Maurice Verheul
The harmony of the Periodic Table

FOREWORD

Music, like literature and the visual arts, has always found inspiration in the natural world – the return of the seasons, the moon and the stars, seas and rivers, mountains and forests, flowers and trees, birds and butterflies, wind and storm, rain and snow. The macroscopic world of natural phenomena was portrayed in a descriptive, poetic vein – the sounds and images of nature and the emotions evoked by them were intuitively translated into music over the centuries. Messiaen's *Catalogue d'oiseaux,* being the product of a systematic effort in empirical data collection, may have represented the first step towards a new path – a musical representation of nature beyond programmatic or fanciful description. But, in general terms, mathematics was the only branch of science to bear a significant connection to music until well into the twentieth century.

Only in recent times – well after the scientific revolutions of the last century began to reshape our understanding of the world – have composers turned to the natural sciences as a novel, deeper source of inspiration, opening up the possibility of directly translating theoretical concepts and experimental data into music, and bringing into play an aesthetic exploration of the microscopic world and the fundamental laws of nature.

The periodic table of the elements, first formulated in 1869 by Mendeleev – a contemporary of Tchaikovsky and the Russian Five – arranges all possible chemical elements according to their atomic number and electron configuration. Its rational, ordered structure has an almost musical logic. Its seven rows, when read horizontally from left to right, resemble a series of progressively expanding variations, while the vertical arrangement in groups suggests a division into smaller suites of related items. However, in the absence of a rigorous organising principle, a collection of 118 programmatic character pieces with whimsical titles would be little more than a curiosity.

A serious, deep musical analogy requires an understanding of what the periodic table really is. Rather than a mere inventory of elements, it is a structured map of all possibilities – that is, all permitted electron configurations – generated by an underlying principle. This hidden rule is the set of quantum-mechanical laws governing electron structure: Schrödinger's equation – formulated exactly a century ago, in 1926 – together with the Pauli exclusion principle and the laws of minimal energy. Likewise, a musical table of the elements needs to be generated by a unified compositional system that generates all permissible structures. In music, like in chemistry, multiplicity should emerge from a single ordering principle.

Maurice Verheul's extraordinary *The Harmony of the Periodic Table* for solo piano solves this problem with astonishing coherence while creating, at the same time, a work of contemplative, transcendent beauty. Verheul's distinctive sound world has a luminous, crystalline, translucent quality, though more sombre overtones occasionally come to the foreground, as in his *Nocturne no. 19 "De profundis"*. His larger works – the *Alida* cycle, *Piano Sonata no. 5* and some of the *Nocturnes* – seem to offer a glimpse of vast, cosmic, previously unknown realms – perhaps the angelic counterpart to the dark, abyssal expanses imagined by Dante and Lovecraft. In particular, the *Alida* cycle explores the macrocosm – astronomy, the cosmic order and the vastness of the universe – in a multisectional musical building of unheard-of scope that comprises colossal works such as the 45-hour *Le Taureau du Ciel*, the longest piano piece ever created.

On a smaller but still rather ambitious scale, *The Harmony of the Periodic Table* can be regarded as a microcosm of Verheul's work and the *Alida* cycle in particular. Not only do its shorter movements recapitulate the moods and tone colours of the larger pieces, but it is built on the same compositional principle – the Alida system, whereby certain aspects of the composition (intervals, scales, overtones) are generated from numerical series and the incorporation of relevant data. In this way, numerical properties of the elements, such as electron configuration and valences – just like stellar data in the *Alida* cycle – were translated into musical structures. Thus, the same unifying system underlies the large and the small in all their diversity.

The use of a common compositional system for both cycles echoes a central concept in many ancient and medieval traditions – the idea that microcosm and macrocosm mirror each other. The human mind has always searched for similar patterns across different levels of physical reality. Alchemists used the same symbols for planets and chemical elements, implying a hidden correspondence between them. Early models of the atom mimicked planetary systems, with electrons orbiting a star-like central nucleus. And the ultimate goal of modern physics is a 'theory of everything' capable of describing both the cosmological and the subatomic worlds within a common theoretical framework.

As a result of the synergy between the compositional system and the composer's intuition, remarkable analogies have emerged. The noble gases, which due to their closed electron configuration do not combine with other atoms, are given austere, static, monodic settings. On the other hand, hydrogen, despite being the simplest possible atom, receives a more elaborate two-part setting in keeping with its complex, versatile chemistry. Within each group, the music tends to become more elaborate and emotionally deeper as we progress towards heavier, rarer elements. Just like electron orbitals, the pandiatonic language generated by the Alida calculations is a quantised system, in which only some discrete frequencies are allowed; moreover, as with electrons, only some configurations of these notes are permitted.

This work belongs in the same category as Bach's *Well-Tempered Clavier* or Chopin's *24 Preludes* in all major and minor keys – works that attempt to exhaust the possibilities of a particular musical system, aiming at universality. Like the periodic table itself, each of these works is an all-encompassing whole, a universe in miniature. Also, the present work shares some of the didactic character of Bach's '*48*'. The overall duration and complexity of the pieces tends to increase from the earlier to the later groups. In this regard, it is significant that the composer has not followed the order of the groups literally but has found an alternative logic, beginning with the extreme simplicity of the noble gases, then moving through the longer columns (s- and p-blocks), leaving most of the d-block (the transition metals) for the end, and concluding with the fantastic intricacy of group 10 and the lanthanides. In the manner of a coda that looks back to the beginning, the actinides are again set as monodic pieces, framing the work in a symmetrical fashion.

It would be just as misleading to regard these pieces as a mere cerebral exercise as much as to hear them as programmatic music. Rather, the composer has achieved a remarkable, multilayered synthesis of the intellectual and the poetic. Some elements seem to have a synaesthetic feel to them – the silvery shine of chromium and its group, the flow of liquid mercury, the clang of bells that one can hear in some metallic elements. More importantly, and perhaps analogous to the link between chemistry and its occult predecessor – alchemy –, there is a mystical quality to this music that is most apparent in the final two books, the lanthanides and actinides – hardly a surprise, since these two rows are 'hidden' in the main layout of the periodic table and the Greek word λανθανειν (*lanthanein*) means "to lie hidden".

There is no paradox in this. Ancient civilizations regarded number, proportion, and cosmic order as sacred, divine, mystical principles. It may not be a coincidence that the more spiritually inclined composers – such as Bach, Scriabin, Messiaen, Stockhausen and Verheul himself – are among the most systematic when it comes to the design of their compositions. It is likely that science, religion and all sorts of symbolism share overlapping mental structures and arise from a common human instinct – the need to connect, conceptualize and systematize the world in order to understand it.

The Harmony of the Periodic Table offers multiple possibilities to the performer. It can be played as a complete cycle, presenting the twenty books in the order established by the composer. For a shorter performance, the groups are to a large extent independent and could be presented as standalone pieces. Performing all the elements sequentially, in order of increasing atomic number, would reveal their periodic behaviour – most conspicuously, the appearance of the restrained monody of the noble gases at the end of each period.

Finally, one could wonder what would be the result of combining these musical elements in the myriad ways they appear in nature, forming molecules and crystals. Would a triptych of hydrogen, oxygen, and again hydrogen somehow represent water? Would potassium, carbon and nitrogen together evoke a deadly poison? Aluminium and oxygen, performed alternately in a 2:3 ratio, would yield a beautiful crystal of ruby, provided that a few atoms of chromium were occasionally inserted in order to give it its characteristic red hue. And the whole human genome, set to music in this way, would take two million years to perform – projecting the microscopic world back into the cosmic scale.

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In the centenary year of the formulation of Schrödinger's equation (1926-2026)