [http://en.wikipedia.org/wiki/Pitch_\(music\)](http://en.wikipedia.org/wiki/Pitch_(music))

WESTERN MUSIC & INDIAN MUSIC

Helmholtz said: "The music based on the temperate scale must be considered as an imperfect music.....If we suppose it or even find it beautiful; it means that our ear has been systematically spoiled since childhood."¹¹¹

Observation:

Our voice can produce several frequencies with the limitation of three or four octaves only. It is known that the frequency between any key and the key immediately to its left is a constant which is being equal to the twelfth root of two or 1.059. By the time we reached the thirteenth key, we have doubled our frequency and thus spanned a whole octave. This division of the octave into twelve 'tones' which have specific ratio between adjacent keys is called an 'Equally tempered' arrangement. Besides the keyboard, most Western musical instruments are tuned to such an arrangement. The Western music defines a standard octave called the 'Middle C octave' (also called the Middle C scale).

We have no need to have just twelve keys in an octave. In fact, the traditional Indian music system over thousands of years is based on a 22 key per octave system. We do not have an 'Equally tempered scale'. One can locate one's frequencies based on some other non-geometric criteria, which might 'sound' better, and such scales are known as 'Just tempered scales'. In fact, the Indian musical system uses one such scale.

Even though Indian musical systems are very different from the traditional Western Music system, we can still get a lot of insight into Indian music using the equally tempered, twelve keys per octave methodology - essentially because it makes things simple.

Some Indian schools of thought even propose that there are infinite frequencies in an octave. The basic reason for demands for more than twelve 'srutis' per octave is that Indian music seems to 'flow' through the frequencies involving a lot of vocal acrobatics and nuances whereas a Western song seems 'jumpy' like a Piano. Because of this Indian classical music cannot be played effectively in a twelve key per octave instrument like a piano. Of course, several Western instruments have been 'adapted' with a little modification here and there, to play Indian classical music - violin, mandolin and guitar, for example. Some other instruments have been simply 'used', without modification, such as the harmonium and the keyboard.

In Indian Classical Music it is not enough to produce just twelve or twenty two tones in an octave one ought to produce even the intermediate frequencies which do not have any keys to produce them are called Microtones. The microtones add variety to the Indian classical music - an extra dimension. The very heart of Indian music is this 'continuous flow' or 'gliding through a continuum of frequencies' or gamakam or microtonal excursions. Thus, it is often said that Indian music is 'melody-based'. Since microtones are so important in Karnatic and Hindustani music and very few instruments can produce all the frequencies in an octave, the best enunciation of Indian classical music is in vocal singing. In the Western Music, 'harmony' is an important element. Orchestration and 'harmony' are absent in Indian classical music.

¹¹¹ Introduction to the study of Musical Scales by Alain Danielou P.220s

Even if there is a 'Jugal bandhi' - a standard fare in Hindustani classical music where two instruments (or even two vocalists) are featured together, the musicians usually follow the same melodic pattern one after another with minor variation rather than play different melodies simultaneously.

'In western music all the notes have an approximately equivalent value because each note can be fifth or third and second or octave of a chord. The significance of the notes as modal degrees is consequently generally nil, and, in any case, extremely weak.'¹¹²

'In Indian music, melody and rhythm are more developed and offer a great variety of subtleties, not possible in Western Music. Indian notes are divided into small units called sruties (22 microtones in all), whereas western music has only 12 semitones. The microtones are more subtle than semitone.'¹¹³

¹¹² Introduction to the study of Musical Scales by Alain Denielou, P.103

¹¹³ History of Music by Padma Iyer, P.244