# Musical Interval and Ratio

**MUSICAL INTERVALS:**

It is necessary to understand what is interval as my subject topic analyzes ragas analyzes with reference to interval. Here I am giving only that detail about Interval which is related to my works. Different types of Interval is used in Western countries.

In Indian music each artiste has their different reference note (Sa) therefore it is very difficult to compare any two raga of different artistes with reference to frequency so I took ratio of each swar with reference note (Sa) so that one can compare any two or many artistes raga easily. Similarly, one can compare even male and female artistes ragas.

Distance between any two notes is known as Interval, which is measured by the ratio of their frequencies. e.g. two notes with frequencies 288 Hz and 256 Hz have frequency interval

$$\frac{288}{256} = \frac{9}{8} \quad 9:8 \text{ or } 1.125$$

'Interval can be described as ratios of frequency of vibration of one sound wave to that of another: the octave a-a', for example, has the ratio of 220 to 440 cycles per second, which equals 1:2(all octaves have the ratio 1:2, whatever their particular frequencies).'[63]

'The relation of a note to another is expressed by the ratio of their vibrations. This ratio is technically called the INTERVAL between two notes.'[64]

The term musical interval refers to a step up or down in pitch, which is specified by the ratio of the frequencies, involved. For example, an octave is a Music Interval defined by the ratio 2:1 regardless of the starting frequency. From 100 Hz. to 200 Hz. is an octave, as is the interval from 2000 Hz. to 4000 Hz. The intervals, which are generally, the most consonant to the human ear are intervals represented by small integer ratios. Intervals represented by exact integer ratios are said to be Just intervals, and the temperament which keeps all intervals at exact whole number ratio Just temperament.

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[63] The New Encyclopedia Britanica micropaedia Vol.3, p.557
[64] Theory of Indian music by Rai Bahadur Bishan Swarup,P.19

**Ratios**

The theories of Pythagoras and Helmholtz depend on the frequency ratios shown in Table 1.

Table 1. Standard Frequency Ratios

| Ratio | Name |
|---|---|
| 1:1 | Unison |
| 1:2 | Octave |
| 1:3 | Twelfth |
| 2:3 | Fifth |
| 3:4 | Fourth |
| 4:5 | Major Third |
| 3:5 | Major Sixth |

These ratios apply both to a fundamental frequency and its overtones, as well as to relationship between separate keys.

**Twelve-Tone Musical Scale**

'The distance between two notes, measured as the ratio of their pitches, is called an interval. If the interval between two notes is a ratio of small integers (such as 2/1, 3/2, or 4/3), they sound good together - they are consonant rather than dissonant.

The pure intervals smaller than or equal to an octave that are commonly considered to be consonant are:

2/1 - the octave
3/2 - the perfect fifth
4/3 - the perfect fourth (the harmonic inverse of 3/2)
5/4 - the major third
6/5 - the minor third
5/3 - the major sixth (the harmonic inverse of 6/5)
8/5 - the minor sixth (the harmonic inverse of 5/4)

The octave is divided into twelve exactly equal intervals. In this system, the smallest interval, the semitone, is not a simple integer ratio, but is the twelfth root of two ($2^{1/12}$) or approximately 1.059. Larger intervals are multiples of the twelfth root of two, Compares just intonation with equal temperament. The intervals in both systems are never exactly the same (except the octave), but they are very close - always within about one percent or better, as shown in the table below.'

| Number of Semitones | Interval Name | Notes | Consonant? | Just Intonation* | Equal Temperament | Difference |
|---|---|---|---|---|---|---|
| 0 | unison | C-C | Yes | 1/1=1.000 | $2^{0/12}$=1.000 | 0.0% |
| 1 | semitone | C-C# | No | 16/15=1.067 | $2^{1/12}$=1.059 | 0.7% |
| 2 | whole tone | C-D | No | 9/8=1.125 | $2^{2/12}$=1.122 | 0.2% |
| 3 | minor third | C-Eb | Yes | 6/5=1.200 | $2^{3/12}$=1.189 | 0.9% |
| 4 | major third | C-E | Yes | 5/4=1.250 | $2^{4/12}$=1.260 | 0.8% |
| 5 | perfect fourth | C-F | Yes | 4/3=1.333 | $2^{5/12}$=1.335 | 0.1% |
| 6 | tritone | C-F# | No | 7/5=1.400 | $2^{6/12}$=1.414 | 1.0% |
| 7 | perfect fifth | C-G | Yes | 3/2=1.500 | $2^{7/12}$=1.498 | 0.1% |
| 8 | minor sixth | C-Ab | Yes | 8/5=1.600 | $2^{8/12}$=1.587 | 0.8% |
| 9 | major sixth | C-A | Yes | 5/3=1.667 | $2^{9/12}$=1.682 | 0.9% |
| 10 | minor seventh | C-Bb | No | 9/5=1.800 | $2^{10/12}$=1.782 | 1.0% |
| 11 | major seventh | C-B | No | 15/8=1.875 | $2^{11/12}$=1.888 | 0.7% |
| 12 | octave | C-C' | Yes | 2/1=2.000 | $2^{12/12}$=2.000 | 0.0% |

* This table shows one variation of just intonation.

In practice, we use the twelve-tone equal-tempered scale and do not use a ten-tone or twenty-tone equal-tempered scale because 'the twelve-tone equal-tempered scale is remarkable. The nearly perfect intervals seen in the table above are not typical of other equal-tempered scales. Consider the six basic consonant intervals less than an octave (described above): 3/2, 4/3, 5/4, 6/5, 5/3, 8/5. The twelve-tone equal-tempered scale is the smallest equal-tempered scale that contains all six of these pure intervals to a good approximation - within one percent.'[65]

[65] http://thinkzone.wlonk.com/Music/12Tone.htm