8 March 1965

READING 7

Law of Octaves (Continued)

Part 1

To continue our study of this Law we start with a stretched string as Pythagoras is said to have done some 2,500 years ago (but now with more modern means of measuring). If we shorten the string we find that the frequency or pitch of the sound rises; if we halve its length the pitch rises exactly an octave, showing that the period of vibration has also been halved. This 'Law of Pythagoras' is the first of those three laws formulated by the French mathematician Mersenne (*Harmonie Universelle*, 1636) which have determined the construction of all musical instruments in the West for more than 300 years. We are now only concerned with the first law (the 'Law of Pythagoras') which can be stated thus:

> When a string and its tension remain unaltered, but the length is varied, *the period of vibration is proportional to the length*;

and, of course, the *frequency* (which is the inverse of the period) is *inversely* proportional to the length.

When any structure whatever is in a state of vibration, its motion can either be regarded as made up of a number of travelling waves; or as made up of a number of free vibrations. These are just two ways of looking at the same thing. By the first way we realise that the law merely asserts that all waves travel along the string at precisely the same speed; by the second it follows that, if musical sounds are produced by the different vibrations, these must be all pure tones; in other words, each could be produced by the free vibrations of a tuning fork. But in the case of a stretched string, such as that of a violin, all are produced simultaneously (the string vibrating in many different numbers of equal parts) and therefore bear the simplest possible relation to the Fundamental Tone or 1st Harmonic. For instance, if a violin is made to sound c' (middle C) of frequency 256 cycles per sec., other tones will be sounded by resonance thus:

Note	c^{I}	c^{II}	g^{II}	c^{III}	e^{III}	g^{III}	$b\flat^{III}$	c^{IIII}
Frequency	**256**	**512**	**768**	**1024**	1280	1536	1792	**2048**
Number of Harmonic	1	2	3	4	5	6	7	8

(data from Jeans, *Science & Music* p.27)

You will see that you simply multiply the fundamental frequency by the number of the harmonic; and that the first 8 harmonics are contained within 3 doublings or octaves.

Upon this same principle the Universal Symbol or Enneagram is constructed; and you will gradually see with its help that these laws apply to everything in the Universe.

Just to give you one out of very many examples: We can take the distances of the Planets from the Sun, for Newton's 'Gravity' acts in this case as the string:

PLANET									
Pluto	Neptune	Uranus	Saturn	Jupiter	Asteroids (e.g.Ceres)	Mars	Earth	Venus	Mercury
Mean measured distance from the Sun in millions of miles									
3670	2796.5	1784.7	888	483.9	246.5	141.7	93	67.3	36
Expected distance									
4096	**2848**	**2048**	**1024**	**512**	**256**	**128**	**96**	**64**	**32**
2^{12}	$2^{11.5}$	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	$2^{6.5}$	2^{6}	2^{5}

This doubling of distances is the basis of the famous 'Bode's law', which is still puzzling scientists because, while it successfully predicted the discovery of Uranus, it appears to them to fail with Neptune and Pluto. That is just because they are ignorant of the Law of Octaves which shows that the Earth and Neptune are in the position of the 1st and 2nd 'intervals' of the Planetary octave, where there is a 'missing semitone'. The other small discrepancies can be understood if one realises that all the planets are moving outwards, those nearest the Sun (excepting the Earth) being up on schedule, while the others further out are lagging behind. Differences in mass of the planets and different 'tensions in the string' can account for this according to Mersenne's second and third laws.

Perhaps the *Planets as a single whole* can be thought of as a musical instrument emitting a rich composite note, whose component frequencies you can work out (if you want to) from their periodic times by means of Kepler's Laws. Remember that pitch or frequency is the inverse of the periodic time, so Mercury would sound the highest note, being on the shortest string.

The same law connects the wavelength with the frequencies of all the 80 octaves of electromagnetic vibrations from low frequency alternating currents to cosmic rays. Within them the single octave of visible light distributes the spectrum of colours distinguished by our eyes according to their wavelengths, from above heat waves of the infrared to the ultraviolet. All the subtleties of colour that the artist perceives and reproduce are to be seen in the inner octaves (between any two notes of the main one), to which most of us are blind.

The Law of Octaves is also in the chemical element, in organic growth, in the human body, and in all the laws of Statistics and Probability which apply to large numbers of things. It is high time that all this evidence for its universality should be put together!

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PART 2

What are the most important things that we can learn from the Law of Octaves for our work in trying to go up that Octave of Self-realization, the Ladder of Seven Steps which the Shankaracharya has described to us?

Surely *one* thing is to make more *intelligent use of 'passing time'*. For those vibrations which you *don't* want, you 'let time go by'. We all know that when one is in a rage, it is better to let the blood cool before going into action! Great Teachers always stressed that:

> 'Agree with thine adversary quickly...'; 'Turn the other cheek'; 'Of necessity disagreements arise, but we Dervishes must be unresistant like water'; 'Who is there that can make muddy water clear? But if allowed to remain still, it will gradually become clear of itself. Who is there that can secure a state of absolute repose? But let time go on, and the state of repose will gradually arise.' etc., etc.

On the other hand, *regarding those vibrations that we want*, we must not let 'the grass grow under our feet'; time must not get in the way. If we feel the 'good impulse' we mustn't delay a moment; we must make immediate resolution and act on it with strong determination at the beginning. The time to meditate, for instance, is *now* (the moment it occurs to you); the time to bring all your attention back to the Mantra is *now*, immediately you find your attention waning. For if our Aim grows cold, it may not warm up again for a long time and we will miss opportunities and perhaps never quite catch up; at the beginning of a time of cooling off the redoubling of efforts is essential; we have, in St. Paul's words, to keep 'redeeming the time'. We have only the present moment, the moment of 'impulse':

One Moment in Annihilation's Waste,
One Moment, of the Well of Life to taste –
The Stars are setting and the Caravan
Starts for the Dawn of Nothing
– Oh, make haste!

The Moving Finger writes; and, having writ,
Moves on: nor all thy Piety nor Wit
Shall lure it back to cancel half a Line,
Nor all thy Tears wash out a Word of it.

Omar Khayyam

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