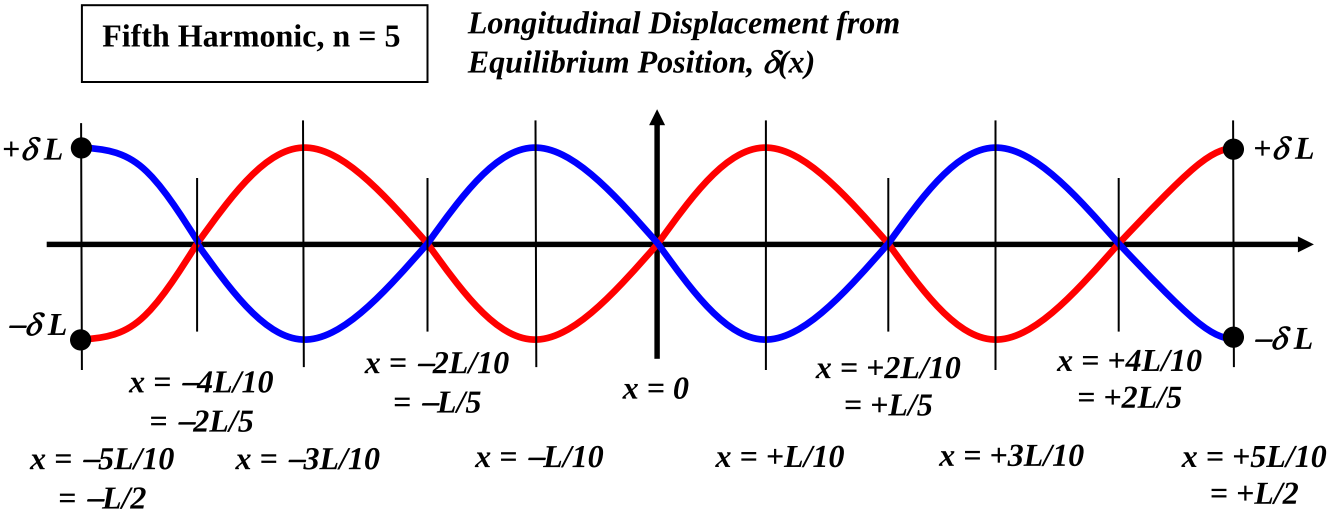
The next higher, fifth harmonic mode of vibration of the rod ($n = 5$) is shown in the figure below. The frequency f_5 is five times higher than that of the fundamental frequency, f_1, since the wavelength, $\lambda_4 = {}^2/_4 L = ½\,L$ for this mode of vibration of the rod is one fourth of that of the wavelength, $\lambda_1 = 2L$ associated with the fundamental mode. This mode of vibration of the rod has five nodes, one at $x = 0$, two nodes located at $x = \pm{}^1/_5\,L$, and two others located at $x = \pm{}^2/_5\,L$. There are six anti-nodes, two located at $x = \pm{}^1/_{10}\,L$, two located at $x = \pm{}^3/_{10}\,L$ and two located at the endpoints, at $x = \pm{}^5/_{10}\,L = \pm{}^1/_2\,L$.



There in fact exists an infinite hierarchy of so-called *normal modes of vibration* of the rod. Note that all modes ($n = 0, 1, 2, 3, 4, 5, \ldots$) of vibration of the rod all have the *same* longitudinal speed of propagation of sound in the rod,

$$v = f_1\lambda_1 = f_2\lambda_2 = f_3\lambda_3 = ... = f_n\lambda_n$$

the frequencies of the higher modes are integer multiples of the fundamental mode, $f_n = n\,f_1$, where $n = 1, 2, 3, 4, 5, \ldots$. The wavelengths associated with the higher modes of vibration are related to the wavelength of the fundamental mode by $\lambda_n = \lambda_1/n = 2L/n$.

When a person excites the rod by holding the rod at its mid-point with one hand and pulling on it with rosin-dusted thumb and index fingers of the other hand, not only the fundamental is excited, but in fact the third, fifth, seventh, ninth, … – all odd-n harmonics ($n = 1, 3, 5, 7, 9, \ldots$) are also excited. Note that the odd harmonics all have a node at the mid-point of the rod, $x = 0$, where it is held.

If the rod is held at $x = \pm{}^1/_4\,L$ to excite the 2^{nd} harmonic, it can be seen that this location is at an anti-node of the 4^{th} harmonic – thus the 4^{th} harmonic cannot be simultaneously excited by holding the rod at this point. Only if harmonics simultaneously have a common node at a given location along the length of the rod, will it then be possible to simultaneously excite more than one such harmonic of the rod.