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BOOK REVIEW

Eric R. Scerri: selected papers on the periodic table

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Pieter Thyssen

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Selected Papers on The Periodic Table represents a wonderful collection of ten influential papers from the hand of Eric R. Scerri (*vide infra* for the contents)—the leading authority on the history and philosophy of the periodic table of the elements, and author of the bestselling book *The Periodic Table: Its Story and Its Significance* (published by Oxford University Press in 2007). Eric Scerri is one of the founders of the philosophy of chemistry and editor-in-chief of *Foundations of Chemistry*. He recently published "an outstanding and much anticipated" (McIntyre 2009) volume of *Collected Papers on Philosophy of Chemistry* (published by Imperial College Press in 2008).

The key articles in this volume are preceded by an extensive and enlightening introduction of twelve pages, and have been chronologically arranged—covering a period of 19 years from 1991 to 2009. All these research papers have been previously published in a number of scientific (*International Journal of Quantum Chemistry*), philosophical (*The British Journal for the Philosophy of Science & Studies in History and Philosophy of Science*), educational (*Journal of Chemical Education*), and popular scientific (*American Scientist & Chemical Heritage*) journals and books (*Fundamental World of Quantum Chemistry*). Although Scerri's papers have been turned into a durable hardbound book with a beautiful cover image of Scerri's revised periodic table, three minor points are to be noted. First of all, the ten papers have been reprinted in the form as they originally appeared. As a consequence, there is no uniform layout, and some of the articles have been printed in a small and difficultly readable font size. Secondly, the book lacks an index—making it hard to find your way through the papers. Also, no bibliography has been included of Scerri's other papers on the periodic table and the philosophy of chemistry in general.

What makes this book especially interesting is the twelve page introduction, in which Scerri recounts the history of his philosophical research on the periodic law during the past 20 years. As Kevin C. de Berg (2010) noted, the introduction provides "an historical snapshot of Scerri's own intellectual journey in matters relating to the periodic table." This

P. Thyssen (✉)
Ph.D. Fellow of the Research Foundation – Flanders (FWO), Department of Chemistry,
Laboratory of Coordination Chemistry, Katholieke Universiteit Leuven, Celestijnenlaan 200F bus
2404, B-3001 Leuven, Belgium
e-mail: pieterthyssen@gmail.com

short biographical prelude thus provides some insight into the motives that caused Scerri to embark upon his celebrated philosophical quest towards a more profound understanding of the nature of the periodic law. But more importantly, Scerri's introduction helps the reader understand how his viewpoints concerning the periodic table (and the history and philosophy of chemistry in general) have evolved over time.

One thus learns for example how Scerri used to consider the periodic table as a mere convention—an artificially constructed *catalogue raisonné* of the elements. As a consequence, Scerri advocated multiple versions of the periodic table, the choice depending on one's own interests. Recently however, Scerri's instrumentalist attitude gave way to a more realistic position according to which there could be only one correct version of the periodic system. Another example of Scerri's changing viewpoints can be found in his latest papers on the periodic law. Scerri has favoured Janet's left-step periodic table for a considerable period of time (with hydrogen above the alkaline metals, and helium crowning the group of the alkaline earths), but he now recently proposed an alternative version of the periodic table, based on the concept of atomic number triads, and with hydrogen and helium situated above the halogens and noble gases, respectively. On the other hand, his antireductionistic opinions and skepticism towards a complete understanding of the periodic table on the sole basis of quantum mechanics represents a constant throughout the book, as is his recurrent emphasis on the macroscopic properties of the chemical elements.

The first four papers in this volume deal with this question of reduction, and Scerri particularly wonders whether the periodic table could be reduced to quantum mechanics. Scerri clarifies that the orbital model and the four quantum numbers account for the *closing of electron shells* (resulting in the cumulative totals 2, 10, 28, 60, etc.), but emphasizes that this differs from the actual *closing of the periods* at atomic number 2, 10, 18, 36, 54, etc. as a consequence of the non-sequential filling of the electron shells. The correct sequence appears to be described with the aid of Madulung's rule, and the question whether this rule could be deduced from ab initio theory is addressed in the sixth paper of this collection.

Another recurrent theme in Scerri's papers relates to the proper accommodation of a number of chemical elements. The ambiguity that currently exists in accommodating these elements naturally results in a number of different periodic tables (thirty to be exact when restricting ourselves to the placement of hydrogen, helium, and the lanthanides and actinides). Chemists for example usually tend to favour the placement of helium in group 0 (VIIIA) of the periodic table. Physicists, on the other hand, have often positioned this noble gas above beryllium in group IIA. As Scerri noted in his introduction, his views on this issue have gone full-circle—initially siding with the chemists, then favouring Janet's table, and recently reverting again to the traditional placement of helium in the zeroth group.

The fifth and longest paper (co-authored with John Worrall) discusses the relative epistemic importance of predictions and accommodations in the acceptance of the periodic table by the chemical community. Although the noted historian of science, Stephen Brush (1996), claimed that Mendeleev's successful predictions of gallium, scandium and germanium had convinced the chemical community of the universality of the periodic law, Scerri and Worrall argued differently. According to these authors, the historical evidence failed to support Brush's propredictivist views. Thus readdressing the issue, Scerri and Worrall asserted that the accommodation of 63 elements into a coherent whole was at least as important as Mendeleev's predictions. Also the accommodation of the noble gases (and, I would claim, the lanthanides and actinides as well) seem to have played an equally important role.

The dual sense of the epistemological concept of a chemical element appears for the first time in Scerri's seventh paper with regard to Mendeleev's legacy and the history of the periodic table. Scerri discusses the philosophical distinction between the element as *simple substance* and as *basic substance*—a fascinating viewpoint adopted by Mendeleev himself, and greatly promoted by the philosophically inclined radio-chemist, Fritz Paneth (1887–1958). According to this point of view, solid sodium metal and gaseous chlorine gas, for example, represent the elements as simple, observable and isolable substances which can be characterized by a plethora of different properties (both chemical and physical). The elements as basic substances, on the other hand, are said to be devoid of any property and represent the material ingredients of simple and compound substances. Thus common table salt does not consist of the simple substances sodium metal and chlorine gas, but rather of the more abstract, transcendental form of sodium and chlorine as basic substances. Mendeleev moreover emphasized that the periodic table represented a classification of the elements as basic substances. He considered the atomic weight to be the characteristic property of basic substances, but this was later changed to atomic number.

In the last three papers of this volume, Scerri introduces the reader to the intriguing concept of *atomic number triads*. Since these triads rely on a simple mathematical relationship between the atomic numbers of analogous elements (i.e. the atomic number of the middle element is the exact average of that of the two other elements), Scerri claims that both the primary *and* secondary classification of the elements could be based on the defining property of basic substances. He therefore attempts to maximize the number of atomic number triads in the periodic table, and this has resulted in the relocation of hydrogen to the halogen group (forming the atomic number triad H–F–Cl), and the accommodation of lutetium and lawrencium underneath scandium and yttrium (instead of lanthanum and actinium as in most traditional medium-long form periodic tables)—thus forming an additional atomic number triad Y–Lu–Lr. Helium's position among the noble gases is retained on the basis of the atomic number triad He–Ne–Ar.

In conclusion, the periodic table does not yet represent an established fact which may be taken for granted by the chemical community. Mendeleev's system continues to be in constant need of improvement and optimization, and numerous contemporary problems call for a more profound understanding of the periodic law. Most importantly, the classification of certain elements has remained ambiguous to this very date and these problematic accommodations have resulted in the creation of a periodic table zoo. Since this situation is diametrically opposed to the view of one optimal periodic system, active research will be sorely needed in this foundational area of chemistry. All of this is rendered crystal clear in Scerri's *Selected Papers on The Periodic Table*. It bundles some of his most brilliant papers into one volume, and it provides the reader with a thorough overview of Scerri's cutting edge research on the periodic table. Scerri has tackled all of these periodic table related problems by approaching them both scientifically, historically and philosophically. Every chemist, philosopher and educator with an interest in the periodic table of chemical elements should definitely add a copy of this volume to his personal library!

Book Contents

Paper 5. "Prediction and the Periodic Table", *Studies in History and Philosophy of Science,* 32: 407–452, 2001 (co-authored with J. Worrall).

Paper 6. "Löwdin's Remarks on the Aufbau Principle and a Philosopher's View of Ab Initio Quantum Chemistry", in *Fundamental World of Quantum Chemistry: A Tribute to the Memory of Per-Olov Löwdin*, E. Brandas, E. Kryachko (eds.), Springer, Dordrecht, pp. 675–694, 2003.

Paper 7. "Mendeleev's Legacy", *Chemical Heritage*, Spring, pp. 22–27, 2007.

Paper 8. "The Role of Triads in the Evolution of the Periodic Table: Past and Present", *Journal of Chemical Education*, 85: 585–589, 2008.

Paper 9. "The Past and Future of the Periodic Table", *American Scientist*, 96: 52–59, 2008.

Paper 10. "The Dual Sense of the Term "Element", Attempts to Derive the Madelung Rule, and the Optimal Form of the Periodic Table, If Any", *International Journal of Quantum Chemistry*, 109: 959–971, 2009.

References

Brush, S.G.: The reception of Mendeleev's periodic law in America and Britain. ISIS **87**, 595–628 (1996)

de Berg, K.C.: Book Review: Selected Papers on the Periodic Table. Science & Education (2010)

McIntyre, L.: Book Review: Collected Papers on Philosophy of Chemistry. Found. Chem. **11**, 181–182 (2009)

Scerri, E.R.: The Periodic Table, Its Story and Its Significance. Oxford University Press, New York (2007)

Scerri, E.R.: Collected Papers on Philosophy of Chemistry. Imperial College Press, London (2008)