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1019 BR Amsterdam
The Netherlands

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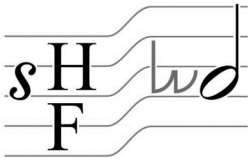
info@huygens-fokker.org
www.thirty-one.eu

EDITOR
Bob Gilmore

DIRECTOR, HUYGENS-FOKKER FOUNDATION
Sander Germanus



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SOME THOUGHTS ON LINEAR MICROTONALITY

Frank Denyer

Over the last eight decades or so, the growing use of microtonal intervals in composition has been influenced by diverse forms of sonic analyses. These have concentrated mainly on certain aspects of the harmonic series, often advocating its authority as the one true 'natural' or 'rational' foundation of all music and naturally appealing to those with latent fundamentalist tendencies. Musical intervals are described as 'true' by means of mathematical ratios that show their objective derivation through scientific experimentation. This may have opened up new areas of enquiry but at the same time it has also led such work to be unusually susceptible to academic pedantry. The harmonic series, because it is 'harmonic', is made up of intervals that are most acutely appreciated when their component notes are heard as simultaneities.

In my own work I have approached microtonal issues from a completely different viewpoint, focusing primarily on the perception of *linear* microtonal relationships. For reasons that will soon become apparent, the two perspectives don't have many points of convergence and we find that both roles and usage bring them into conflict. The fact is that our human perception of micro-intervals is considerably altered when we hear the constituent notes linearly (i.e. one after the other) rather than together, a fact that can be easily verified in the laboratory.

The linear investigation I advocate is not based on an extracted set of mathematical relationships, but on the observations of our perceptive intelligence allied to the unaided capacities of the human ear and the interpretation of its data by the brain. So much of our hearing is interdependent with other mental functions that we must take the whole skein together, and there can be no excuse for excluding awkward aspects of listening, such as our inherent capacity to privilege certain aural information, or our propensity for misperception and aural illusion. Neither should we devalue the unique capacity of such a complex web to trigger responses in far flung neural networks of the brain, because that is exactly what gives sound its unrivalled suggestibility and essentially its capacity to become music.

Let us first consider one tiny piece of actual perceptual evidence. Laboratory data shows that even primary intervals such as the octave or fifth, when heard linearly, are usually judged by musicians as being 'completely in tune' only after their mathematical identity has been slightly modified, most often by making them a few cents narrower. In a test I conducted at Wesleyan University in 1977, two tuneable oscillators were set up in such a way that when either one was sounding the other was muted. Thirty-five musicians attended individually and each was asked to tune one oscillator to a perfect fifth or an octave above the other. They were free to go back and forth between the oscillators any number of times, and no time limit was imposed. Interestingly, the resulting (melodic) intervals were, on average, tuned flatter than their harmonic counterpart.

The concept of being *in tune* or *out of tune* is of particular importance to this discussion. The question is: being in tune with what? My own temperament leads me to feel comfortable when I recognise an inner point of ultimate reference with the power to at least modify the rigid application of the external evidence (much as the individual conscience is central to judgements of guilt or innocence in western legal systems).

Being *in tune* or *out of tune*. Historically, humankind has at times imagined there might be a music with unique revelatory potential if it were strictly confined to just one of these categories (usually to the in tune part). This initiated a desire to purify music so that it might reflect either the divine itself, or the sounds from a remote heavenly sphere, or perhaps conform to ideas of a lost golden age, or some kind of realm more perfect than the one we all now share (although as with some extreme religious or political groups, the resulting music never seemed quite pure enough to do the trick; perhaps even more accurate or stringent rules were required. But for the irredeemably disillusioned there still remained the dream of an unheard, silent or unstruck music, of which there are numerous world traditions).

Clearly, in order to exist in this world, music must find some practical accommodation between the tuned and the out of tune, although special roles for the latter have often been carefully formulated. Not only roles but rules, their nature and scope being almost as diverse as humanity itself, clearly mirroring the historical and cultural orientation of the groups that created them. Incorporating notes that are in tune with others which are out of tune has obvious philosophical implications that are deeply embedded. Apart from religious and philosophical belief, being in tune or out of tune can just as easily suggest parallels with social definitions of 'belonging' and 'not belonging' and/or the role of comfort and discomfort in a life-view.

In practice, this interface between the tuned and untuned may be extended from a sharp but crude division between good and evil, to a more ambiguous but productive no-man's land, or even to a full gradation of values stretching all the way between the two extremes. For musicians at least, being in tune and out of tune cannot ever be a mathematically fixed issue, because it must always be mediated by the inherent capacities of musical instruments and voice, the limitations of the human ear, and remain susceptible to many wider aesthetic considerations. Taking an extreme case, comparing a piano that has been tuned with an electronic tuner to one tuned by ear, it is clear that the exact type and degree of difference remains an issue for musical discussion and personal aesthetic taste.

The first vague glimpse of this matrix of interconnections floated into my consciousness in the early seventies. I had noticed that open-holed woodwind instruments, whether from Europe or Asia, could create remarkably fluid and organic melodic continuities, but that these features were diminished when the player performed the same phrases and with similar articulation but on a standard orchestral flute, although the latter had the capacity to produce notes that paradoxically were said to be more in tune. Open-holed instruments allowed a kind of rounding of certain intervals precisely because the intonation was more malleable and it was clear that an experienced player took full advantage of this. It followed that late 19^{th}/ early 20^{th} century European woodwind instruments with their greater uniformity of bore, accuracy in the location and size of finger-holes, precision key mechanisms, not to mention developments of mouth plates and reeds, would be correspondingly less responsive to my particular aspirations as a composer, searching as I already was for a melodic line inherently more flexible and fluid than any I had ever come across.

A long time ago, when writing my piece *After the Rain* (1983) and trying to envisage a suitable ensemble of wind instruments to support solo shakuhachi and solo violin, I chose 3 ocarinas and percussion, partly because the ocarina had a particularly large number of variables that affected pitch, and this unpredictability tended to create a soft edged intonation which was further reinforced by the instrument's soft attack and general dynamic level. It might have been argued that it merely produced a certain randomness of intonation, but I thought that this might already go some way to modifying the hard-edged intonation from the tyranny of which I was trying to escape.

Returning to the present discussion of linear intervals and their particular qualities when they become slightly narrower than their harmonic counterparts: slightly flattening a primary interval softens its outline. When intervals like octaves, fifths and fourths are treated in this way there is also a greater propensity for the two notes to bind together as a unit, an important factor when attempting to use a diversity of intervals to make coherent melodic wholes. The exact degree of narrowing must be left to the taste and experience of individual

performers, although it will still remain bound within the norms determined by the musical context and genre, and as I have said previously, by the physical limitations of the instrument itself and by many wider cultural issues. The important thing is that such adjustments can never be exactly pre-determined for all individuals and for all circumstances, even within one piece.

The opposite tendency occurs when a primary interval is slightly widened. The sharpening of an interval increases its outward movement and it appears brighter and more energetic (although this might equally well be perceived as brash and harsh). Here there is a tendency for the notes to separate and the bonds that link them to weaken. (In a real musical context there may be other factors that nullify both considerations. Harmonic content is particularly virulent in this respect.)

So narrowing might be compared to a visual artist rounding off the corners of a primary shape like a square, rectangle or triangle; whereas randomly mixing narrowing and widening would be more like drawing geometrical shapes 'by hand'. Neither affects the fundamental identity of the primary shapes themselves, but compared with the hard, precisely delineated figures drawn with ruler and compass, they appear less rigid, more inherently flexible, and so 'more humane' perhaps.

Such adjustments of intonation all occur at the micro-level. But it is precisely at this level where another facet becomes inter-connected. The very tiniest changes of frequency appear not as pitch alterations at all, but as changes of timbre. In the other direction it follows that a particular timbre change might have an impact on our pitch perception. This suggests that instrumentation may actively affect our judgments of intonation.

At this point we might pause to consider the distinction between 'pitch' and 'note'. Excuse me if we take some rather banal examples to start with. If the Berlin Philharmonic decides to raise its standard pitch very slightly, clearly the musicians will continue to play the same notes. If the pitch of an unaccompanied singer gradually becomes sharper during the course of a piece, the actual notes remain the same although their individual frequencies may be increasing. While working in Kenya's Kerio Valley I noticed that lyre players could consider two strings to have an octave relationship and be acceptably *in tune* even when one of them was more than a hundred cents out of tune. Perhaps by having only five notes loosely strung between the octaves meant that the identity of adjacent notes was never compromised by such a deviation, and because the essential pitch relationships remained the same, they were indeed *in tune*. In all three cases outlined above, the musical context has maintained the structural function of the notes and so they are not considered as having altered.

Thus arises an interesting question which has long fascinated me. What particular musical conditions might I create that would allow a very slight frequency change to be perceived as a distinctly *different* note rather than a variant of the same note; and how, on the other hand, could I make a significant frequency change of perhaps more than a hundred cents seem like *the same* note?

The following example from *Tentative Thoughts, Silenced Voices* (2002-3) illustrates how I have dealt with this and other related issues in practice (Figure 1). (A key to the accidentals I use for microtones is given in Figure 2.)

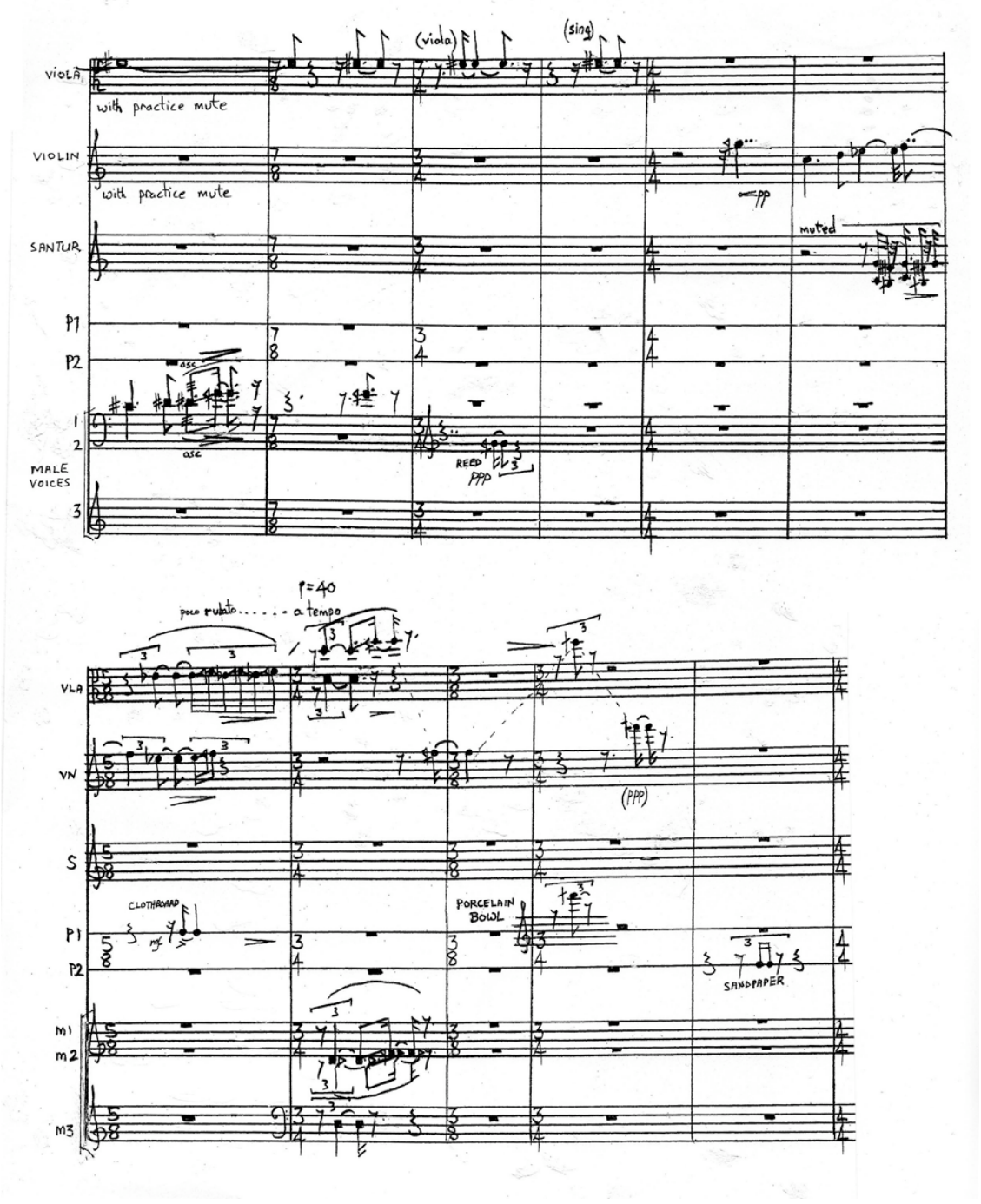

Figure 1: Denyer, *Tentative Thoughts, Silenced Voices* page 4, bars 1-9; © 2003, Frank Denyer

The play between the semitone sharp *f1* in the viola, and the last note of the two male singers (a sixth-tone flat *g1*) is first heard as two versions of the same note, although it is certainly wide enough to be perceived as a pitch change and not a timbre change. The voice note is disguised by first appearing merely as the end of a small glissando. Subsequently (bar 2)

these notes are repeated in alternation between the viola (sharp *f1*) and the first male voice (sixth-tone flat *g1*), and then in bar 3 between the viola and the concertina reed, and finally spread out over the whole of bars 4 and 5. During these 4 bars (bars 2-5) perception has been gradually changing from what appears to be two versions of the same note, to two quite separate notes in opposition. The upper one is then taken up by the violin an octave higher (sixth-tone flat *g2*) as the starting point for the next musical paragraph, which moves off with a more confident melodic intent through the interval of a falling perfect fifth, albeit narrowed by a sixth-tone. The violin adds the next five notes that are purely diatonic (bar 6) but accompanied by the santur with quarter-tone shifts. The latter do not appear as variants of each other as one might expect, or as triadic blurring, but as a definite *stepwise* movement, partly because the santur is muted. The main melody is transferred to the viola (bar 7), creating a subtle timbre change, and immediately thereafter a quarter-tone vibrato-like ornament is heard that is obviously a single note despite its pitch alterations. The addition of the rubbed clothboard to this particular viola note helps smudge even further the variations in frequency.

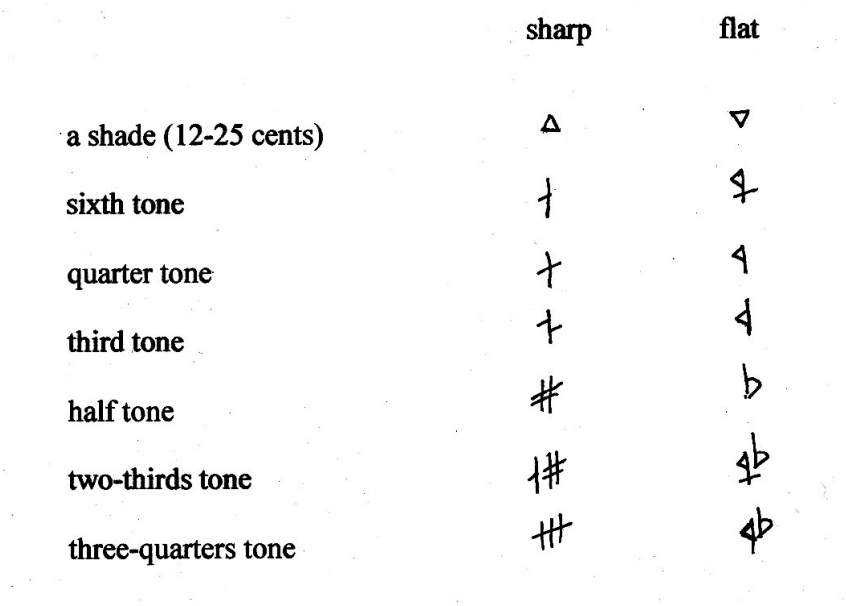

Figure 2: accidentals for microtones used in scores by Frank Denyer

Over the years I have accumulated a collection of simple pitched and non-pitched percussion instruments whose sounds are produced by friction. (Friction percussion is quite undeveloped in the western instrumentarium, so there are gaps to fill and scope for experiment.) As in the musical example above, non-pitched friction percussion can be useful adjuncts for many pitched instruments as well as having much potential in themselves. Take a flute, for instance. Its almost sine-wave purity is frequently enriched by the well known addition of noise elements from the player's voice or breath, but with friction percussion instruments of the right type, this process may be considerably intensified and extended.

As a more subtle example of linear microtonal thinking I would like to turn to the opening of my piece *Ghosts Again* (2005) (Figure 3):

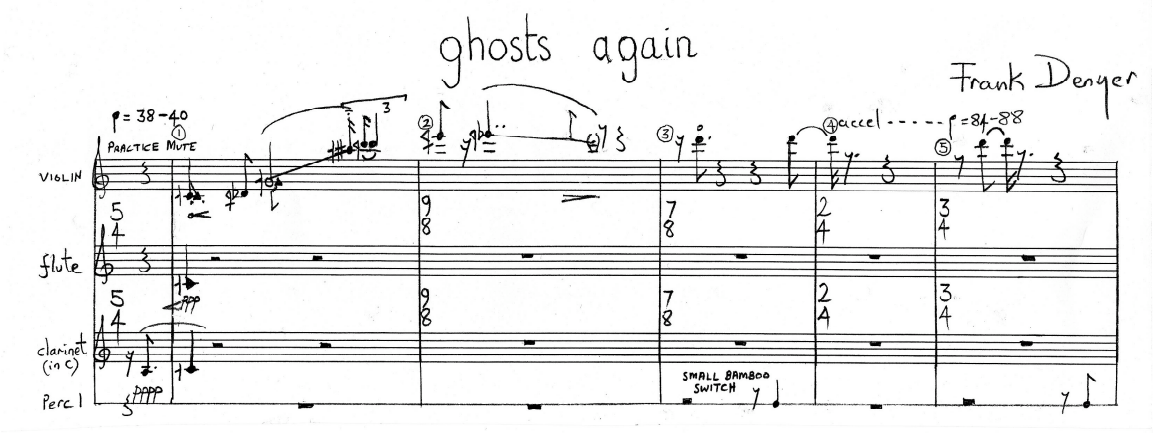

Figure 3: Denyer, *Ghosts Again* page 1, bars 1- 5; © 2005, Frank Denyer

It starts with a melodic arc that can be thought of as an elaborate anacrusis leading the ear forward to the note d3 (bar 2) which, as in the previous example, is first introduced only as the end of a glissando, but which is then more firmly established by being repeated. The main purpose of this anacrusis is to imbue d3, when it arrives, with a floating, un-rooted and somewhat strange character difficult to describe. I'll try to outline how this happens. The clarinet opens with an upward legato minor third that is flattened by one-sixth of a tone. This flattening softens and constrains the interval but at the same time gives it an inner tendency to expand outwards, which it does after it has been taken up by the violin (expanding from a sixth-tone sharp c1 to a two-thirds flat d1). From there it sweeps upwards in a long and unexpected curve that is tonally disorienting, especially as it comes to rest on a strange two-thirds sharp a2 that is immediately 'corrected' by a very slightly sharpened version of this same note (a quarter-flat b2). At this juncture the ear is naturally confused, but the perfect fourth leap up to the first beat of the following bar helps put firm tonal ground beneath our feet, despite the fact that the fourth is slightly widened by approximately 16 cents (from quarter-tone flat b2 to a sixth-tone flat e3) but this pulls us back to a truer perfect fourth (quarter-tone flat e3) although any security gained is quite fleeting as the note again slides down until it finally arrives on the all important d3. The latter seems strange because, since the opening the ear has been made to readjust its basic tonal orientation microtonally and this note of arrival is unrelated those recent events although closely related to where we originally began with the first clarinet note. And so the pitch appears in all its oddness. This is crucial for what follows as the next few minutes are entirely taken up with its further adventures.

Although in this paper it is only possible to touch briefly on some simple aspects of this terrain, I would nevertheless like to add some thoughts about training and preparation. For me unusual intervals are only viable after they have been completely internalised by the performer. This means more than being able to mimic them and implies that they have been absorbed into the substrata of the artist's subconscious. Is this asking too much? If not, how can it be achieved?

A culturally shared collection of musical pitch relationships is already an inner part of each individual's life from very early childhood. As such they act as a referent and norm for many musical judgements. This pitch repertoire slowly expands as the child matures but for musicians it becomes much more extensive even within the early years of training. All intervals have the potential to accrue variants or modifications that also become deeply embedded by reference to familiar musical contexts. In a particular context utilised by a performing musician, it is not uncommon for modified intervals to be used to realise the true authenticity of the music which any experienced listener can immediately recognise (the pitching of blue notes in jazz would be one obvious case but all genres are riddled with them,

indeed at a more refined level it may be that the majority of notes used will fall into this category). To give another example: performers of Hindusthani classical music will have certain absolute intervals - the primary ratios sounding the octave and fifth - ever present in their sub-conscious but then represented externally in performance by the ever present drone. However, they will be able to draw on many other pitches whose precise position is more subtle and is absorbed through the aural tradition. They will also recognise a third category of notes whose precise pitch is somewhat contentious because so variable and open to individual taste. The flattened 3rd in raga Jaijaivanti is one such note, its placing dependent on individual experience and understanding and always something to be argued over by cognoscenti. An experienced dhrupad singer cannot sing Jaijaiwanti without employing the flattened third but can cleverly give the illusion of this note by subtle microtonal inflections of the second degree of the scale not directly touching the third at all. This aural slight-of-hand is heard in many performances by masters of the form.

Musicians of all genres will have internalised several different variants of the same interval. Whatever comprises the musician's primary internal repertoire, it is of course perceived by them as 'the norm' and will be a fundamental reference point for any later expansion through training. However, in adult life the ability to add new and unfamiliar intervals usually slows down even with rigorous practice. This is the problem.

Nevertheless, I have found that for the preparation of my work, preliminary pitch training still pays considerable benefits. For example, performers can quite easily learn to reproduce a melodic relationship 6-14 cents off a unison or octave and not confuse this with an interval of 28-33 cents or one that diverges by 40-45 cents. These distances soon become distinct and stable. It then becomes easier to progress to the introduction of really new intervals such as +/- 240 cents, +/- 633 cents, +/- 943 cents, or +/-1022 cents. Each of these has a distinct flavour that is soon recognised. (I give these as simple examples but in reality the task is related to the particular demands of the composition in hand.)

Practising equidistant heptatonic scales from various starting points can be a useful way to break away from the ever-ready western chromatic reference and the diatonic scales it supports. Then try alternating this scale with an equidistant octatonic scale on the same fundamental. In itself the octatonic scale is easier to navigate simply because alternate notes are a comfortable minor third apart (each interval is a three-quarter tone). When both feel comfortable, alter one degree of each scale by a sixth-tone. Then repeat the scale this time altering the same degree by a quarter-tone. Following this, alter two degrees of each scale by one of the microtonal intervals practised initially, i.e. 28-33 cents or 40-45 cents. Go on to alter one degree in one way and another by a different one. Such exercises can be extended as required.

The technical limitations of unmodified equidistant scales derive from their rigid symmetry, a consequence of being comprised of identical intervals. Each transposition or tonic shift can therefore only produce a clone of the same scale.

In more recent years I have come to use more elaborate methods and to give an idea of them I would like to take an example from *Unnamed* of 1998 (Figure 4). This is a long solo composition for shakuhachi. It is helpful to keep in mind that here 'a note' is often a 'pitch-field' rather than a discrete frequency. These fields are not uniform in scope. In passages that use, or partly use, the equidistant heptatonic scale, I have attempted to give each note its own particular set of characteristics within its individually sized pitch-field. One degree might have variant alternatives that result in very slight shifts in its pitch position almost each time it occurs; another has satellite notes that tend to blur or colour it like ornamental moons and it will never be heard in isolation; then there are others that always appear in movement, traversing their field, while still others that have narrow fields and remain stable and unadorned. In addition to this now complex scale the piece as a whole contains several other note sources with quite different derivations but which simultaneously share the musical territory. First, there are the four strongest notes of the shakuhachi (foundation tone, fifth, octave, twelfth and fifteenth), then the pentatonic scale produced by the open holes of the instrument (not at all equal-tempered pitches), then some more complex notes produced

through the shakuhachi's characteristic *meri* technique, and finally sections of the western chromatic scale (with the addition of some quarter-tone passing notes). All together, these make a very complex matrix of pitch material, an extremely fine but quite asymmetric grid or galaxy. For the player it would be impossible to internalise so many micro-pitches if they were all presented as equal dots in the firmament. However, by understanding from exactly which system each note is derived, the whole can be internalised by reference to a few simple subsets. I did this in the notation by indicating each of the principal subsets with a different colour. From a compositional point of view this unevenly distributed galaxy allowed a flexibility of line to emerge, as well as the possibility to rest in various tonalities along the way.

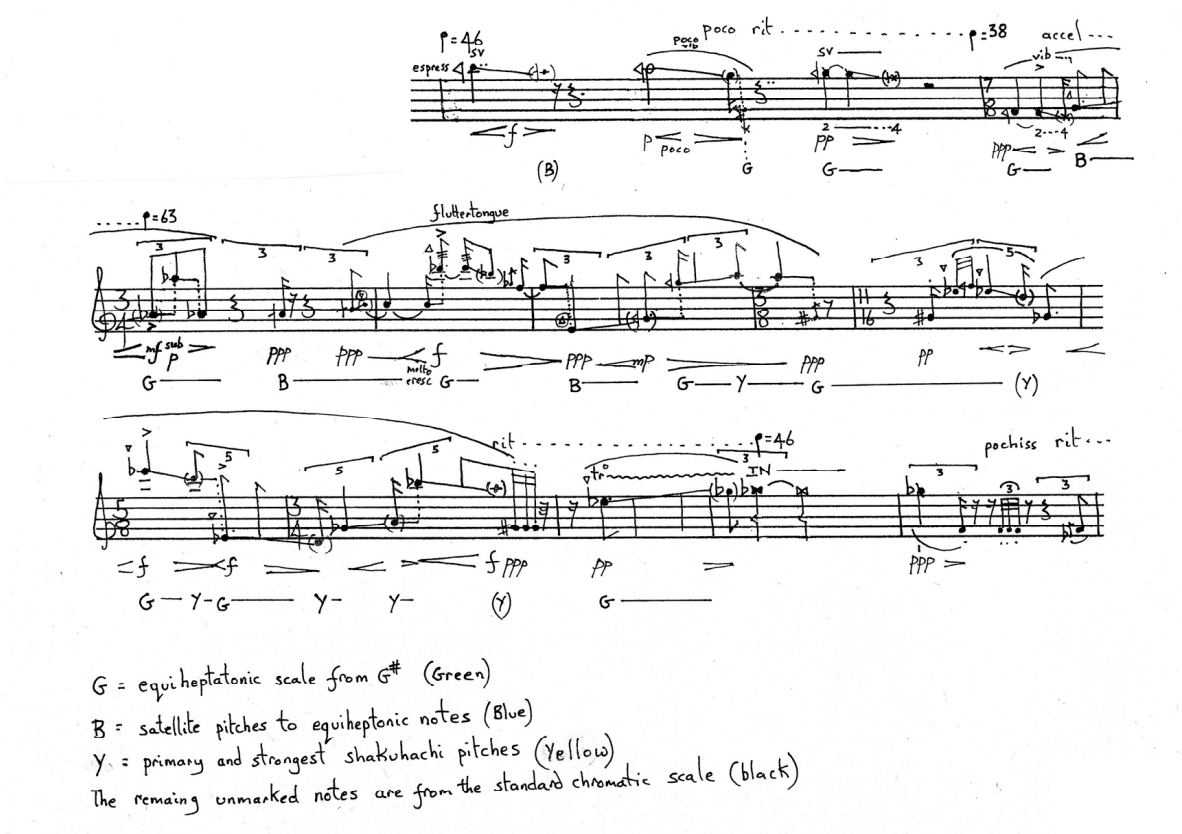

Figure 4: Denyer, *Unnamed* page 8, bars 6-14; © 1998, Frank Denyer

Such systems do not have any value in themselves and are of no concern to the listener; indeed the last thing I want is for the listener to be preoccupied with microtonality. They are used only as a compositional tool in order to make possible the kind of melodic structures I am interested in.

To some extent I can now find my way around such spaces instinctively and such schemes have lost much of their intended purpose. Even at its most prescribed this terrain essentially remains an open one because it has to be forever susceptible to the unconscious aesthetic considerations of musicians. It is principally this factor that informs the lineality and allows for the exploration of those deeply mysterious and ambiguous areas that form the borderlines between conscious and sub-conscious perception.

December 2008