



## CHAPTER SIXTEEN: HARMONICS

### WHAT ARE HARMONICS?

Harmonics are theoretically speaking always a part of our sound. In fact, they are an integral part of **any** sound. They are the notes or *overtones* which sound above every fundamental pitch, except for that of a pure sine wave. Harmonics contribute to the *timbre* or tone-colour of a note, which allows us to distinguish a violin from a trumpet, or an A played on our E string or the same pitch played as an open A string. In the technique of playing harmonics on the bass, we are concerned with the emphasis or isolation of certain harmonics.

### THE HARMONIC SERIES

Each note we play contains not one but a series of harmonics rising above it. The harmonic series is a natural acoustic phenomenon that is universal for all pitched sounds and instruments. What differs between sounds and instruments is the relative presence or volume of the different harmonics in the series, which combine to create a mix which is characteristic to that particular instrument or sound. This mix is generally referred to as the *timbre*, and when graphed creates a characteristic *waveform*. Spectral analysis shows that a flute's waveform is far different to a piano's, for instance. To be completely accurate, two sounds are not only differentiated by their waveforms but also by the different combinations of attack and decay they possess, and also due to the presence of various noise components in the sounds (wind from the breath, hammer action, etc.). To complicate matters more, the harmonic series mix is not fixed for each instrument or even each note on each instrument, but rather changes over the duration of each sounded note, and over the registers and dynamic range of the instrument. Herein lies the difficulty of effectively synthesizing and electronically reproducing the sound of acoustic instruments!

The harmonic series was discovered simultaneously in China by using overblown flutes, and in Greece by using a distant predecessor of the electric bass guitar - the monochord! The monochord was simply a string terminated at both ends, mounted on a box, and put under tension with a movable bridge. The Greeks (including Pythagoras) discovered the musical ratios that form the basis of acoustics, and found that by touching the vibrating string at certain points, alternative higher notes would ring out. "Ring" is the operative word, as harmonics have a bell-like effect, as you will discover.

The harmonic series is notated in Exercise 16-1 from B, E, A, D, and G, up to the 9th harmonic. I have numbered the harmonics and also the function of the pitches in terms of the first. Play these notes in order, changing octaves when necessary and fretting them anywhere you like. Listen to the melody contained within the series. Do you recognize any part of it? Doesn't it sound very major-scale-like and melodious?



EXERCISE 16-1

Harmonic series from B

1. tonic 2. octave 3. P.5th 4. octave 5. M.3rd 6. P.5th 7. m.7th 8. octave 9. M.2nd 10. M.3rd

Harmonic series from E

1. tonic 2. octave 3. P.5th 4. octave 5. M.3rd 6. P.5th 7. m.7th 8. octave 9. M.2nd 10. M.3rd

Harmonic series from A

1. tonic 2. octave 3. P.5th 4. octave 5. M.3rd 6. P.5th 7. m.7th 8. octave 9. M.2nd 10. M.3rd

Harmonic series from D

1. tonic 2. octave 3. P.5th 4. octave 5. M.3rd 6. P.5th 7. m.7th 8. octave 9. M.2nd 10. M.3rd

Harmonic series from G

1. tonic 2. octave 3. P.5th 4. octave 5. M.3rd 6. P.5th 7. m.7th 8. octave 9. M.2nd 10. M.3rd

The harmonic series, though largely a special effect on bass, is actually intrinsic to the operation of many other instruments, including the trumpet, trombone, and french horn. It is also intrinsic to the style of singing found in countries such as Tibet and Tuva. "Mongolian throat singing", also known as "harmonic singing", involves a droning tonic pitch underneath a melody fashioned from the notes of the harmonic series, emphasized from the strong tonic pitch by manipulating the resonating cavities in the vocal tract.