On Violin Harmonics

Download article in PDF

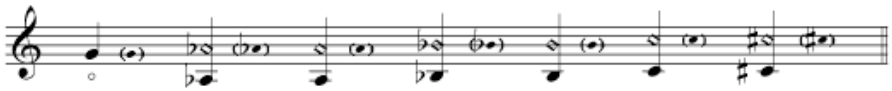
In the technique of violin playing few areas are as unclear as that of harmonics. That an easily accessible, standardized, and current chart of the many harmonics is not available to composers is one side of the problem. The fact is that when a composer goes to a violinist for a fingering and is told that there is only one way to produce a certain resultant sound (and most violinists do not really know the possibilities of their instrument) he accepts this as authority, even though the choice may have no relation to the ease with which a whole passage can be played. This lack of knowledge on the violinist's part is certainly more distressing than the composer's guess. I hope that what follows will help clear up this general fogginess, both for composer and performer.

There are two types of string harmonics — natural and artificial. A natural harmonic is the pitch (resultant) that is produced by lightly touching an open, vibrating string (the fundamental) at one of the nodes located at 1/2, 1/3, 1/4, etc. the length of the string. An artificial harmonic is a harmonic whose fundamental must be artificially created by stopping (shortening) the string to the desired fundamental. This is done by pressing strongly with a lower finger (usually the first, except in the case of third harmonics or fourth harmonics using an extension fingering — the latter being uncommon), and then obtaining the resultant by touching lightly with a higher finger one of the nodes at 1/2, etc. the length of the shortened string. This artificiality of the fundamental is one of three characteristics that differentiate natural from artificial harmonics.

The resultants that we hear are, of course, the partials of the fundamental. The first through fifth partials are the only resultants that are used. Partials higher than these are almost totally unreliable because of the small distance involved in their fingering, and because the intervallic ratios of the harmonic series are not easily combined with the unclear system of violin intonation (which, whatever that is based on, does not take into consideration the small number ratios of the harmonic series). These small number ratios are already a problem with the fourth and fifth partial, but more of that later. In the set of all the possible natural harmonics excited from one fundamental, we find that many of the resultants can be produced at more than one place on the string. This is because of the division of the string in the harmonic series into small number ratios. There is an ordering of partials up to the mid-point on the string (octave) and from there the same ordering in retrograde from octave to bridge. This duplication of resultants is impossible in a set of artificial harmonics excited from one fundamental, because the four fingers used for pitches on the violin can barely stretch the octave on one string — (equal to a twelfth on adjacent strings). This non-duplication of resultants is another distinguishing mark of the artificial harmonic, and the possibility of vibrating the fundamental is the third characteristic. Generally, all natural harmonics have a "purer" sound than artificial ones, though if the artificial fundamental is well stopped, much of its impurity disappears.

Since we have determined above that all possible different harmonics of one fundamental fall within the span of one octave, let us convert these small number ratios into intervals up to the octave. Consequently, harmonics occur at the lightly touched octave, fifth, fourth, major and minor third, and major sixth. The last is of no use since the stretch (equal to a major tenth) is not always secure, and the range of the major sixth harmonic is exactly that of the major third. The touched octave, whose resultant is an octave higher than the fundamental, is another matter. While the stretch is greater than that of the major sixth, it is the only way to produce the resultants below d — 4th line — treble clef (see Ex. 1).

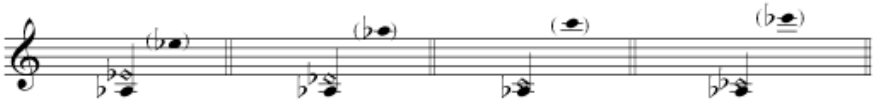
Ex. 1



The first of these, being a natural harmonic, needs no restrictions. The others must be used with extreme care; one must give a reasonable amount of time to prepare the stretch, and not require it to be held too long. This word of caution is due to the fact that some violinists' hands cannot possibly make the reach, regardless of the amount of preparation, and for those who can it is not yet common practice to go flying all over the fingerboard and land on an artificial octave harmonic. The maximum dynamic level of an artificial octave harmonic is not loud. The sound is rather throaty and tremulous, but could be made use of. Above the range indicated, the artificial octave harmonic is superfluous.

The resultant of the touched fifth is one octave and a fifth higher than the fundamental (Ex. 2). The touched fourth gives a resultant two octaves higher than the fundamental (Ex. 3). The touched major third's resultant is two octaves and a major third higher than the fundamental, and the minor third gives a resultant two octaves and a fifth above the fundamental (Ex. 4 & 5).

Ex. 2 Ex. 3 Ex. 4 Ex. 5



It is with these two types of third harmonics that we run into the problems of the small number ratios mentioned above. As is probably clear by now, when we talk of small number ratios in the harmonic series, we are referring to the "just" intervals, in this case the just major third of 4:5, and the just minor third of 5:6. The 5:6 minor third is 316 cyclic cents wide (16 cents sharper than the equal tempered minor third of 300 cents), and the 4:5 major third is 386 cents wide (14 cents flatter than the equal tempered major third). This means that the distance between the 4:5 and 5:6 third is only 70 cyclic cents. This makes a rather small

semitone as opposed to the equal semitone of 100 cents. Consequently, while one of these thirds must be flattened, and the other sharpened (otherwise they will not speak), one must be cautious not to overdo either correction as it may result in the breaking of one resultant to another. This is the main reason that third harmonics, especially minor third harmonics, are not always used by violinists. However, the delicacy of touch required in third harmonics is quite possible and provides an invaluable technical resource in passages of quickly changing harmonics over a wide range. They are also indispensable in double harmonics.

Generally, if a violin player is not secure in third harmonics it is best for him to switch to a fourth or fifth harmonic, until he learns the technique of handling thirds. There are no restrictions on the fourth and fifth harmonics; both have large dynamic range, and the fifth is slightly purer than the fourth. Both fourth and fifth are purer than third harmonics, which do not have quite the dynamic range of the former. With all these cautions about third harmonics, I would still prefer them to awkward string changes, as with good touch and an incisive attack from the bow these disadvantages can be minimized.

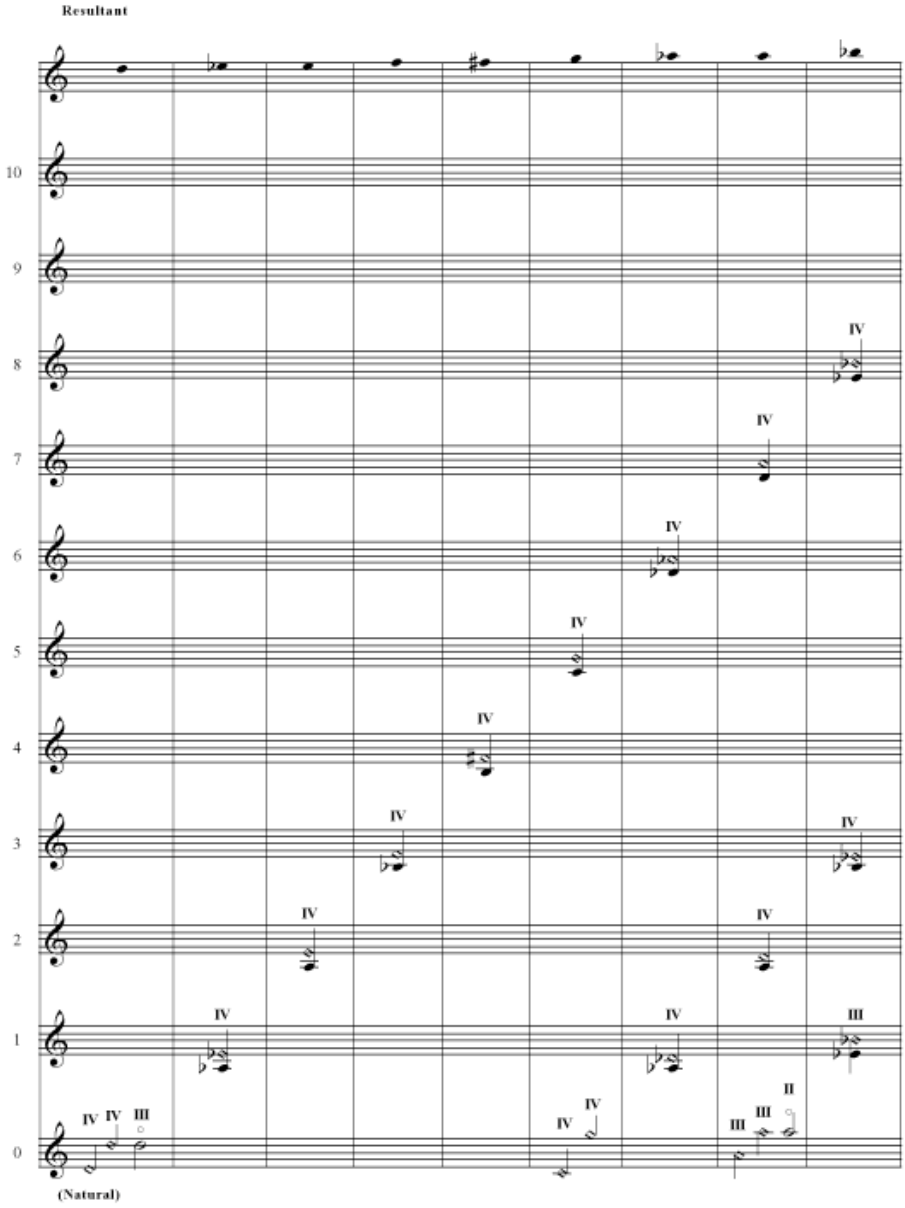
Double harmonics are two harmonics played simultaneously on adjacent strings. They may be either two natural harmonics, two artificial harmonics, or one natural and one artificial harmonic. Both harmonics should be either in the same position or in adjacent half-step positions. It is possible to play double harmonics with three or even two fingers. In that case one finger either stops both fundamentals, or touches both nodes. The same finger cannot stop a fundamental on one string, and touch a node on the other. The dynamic of these double harmonics depends considerably on the bow stroke. Another type of double stop possible is that of combining a regular note with a harmonic on an adjacent string. The above restrictions on fingering still apply. These types of double stops are quite possible, though they are a problem in terms of bow stroke. It is not necessary here to go into exact detail regarding bow strokes for this type of double stop. Let it suffice that one must be cautious of overplaying the real note, as it will automatically be louder than the harmonic.

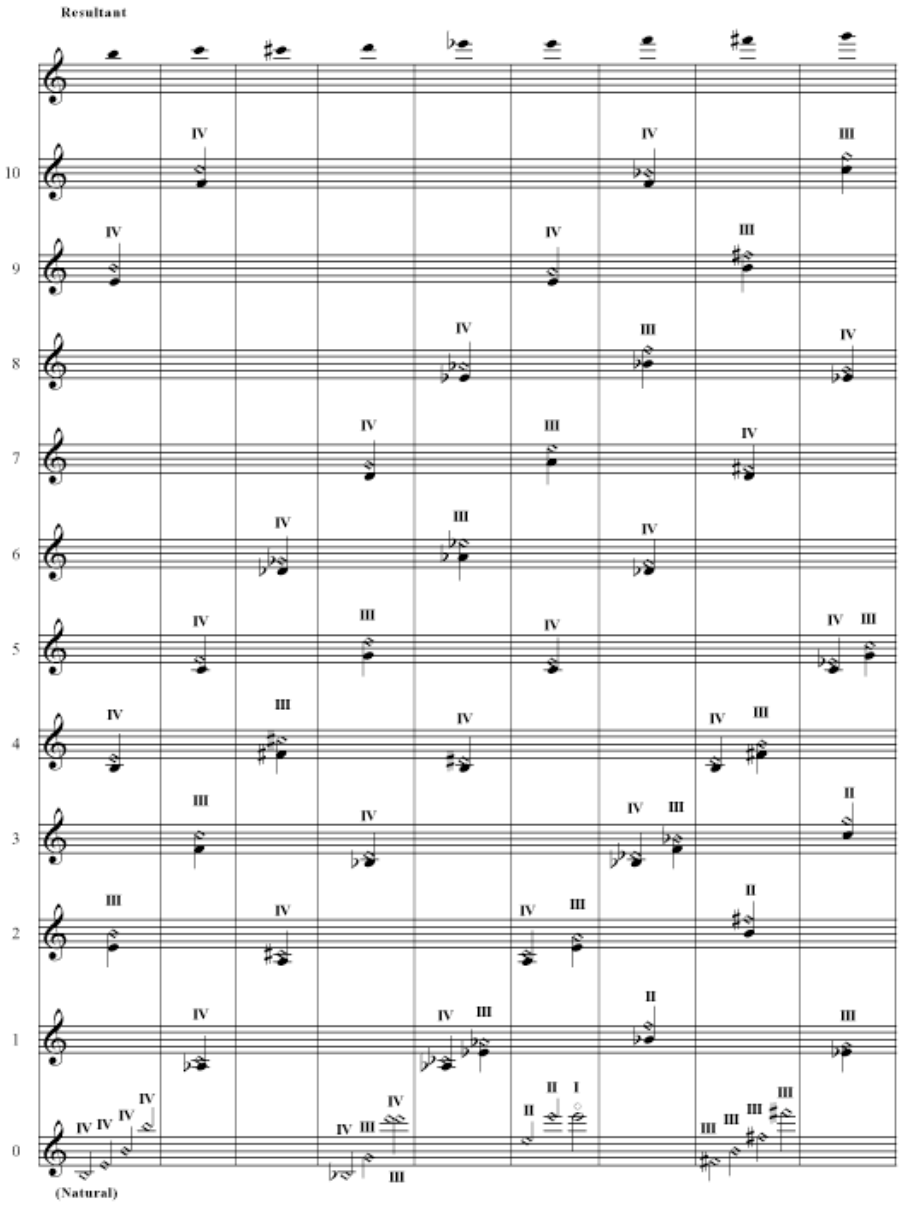
The chart of the various harmonics is read as follows: reading vertically will give you all the possible ways to produce a given resultant; horizontally, the top staff gives resultants, and the staffs numbered 1-10 are half-step increments in ascending positions along the violin fingerboard. The 0 staff gives the natural harmonics, which are not as position-bound as the artificial ones. The numerals I, II, III, and IV, signify respectively E, A, D, and G strings. The procedure for determining a fingering for two successive harmonics is as follows: locate both resultants, and then find the choices that are closest to each other horizontally, and involve the same or adjacent strings. (See the chart on the following pages.)

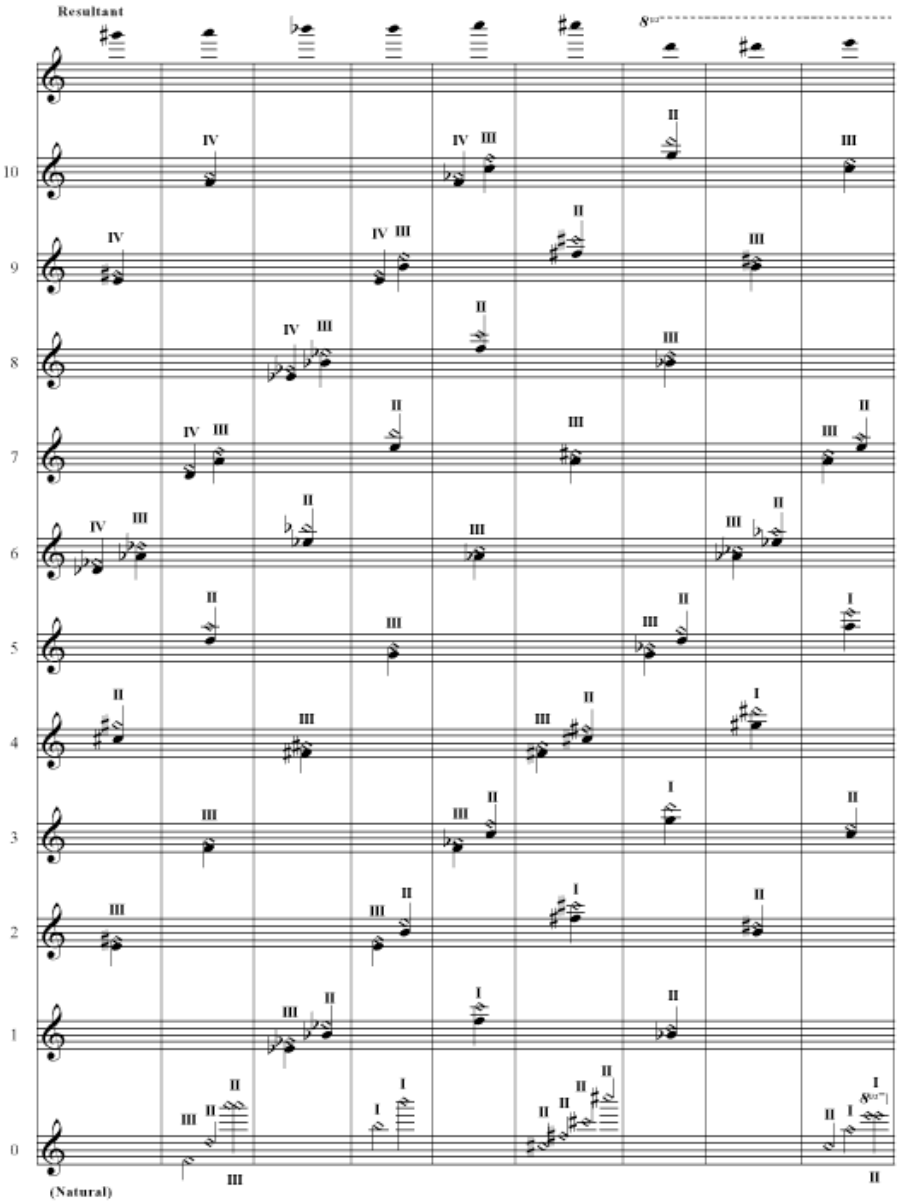
A word about notation. Only natural octave harmonics should be written with a round note head and a small zero above the note. All other harmonics should be written with diamonds. All harmonics should have the resultant indicated in parenthesis next to the harmonic. This small effort insures that the right note will be played by the performer even if he cannot use the composer's fingering. If one especially desires a particular timbral quality, the string should be indicated. In actuality, however, timbral differentiation is minimized among strings now that all four strings are available with aluminum winding, though in very high positions, on sustained notes, timbral variation is still easily perceptible (i.e., between a minor third harmonic high on the D string or on the A string and the same resultant produced on the E string with a fifth harmonic).

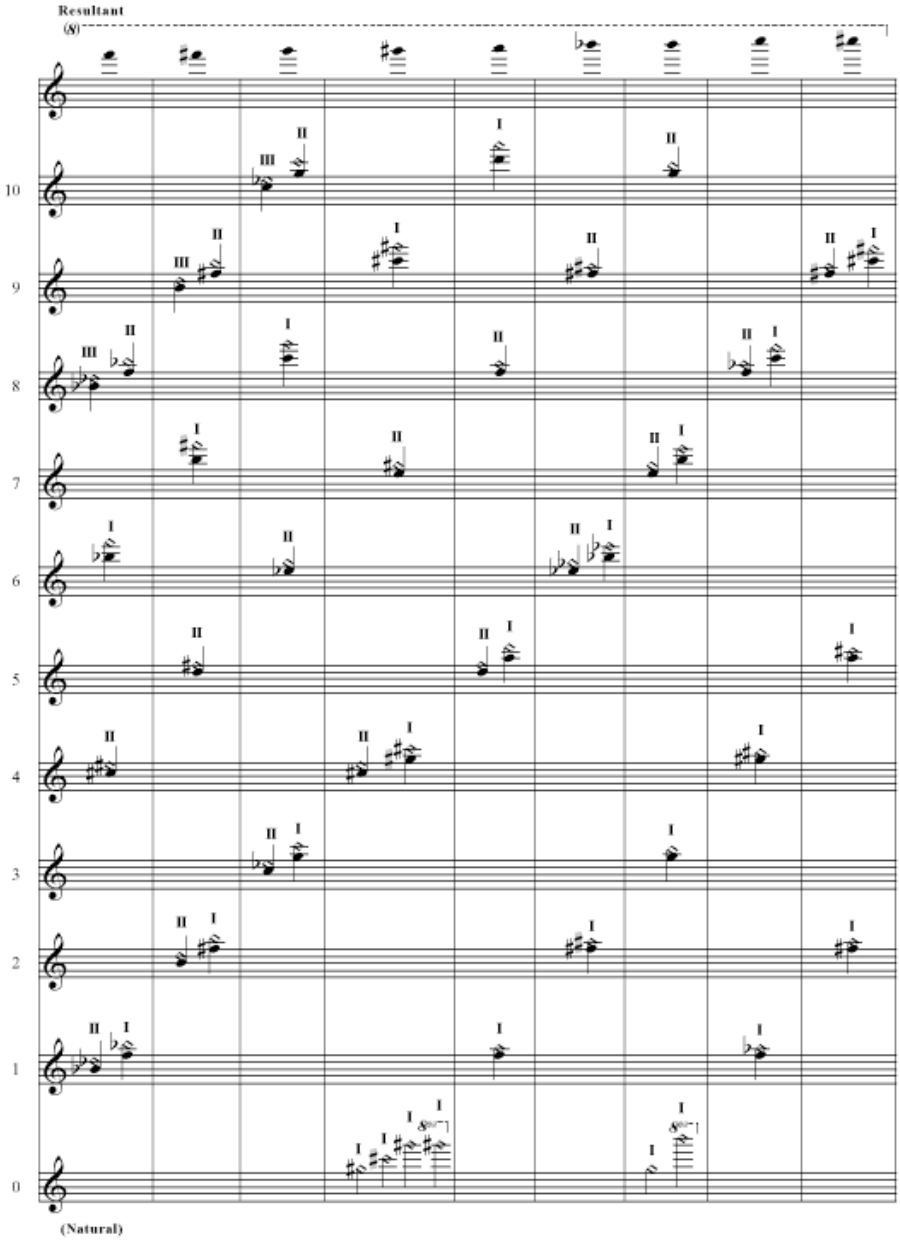
Paul Zukofsky

Originally published in
Perspectives of New Music
Volume 6, Number 2
Princeton University Press
Spring-Summer 1968


Resultant
10
9
8
7
6
5
4
3
2
1
0
IV IV III
IV
IV
IV
IV
IV
IV
IV
IV
IV
IV
IV
III
III III II
(Natural)


Resultant
10
9
8
7
6
5
4
3
2
1
0
(Natural)


Resultant
(Natural)



Back to Top

Home | Recordings | Events | Publications | Links | Contact