



SPECTRAL TECHNIQUES IN HORATIU RADULESCU'S SECOND PIANO SONATA

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I. Introduction

This article offers an analysis of the Second Piano Sonata *'being and non-being create each other'*, op. 82 (1990–91) by Horatiu Radulescu (1942–2008), the first work in which Radulescu applied the spectral techniques he had developed in his music since the late 1960s to that most apparently unpromising of instrumental media for this type of approach: the solo, equal-tempered piano. And it has a quite specific aim: to analyse Radulescu's sonata in a descriptive language as close as possible to that used by the composer himself.

The analysis presented here has grown from my conversations and e-mail exchanges with Radulescu about the work (as well as his Third and Fourth sonatas) in autumn 2003, when I was preparing the liner notes for a CD recording of those works by the German pianist Ortwin Stürmer, who commissioned them.¹ I have supplemented the information gathered from these discussions with materials from Radulescu's archives, notably a recently-discovered, unpublished analysis of the work he himself wrote, probably shortly after its composition, which both reinforces and augments the description he provided in my conversations with him.² In attempting to describe the compositional techniques of the sonata in the light in which Radulescu himself saw them I am in no way suggesting that the composer's own view is the 'best' way of thinking about this music, or the only one that counts. My point is merely that it is at least interesting – and in this case possible – to know how Radulescu himself conceived of this music, if only to provide a reference point for future analyses that might well see it in somewhat different terms. Because Radulescu's spectral techniques have rarely been discussed in print I have concentrated disproportionately on the pitch content of the work, saying less about its rhythmic, textural or formal aspects, except briefly to describe some of the ways in which these aspects articulate and help define its 'spectrality'.

¹ Stürmer first recorded the Second Sonata in 1993; this version was released on the CD *Ortwin Stürmer: Klavier* (together with works by Wohlhauser, Herchet, Flammer and Ingham), on the Freiburg label *Ars Musici AM 1086-2* (1993). He recorded it again in 2002, together with Radulescu's Third and Fourth Sonatas; this was released as *Horatiu Radulescu: Lao-tzu Sonatas*, CPO 999 880-2 (2004). I would like to acknowledge the inspiration of three pianists in particular who have played the work: Ortwin Stürmer, Ian Pace, and the Irish pianist Maria McGarry, who asked me questions about the Second Sonata that I couldn't immediately answer, inspiring me to write the present article.

² This undated, 11-page, handwritten document, written in English, is essentially an unedited draft of an article that, to my knowledge, was never properly completed. Although he wrote many programme notes about his compositions, extended analyses of his works by Radulescu himself are otherwise few and far between.

II. Radulescu and the piano

Radulescu's six piano sonatas span almost 40 years, virtually the whole of his composing life. Shortly after completing his First Sonata *Cradle to Abysses* op. 5 (1968), an early student work from Bucharest, Radulescu had a vision of a radically new kind of music, the technical underpinning of which would utterly transform his compositional language. This he called the 'spectral technique of composition'.³ The first work composed in this new manner, *Credo* for nine cello (completed shortly after his move to Paris in 1969, but not premièred until 1979) uses the first 45 natural harmonics of the cello's low C as musical material; upon these components of the sound spectrum Radulescu builds 'micro-music events' that penetrate inside the cello timbre to reinforce and animate the rich inner life of each sound.⁴ *Credo* led Radulescu to conceive of the material of music not as abstract notes to be permuted on the page, but as living matter, as what he called 'sound plasma'. He felt, as he wrote in his article 'Musique de mes univers' in 1985, that to move forward from the excessively self-referential complexity of much post-war European music 'it was necessary to "enter into" the sound, to rediscover the ocean of vibrations that Pythagoras scrutinised two thousand years ago'.⁵

This spectral approach necessitates a much richer palette of pitches than a single equal-tempered piano can easily provide. Radulescu's music, from that point onward, was conceived in the complex, unequal intervallic relationships that characterize the harmonic series, and for some time works for solo piano were absent from his substantial output. In the 1970s and 80s he composed for a dizzying diversity of ensembles, often radical in conception – for seven identical woodwinds in *Capricorn's Nostalgic Crickets* (1972/80); for nine orchestras in *Wild Incantesimo* (1978); for 34 children's voices with 34 spectrally tuned monochords in *Do Emerge Ultimate Silence* (1974/84); for nine string quartets, one placed in the centre and eight around the audience (like 'an imaginary viola da gamba with 128 strings' in the Fourth String Quartet (1976–87). The earliest versions of *Outer Time* (1980) were for 23 flutes or 42 Thai gongs; and *Byzantine Prayer* (1988), composed as a requiem for his friend Giacinto Scelsi, calls for 40 flautists playing 72 flutes. The incredible sound-worlds of these pieces are much more than simply 'microtonal': like a sculptor, one has the sense of Radulescu moulding and shaping his 'sound plasma' into vibrant life.

The love that Radulescu felt for the great traditions of Western music meant that he could not simply dispense with so central a constituent of that tradition as the modern grand piano. Rather, he ventured through several stages of 'reinventing' the piano so that it too could form a viable part of the new sound-worlds of his imagination. The first such rein-

³ Although he often (rather immodestly) claimed to have been the founder of the musical movement it denotes, the term 'spectral music' was coined not by Radulescu but by Hugues Dufourt in 1979 in a short article entitled 'Musique spectrale', which effectively introduced the term into music history (no matter how much its main exponents may try to distance themselves from the simplifying nature of the label). Radulescu is not named in Dufourt's article, neither as the founder of spectral music nor in any other capacity, but then neither is any other composer: the text focuses on the nature of this new musical tendency and its aesthetic basis, not on a history of the genre or a roll call of its protagonists. Dufourt, 'Musique spectrale', Paris: Société Nationale de Radiodiffusion, Radio-France, March 1979. Reprinted in *Conséquences* nos. 7–8 (1986), pp. 111–115.

⁴ Radulescu (2003), 'Brain and sound resonance: the world of self-generative functions as a basis of the spectral language of music', *Annals of the New York Academy of Sciences*, 999, 323.

⁵ Radulescu (1985), 'Musique de mes univers', *Silences* 1, 50–57 (translation by Bob Gilmore); see also Radulescu (1975), *Sound Plasma – Music of the Future Sign* (Munich: Edition Modern).

vention was the most bold: to lay the piano on its side, and play on the spectrally retuned strings directly with fine, rosined threads that are woven through the field of strings in V shapes. ‘The instrument is presented in a new light’, Radulescu wrote; ‘it now resembles a religious object – a Byzantine icon. At a time when religion was only possible in Romania through music, I called this instrument the Sound Icon’.⁶ Works like *A Doini* (1974) for 17 players with sound icons, or *Clepsydra* (1983) for 16, are compelling examples of the composer’s quest for the ‘emanation of the immanence’, the actualization of the music immanent in a vibrating body.

The next stage of reinvention was to have the piano retuned spectrally, so that intervals corresponding to the natural harmonics could be heard free from the distortions of temperament: this procedure was used in 1990 in *Outer Time* (for two grand pianos spectrally tuned; a second version followed in 2001) and in 1995 in *Animae Morte Carent* for oboe d’amore and (partly) spectrally retuned piano. The most direct step back to the ‘normal’ piano came about through a superb piece for a different sort of keyboard: the organ work *Christe Eleison*, written in 1986 for the organ of the Speyer Dom in Germany. In this piece Radulescu found he could effect a meeting between his spectral techniques and the tempered scale, thereby preparing the ground for a reconciliation with the piano. When a commission came in 1991 from the Ministry of Arts and Sciences in Baden-Württemberg to write a work for the Freiburg pianist Ortwin Stürmer, he responded with a new sonata, his Second, fully 23 years after the first. Four more piano sonatas, a Piano Concerto, and a sonata for cello and piano followed.

The Second Sonata (composed in Freiburg and Versailles in 1990–91 and premièred by Ortwin Stürmer at the University of Freiburg im Breisgau in 1991), as well as the Third (1992–99), Fourth (1993), Fifth (2003) and Sixth (2007), are all inspired by the *Tao Te Ching* of the Chinese philosopher Lao-tzu (6th century BC) in the English translation by Stephen Mitchell. Phrases from the *Tao* are appended to the works as overall subtitles and sometimes also as headings of individual movements. The title of the Second Sonata is *being and non-being create each other*, which is from verse 2 of Mitchell’s translation of the *Tao*:

Being and non-being create each other.
 Difficult and easy support each other.
 Long and short define each other.
 High and low depend on each other.
 Before and after follow each other.⁷

In the analysis that follows I am less concerned with the relation of the music to its poetic inspiration than I am with discussing the relationship of Radulescu’s spectral models to the 12-note equal-tempered tuning of the piano; but just as the text is concerned with the mutual dependence of opposites, so too (it might be said) is Radulescu pointing to the commensurability of two apparently contradictory musical systems, and generating from their intersection the elements of a new musical language.

⁶ Radulescu (1990), liner notes to the LP *Clepsydra/Astray* (Berlin: Edition RZ, RZ 1007).

⁷ Mitchell, Stephen (1988), *Tao Te Ching: a new English version* (New York: Harper & Row). There is much debate about whether Lao-tzu (alternatively written Laozi) actually existed, and, if so, whether he actually wrote the text that has come down to us under the name *Tao Te Ching* (*Daodejing*), in all its myriad versions. Radulescu himself seemed to be in no doubt about his existence. In the context of discussing with him Mitchell’s version, it emerged that Radulescu was not much interested in comparisons between different versions of the text – all of which reinforces the idea that Mitchell’s book was primarily a source of poetic inspiration for him rather than the key to a serious study of Daoism.

III. The natural harmonic series and equal temperament

As is well known, the intervals of the harmonic series do not correspond exactly to the equal-tempered tuning of the modern piano. Whereas some musicians like to persist in the belief that natural harmonics are for this reason 'out of tune', the reality of course is more like the opposite: it is 12-note equal temperament that intentionally falsifies whole-number vibrational relationships (such as those of harmonics to a fundamental) in order to create a compromise tuning that offers the largest number of useable musical intervals with the smallest number of discrete pitches. Figure 1 shows the fifth octave – partials 16 to 32 – of the natural harmonic series on a low B \flat , the 'tonic' of the beginning and ending of Radulescu's Second Sonata, both with regard to their approximate equal-tempered equivalents in staff notation and their cents values (relative to B \flat) rounded up to the nearest whole number. Deviations of more than 10 cents (one tenth of a semitone) from a tempered pitch are indicated by arrows above the note-heads.

Figure 1:
Partials 16–32 of a low B \flat (29.14 Hz, the bottom B \flat on the piano), with cents values and approximate staff notation relative to the twelve-note equal-tempered scale.



As can be seen, it is the 7th, 11th, 13th, 21st, 23rd, 25th, 29th and 31st partials, as well as their doublings in higher octaves, that are furthest in pitch from any note in the 12-tone equal-tempered scale. The seventh partial, for example (or its two-octave equivalent, the 28th), at 969 cents, is 31 cents lower than the tempered A \flat (1000 cents); the thirteenth (in this octave the 26th), at 841 cents, is 41 cents higher than the tempered G \flat (800 cents). The most extreme deviation is the eleventh partial (in this octave the 22nd) which, at 551 cents above the fundamental, forms almost exactly a quarter-tone between the perfect fourth (500 cents) and the diminished fifth (600 cents).

Most of the time when listening to music we accept small amounts of mistuning of an interval as being of little or no consequence. The American composer James Tenney helpfully proposed the concept of *tolerance* in the perception of interval size, which he defined as a perceptual mechanism by which a certain amount of mistuning of an interval will not threaten the perceptual identity of that interval to the ear.⁸ This mechanism is context-dependent, so that for example the permissible tolerance range for a violinist tuning the perfect fifth between two adjacent open strings is very small, whereas in other musical contexts wider degrees of tolerance, even up to 10 cents or more, may be acceptable.

In a way that most of his other music does not, Radulescu's piano music stretches this tolerance concept to a considerable degree, asking us to accept very large deviations – as much as a quarter-tone in the case of the eleventh harmonic – as nonetheless offering approximations of the intervals of the harmonic series. This, it should be noted, is true of much spectral music – the music of Grisey and Murail hardly ever abandons equal temperament, although it generally extends its range by the incorporation of quarter-tones and occasionally eighth-tones. (Grisey wrote no solo piano music past his student years, but Murail has a large and growing catalogue of piano music, including the early spectral

⁸ James Tenney, 'John Cage and the theory of harmony'. *Soundings 13: The Music of James Tenney*, ed. Peter Garland (Santa Fe, NM: Soundings Press, 1984), pp. 55–83.

'classic' *Territoires de l'oubli*.⁹) I will return to the question of 'acceptable' tolerance in the last section of this article, but for now I will note simply that Radulescu is, in this way, part of a shared practice in piano literature where, harmonically and intonationally, *implication* is as meaningful as literal statement, a practice that reaches back before spectralism not only to Messiaen, Ives, Debussy, Liszt and others but, arguably, to all composers who wrote tonal music for the piano.

IV. 'Spectral signatures' in the Second Sonata

Before looking at the Second Sonata in detail I propose to describe some of Radulescu's characteristic sonorities by way of introduction to his musical language. The construction of some of the prominent chords in the piece shows the logic of his spectral language in a straightforward form.

The opening bars of the piece (Figure 2) offer several such examples. The initial figure, heard three times at the beginning of the Sonata and many times thereafter (in various transpositions), is one of what Radulescu called his 'spectral signatures', vertical sonorities that recur in several works. This opening sonority is derived from a harmonic series on a low B \flat , the bottom B \flat of the piano (29.14 Hz). In relation to this B \flat , the F–B \flat dyad at the beginning of m. 1 can be understood as analogous to the 6th and 8th partials respectively.¹⁰ The subsequent three-note chord in the right hand, consisting of D, E, and E \flat , is analogous to the 10th, 11th, and 21st partials.

Within the structure of this opening sonority an important principle is inherent, the idea of 'spectral self-generative functions' (as Radulescu called them). This idea is derived from the electronic music of the 1960s and 70s, where experiments with a ring modulator showed that, under certain conditions, the combination of two or more musical tones yields additional 'sum' and 'difference' tones in the ear of the listener. The combination of two sine tones of, say, 300 Hz and 200 Hz produce a higher-pitched sum tone of 500 Hz (300 Hz + 200 Hz) and a lower-pitched difference tone of 100 Hz (300 Hz – 200 Hz).¹¹ These sum and difference tones are psychoacoustic phenomena resulting from the listener's perception of the two sounding tones; although they are not actually being sounded by any external vibrating body they are nonetheless 'real' in experiential terms. Radulescu believed this ring-modulation principle demonstrated something meaningful about the harmonic relationships between tones, and he used the principle widely in his music. In the second chord of the opening bar (Figure 2) we can see that, metaphorically, the 10th and 11th partials (D and E) 'generate' the sum tone 21 (E \flat ; 10 + 11 = 21) and the difference tone 1 (B \flat ; 11 – 10 = 1). We could also equally well say that the 1st and 10th partials generate

⁹ In a public interview with Julian Anderson, given as part of the Murail Composer Day at the Barbican, London, on 7 February 2009, Murail remarked that *Territoires de l'oubli* is arguably as much 'about' the non-tempered resonance of the piano as it is about the tempered pitches actually produced by the keys. In the programme note to the piece included in the published score (Paris: Editions Musicales Transatlantiques), he writes that in this work he regarded the piano as 'a group of strings whose vibration is caused by sympathetic resonance or by direct action of the hammers'. See also Marilyn Nonken, 'La notation ne peut rendre compte du fait': Performing Murail's *Territoires de l'oubli* in *Tempo* Vol. 62 no. 244 (April 2008), pp. 2–10.

¹⁰ Here we are talking about *simulations* – actual notes – not the partials themselves, which could however be produced (as they occasionally are in piano music by composers like George Crumb and others) by lightly stopping the string at the relevant nodal points with the left hand and playing the key that activates that string with the right. Radulescu does not use this technique in his piano sonatas.

¹¹ In FM synthesis these two tones are called the 'carrier' and the 'modulator', but I never heard Radulescu use these terms.

the 11th partial in sum; or that the 21st and 11th partials generate the 10th in difference.¹² Radulescu liked to characterize pitch relationships generated in this way as 'healthy'.

HORATIU RADULESCU
"being and non-being create each other"
SECOIND PIANO SONATA OPUS 82

I. Immanence

Glisso
♩ = 280

Figure 2:
Radulescu, Second Piano Sonata,
movement 1, mm. 1–9.

A sub-principle adheres within this practice. Radulescu believed that in these 'ring-modulated' sonorities the component partials should stay in the correct octave placement and should not be freely transposed by octave (i.e. not transposed *downward*; transposition up by an octave was permissible, as the transposed pitches would then simply correspond to a partial from a higher octave). In other words, to transpose the E_b in m.1 down by an octave to make the semitone cluster $D-E_b-E$ would, in his terms, make no sense: there is no partial in the harmonic series between the 10th and the 11th, so such a transposition would violate the spectral logic he was trying to establish. (The only way this might be justifiable is if one then considered the fundamental to be an octave lower still, so that the three notes of the cluster would be analogous to partials 20, 21 and 22. In this particular context that would imply an extremely low fundamental, 14.6 Hz, which is below the normal threshold of pitch perception and even below the 'black octave' of the Imperial Bösendorfer piano which Radulescu so adored.¹³)

A further example of a 'spectral signature', the most characteristic of all, comes in m. 4. This three-note chord implies a new fundamental, a low C, to which its constituent tones can be seen to stand in the relation of 5th partial (E), 16th partial (C), and 21st partial (F). Once again the ring-modulation principle is applied here: $5 + 16 = 21$, or conversely $21 - 16 = 5$. This chord, in various transpositions, was an early "discovery" of Radulescu and occurs in some of his earliest scores, including the orchestral work *Taaroa* (1969); he even played the chord on the piano for the conductor Sergiu Celibidache, who came to share his enthusiasm for it.¹⁴

¹² To convert these partial numbers into actual Hz values we need simply to multiply them all by the frequency of the Bb fundamental, 29.14 Hz.

¹³ The lowest note on the Imperial Bösendorfer is C, 16.35 Hz.

¹⁴ Radulescu, personal communication. An enthusiastic letter of recommendation on behalf of Radulescu written by Celibidache on 3 July 1971 is among the papers of the Radulescu archives.

Another characteristic chord (although one specific to this piece, and not therefore a 'signature', unlike the ones just discussed) appears in mm. 8–9, a large chord that will gain in prominence in the Sonata's second movement. Here the four-note sonority at the beginning of m. 8 corresponds to partials of a C fundamental, the partials in question being 2 (C), 5 (E), 11 (F#) and 21 (F), with the subsequent addition at the end of the bar of partials 18 (D) and 128 (top C). This chord is not a manifestation of the 'self-generative functions' principle, but is what Radulescu called a 'preferential filtering' of the spectrum, meaning that elements from a single harmonic series were chosen more or less freely to create a particular sonority, the voicing of which suited the immediate needs of the register and texture of the music at that point. This is akin to the *formant* regions within a complex sound, particular peaks in intensity at certain partials. In his discussions of the Second Sonata Radulescu termed this chord the 'Origin-chord'.

The opening bars of the Sonata, heard as a continuity, demonstrate an important compositional principle in Radulescu's music: any given piece will not necessarily remain for long on one particular spectrum, but instead will modulate freely from one spectrum to another as desired. In some works the spectra are closely interrelated, as for example when Radulescu builds a new spectrum from one particular partial of the initial spectrum.¹⁵ In this Sonata, for pragmatic reasons, the spectra relate to each other by equal-tempered semitones or combinations thereof.

V. Analytical overview

The Second Sonata has an ideal overall timing of 13 minutes, its three movements relating to each other in the unequal (and Fibonacci-inspired) proportions of 8 minutes, 3 minutes and 2 minutes. The first movement, 'Immanence', is, Radulescu insisted, a sonata form, albeit of an idiosyncratic sort, with the first nine bars (Figure 2) equivalent to a first subject group. These bars present, as we saw above, several of his 'spectral signatures': the wide spacing of this opening material gives a sense of immensity and a strength of utterance typical of the composer. The music is notated in a metre of 2+2+3, against which the opening three bars can be heard as a powerful syncopation. This opening material is followed by a bridge passage of a more gentle nature, with a new division of the bar as 2+3+2 (Figure 3).

Radulescu described the pitch world of mm.10–15 (B, G, A_b, A, B_b, C) as a 'pseudo-spectral modus'. He nonetheless also considered the pitches collectively to be a *formant* – a particular filtering of a spectrum. But here, as often happens in his equal-tempered music, it is not immediately evident to which spectrum this collection of pitches should be heard to belong: the fundamental here could be heard as G, or C, or even A_b or A. (The functional relation of the pitches to each other is therefore different in each case.) If the fundamental is considered to be C, for example, the sequence could be analysed in spectral terms like this:

¹⁵ This technique is encountered frequently in his string music. In *Lux Animae*, for solo viola or cello, the open strings of the instrument are tuned to simulate the 3rd, 4th, 7th and 11th partials of a low E fundamental. In the piece, however, Radulescu asks the player to play natural harmonics on all four strings, thereby sounding actual harmonic spectra built from the four pitches, as though they were themselves fundamentals. This principle Radulescu referred to, in quasi-mystical terms, as 'the emanation of the immanence'; other harmonic spectra are, as it were, 'immanent' within the partials of a single spectrum. The string scordaturae employed in various of his other works use this principle either partly (Fifth String Quartet) or wholly (Sixth String Quartet).

B	G	A \flat	A	B \flat	C
15	24	26	27	28	32

If as A \flat , then:

B	G	A \flat	A	B \flat	C
19	30	32	34	36	40

It should be added that Radulescu welcomed these ambiguities of interpretation and did not consider one to be particularly more 'correct' than another.

This bridge material is suddenly invaded by a new loud element, a short rhythmic figure which the composer called a 'thunder element', first occurring at m. 16 (see Figure 3). This brings us back to the sound world of the opening, and re-emphasizes the initial B \flat fundamental, with however a curious low note, the bottom A of the piano. Spectrally, this A can be thought to relate to the B \flat spectrum in two possible ways: as the fifteenth partial of an extremely low fundamental, 1.82 Hz (which, as an interpretation, seems rather absurd); or, to invoke a concept found in some of Radulescu's earlier scores, as a 'false fundamental' – not the literal fundamental but a note close in pitch, that therefore adds a new and (in context) more aesthetically desirable colour to the harmony than would a simple octave. (Perhaps the legacy of forbidden octaves in serial music raises its head here: octave sonorities are rare in Radulescu's music.)¹⁶

Figure 3:
Radulescu, Second Piano Sonata,
movt. 1, mm. 10–16.

There is one final element in this first subject group, a fanfare-like idea which occurs at first rather briefly in mm. 24–28, although it will undergo more extensive transformation later in the movement. This idea Radulescu likened to the animated cries of a large bird. It is composed entirely of perfect fifths and minor thirds – an intervallic grouping he also used prominently in a piece written around the same time, *Agnus Dei* (1991) for two violas – and seems to resist any plausible spectral interpretation. When this material is answered in mm. 29–31 by the quiet, gong-like resonance of the E \flat below middle C, the right pedal (held down since m. 24) creates a texture in which all 12 pitches of the tempered scale are in the air.

¹⁶ Occasionally Radulescu would refer to these 'false fundamentals' as 'false grandfathers', connecting to his idea that the relationships of the partials in the spectrum had genealogical connexions and formed what he termed a 'family tree of functions'. 'I think music is done only by this force of attraction between the spectral elements. It's a family of self-generating functions, a genealogy of pitch'. Radulescu in Gilmore (2003), 'Wild Ocean': an interview with Horatiu Radulescu'. *Contemporary Music Review* vol. 22 parts 1+2, p. 113.

The second theme, occurring first at m.32, is an invented folk-like melody played quietly in the right hand as though a spectral emanation from the pedal notes played very strongly by the left (Figure 4). The tune itself, in its extreme simplicity, suggests a Lydian mode on D, but the bell-like pedal note from which it emerges is an ‘alien’ G natural, not part of the mode. Radulescu explained this bimodality in spectral terms: G is the actual fundamental here, and the Lydian mode is actually partials 8, 9, 10, 11 and 12 of D, itself the third partial of G. This is an example of the ‘emanation of the immanence’ idea (discussed in footnote 15): just as the G contains a whole harmonic series, so too does each of its partials contain its own potential (if hidden) series, one of which is here allowed to sound. Bar 35 may be considered a transposition upwards, by a tone, of this relationship.

Figure 4:
Radulescu, Second Piano Sonata,
movt. 1, mm. 32–35.

Radulescu described this theme as ‘flourishing in a “special-state” sonority’, by which he perhaps meant that although spectral in its derivation, the melody also clearly suggests a Lydian mode if seen through the lens of music history. The presentation of the theme follows a mini-ABA form, its 24 bars divided into three equal groups of eight bars. B inverts the melodic contour of A, and presents also a registral inversion, with the G ‘fundamental’ shifting two octaves higher as though it were itself now an upper partial.

Closing the exposition, some material from the first group returns briefly before a further elaboration of the ‘fanfare’ materials at mm. 60–64 (Figure 5). The pitch collection here, with eight main elements, is a large formant of self-generative functions, still with B \flat as fundamental:

F	B \flat	A \flat	D	E	B	C	E \flat
3	4	7	10	11	17	18	21

Into this sonority are added occasional other high pitches which are either 8th or 12th partial relationships (in more conventional terms, octaves and twelfths) above the pitches of the formant. The exposition ends with material from the ‘bridge’, elaborations of three spectral chords which modulate between different spectra. These chords are:

- mm. 65–66: B \flat , C, B, E (partials 7, 8, 15 and 40 of a C spectrum);
- m. 67: F, G, F \sharp , C \sharp (partials 15, 17, 32 and 48 of an F \sharp spectrum);
- m. 68: B, G, C (partials 5, 16, 21 of a G spectrum).

Figure 5:
Radulescu, Second Piano Sonata,
movt. 1, mm. 60–64.

The development section begins at m. 76. For much of the time Radulescu puts ideas from the exposition into dramatic confrontation, at a fairly rapid rate of change. Sometimes the materials are enriched with added functions, as for example in m. 81 when the 5–16–21 chords gain an 11th partial. The 'bridge' figure from the exposition gains in prominence and appears in some surprising new garb, beginning at mm. 91–92 (Figure 6). Here it is set against a pedal note that is in fact its fifth partial:

G#	F	E \flat	D	C	A	G
44	38	34	32	28	24	21
F#						
20						

Figure 6:
Radulescu, Second Piano Sonata,
movt. 1, mm. 91–92.

This idea subsequently recurs in a canon at the major third below, and later in a three-voice transposition canon at m. 101. The fanfare-idea also returns, with greater elaboration of its material. A second part of the development section begins at m. 127. Among its main features are re-explorations of material from the exposition with further spectral enrichment (added pitches, or 'functions', in various registers); and the increasing use of canonic textures, as for example when the Lydian-mode second subject returns in a unison canon at m. 154 and, even more elaborately, both forwards and in retrograde, at m. 177.

The brief recapitulation section begins at m. 196, with the first and second subject groups presented in reverse order. The second subject is now presented on a fundamental of C, but without further elaboration. Materials from the first group recur from m. 220 to the end, in a kind of kaleidoscope that throws their original sequence into new and playful patterns. A recurrence of the large chord of mm. 8–9 (Figure 1) ends the movement and paves the way for what follows.

The second movement, 'Byzantine Bells', is notated in 13/8 time throughout, the bars divided as 7+6 and further subdivided as 3+2+2 followed by 3+3. It is not really possible to hear these divisions, however, as the frequent use of syncopations across the bar and half-bar, together with accented occurrences of various melody notes, obscures the perceptibility of the underlying metre. The movement unfolds a long, non-repeating, unaccompanied melody built from a six-note mode spanning a perfect fifth (B C D E F F#); conventionally, this might be regarded as a mixture of Locrian and Phrygian. The right pedal is held down throughout the movement, giving the sense of music travelling to the listener across a great distance; given its title, the music evokes a melody of bells from a distant church tower. The monophonic texture is repeatedly and dramatically interrupted by recurrences of a sudden *fortissimo* chord on a C fundamental (the 'Origin-chord', one of the prominent chords from the first movement). Figure 7 shows the first ten bars of the movement.

Adagio

Ped throughout

Figure 7:
Radulescu, Second
Piano Sonata, movt. 2,
mm. 1–10.

Radulescu’s own conception of the melodic nature of this second movement was, however, somewhat different to the one just given. He regarded the melody not as the mixing of modes but as the ‘introspection’ of the ‘Origin-chord’:

C	E	F#	F	D	C
2	5	11	21	18	64

In this ‘introspection’ the chord’s pitch functions were now grouped into a asymmetrical hexachord with enriched 15th function. Even though compressed within the ambit of a perfect fifth in the middle of the piano keyboard, with the implied actual fundamental now an octave lower, Radulescu still interpreted this mode spectrally, thus:

B	C	D	E	F	F#
15	16	18	20	21	22

The function of C as the fundamental is however obscured by the actual nature of the music. The 32 bars of the movement are divided into six

regions, the end of each region marked by an occurrence of the *fortissimo* chord (except for the last, in which the final melody note is held in a steady diminuendo until the *attacca* beginning of the third movement). Each region emphasizes one or two pitches from the six-note mode as a kind of temporary tonic or *finalis*; these 'central sounds' are so indicated in the score, and further highlighted by accents or *tenuto* marks each time they occur:

mm. 1–9	central sound B
mm. 10–16	central sound F# (mm. 10–12); central sound E (mm. 13–16)
mm. 17–22	central sound E (mm. 17–18); central sound C (mm. 19–22)
mm. 23–29	central sound F
mm. 30–33	central sound D
mm. 34–36	central sound D

As can be seen, the six pitches are not prolonged for equal amounts of time; it is the opening *finalis*, B, that is maintained the longest. This fact, and its position as lowest pitch of the six-note mode, suggests it as the 'perceptual tonic' of the melody, standing in a powerful tension against the C fundamental of the reiterated 'Origin-chord'. But as we listen, the effect of the continuously depressed right pedal is, as Radulescu said, 'to keep all the pitch functions in a kind of dizziness of bells'.¹⁷

The brief finale, 'Joy', is in an *aksak* macro-metre of 15 beats divided as 2+2+2+3+3+3. Into its ostinato structure is set a melodic fragment from an early composition of Radulescu from 1967, which is here heard afresh in the spectral language of his mature self; this seems, symbolically, a gesture of integration of the old with the new. The movement is built mostly from further workings of the first group material from the first movement, with new transpositions and registral placements. After a single, fragmentary appearance of the first movement's second subject, the work closes with very quiet reiterations of a single B_♭ (233.1 Hz), the eighth partial of the initial fundamental B_♭, a sound that Radulescu described as 'the soft "small gong" of the immense and secret Destiny'.

VI. Paradoxes and conclusions

Since its première in 1991, Radulescu's Second Sonata has been performed by an impressive number of pianists both inside and outside the new music world. Together with his Fourth Sonata it has proved among the most palatable of his compositions to audiences not used to a diet of spectralism and microtonality. In this and other ways it is, paradoxically, a relatively uncharacteristic creation. It is the first of his works since his student years to be divided into movements, more or less in the Classical manner, setting a pattern that would be retained in his subsequent sonatas. From another perspective, it is the only one of the later sonatas that does not manifest the obsession with folklore prominent in much of the output of Radulescu's last two decades; the Third, Fourth, Fifth and Sixth Sonatas, as well as the Piano Concerto and other works, quote liberally from folk melodies of Romania, Hungary and other nations (many of them taken from Bartók's collections), whereas the Second Sonata has only one, invented, 'folklore' element.

More importantly, Radulescu's Second Sonata is highly idiosyncratic with regard to its use of spectral techniques, as the informed reader will by now have realised. 'Spectral music' admittedly is a very broad church – Gérard Grisey remarked in 1990 that 'Ce qui me gêne dans ce terme

¹⁷ Radulescu added that although the score does not say so, the 'modal bells' music might be performed *una corda*, except for the occurrences of the 'Origin-chord'.

c'est son imprécision: on peut y mettre à la carte des compositeurs aussi différents que Hugues Dufourt et Horatio Radulescu!¹⁸ – but the Sonata is distinct not only from the practice of the 'classic' French spectral music of the 1970s and 80s but from Radulescu's own earlier compositions. The main difference is that the piece is not especially interested in timbral phenomena, the exploration of which Murail and others have identified as part of the essence of the spectral approach.¹⁹ Structurally, too, Radulescu has not attempted to derive new formal models from an investigation of the inner life of sounds in the way that many French spectral scores did; rather, he has been concerned to revivify classical forms with the use of a spectral approach to harmony. Yet even on the level of harmony, as discussed above, the limitations of 12-note equal temperament as a means of conveying the pitch relationships of the sum- and difference-tone approach employed in this Sonata mean that the real 'spectrality' of the music is focused, uncharacteristically, on this domain only. Radulescu himself well understood these issues, and yet this did not stop him from pursuing the approach taken in this work in his later essays in the sonata genre.

Finally, the Second Sonata is in fact a very much more conventional piece than most of Radulescu's earlier spectral scores and many of his subsequent ones, for example the orchestral work *Angolo Divino* (1993–94) or the partly contemporaneous Fifth String Quartet '*before the universe was born*' (1990–95). But it would be wrong to see the piece simply as a retreat from the radical and often extravagant work of the preceding two decades. Rather, it seems to me that in this work Radulescu makes one of his many attempts to show that the new approaches inherent in the spectral paradigm were a natural evolution from the ongoing tradition of western music, and that here he was concerned mainly with their potential application to classical forms, almost as a kind of experiment. In an interview in 1996 I put it to him that it seemed surprising, given his obsession with the precise nature of the intervals of the harmonic series and his frequent use of a spectral *scordatura* on string instruments, that much of his recent music was for the piano. 'But I would say', he replied, 'that these sonatas simulate, with the equal-tempered scale of the piano, very new harmonic, heterophonic, polyphonic and monodic structures created by the self-generative spectral functions. For me they retain the splendour and the wild purity of these pitch materials'.²⁰ It is a testament to Radulescu's integrity that his sonatas, despite the concentration of their spectral content in the sole domain of harmony, involve no softening of his language. For many listeners they seem to fulfil the criterion Radulescu set for his own music in his book *Sound Plasma*:

Coming from and going towards THE ETERNAL (the outer time) the music CREATES into the time A MAGIC STATE OF THE SOUL. This is its single aim and reason to exist.²¹

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¹⁸ 'What bothers me about the term is its imprecision: you can put side by side composers as different as Hugues Dufourt and Horatio [sic] Radulescu!' Grisey, Gérard, *Écrits: ou l'invention de la musique spectrale* ed. Lelong, Guy, and Anne-Marie Réby (Paris: Éditions MF, 2008), p. 244.

¹⁹ See for example Murail's contributions to the panel discussion 'Analysis, phenomenology, and ethnomusicology in spectral music', in Reigle, Robert, and Paul Whitehead (eds.), *Spectral World Musics: Proceedings of the Istanbul Spectral Music Conference* (Istanbul: Pan Yayıncılık, 2008), pp. 13–29.

²⁰ Gilmore, Bob (2003), "'Wild Ocean': an interview with Horatiu Radulescu," in *Contemporary Music Review* vol.22 parts 1+2, 118.

²¹ Radulescu, Horatiu, *Sound Plasma – Music of the Future Sign* (Munich: Edition Modern, 1995), n.p.