

# C<sub>n</sub>S

## La Chimica nella Scuola

n. 5 anno 2021

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- › **Metodologie didattiche per l'università e percorsi laboratoriali per la scuola superiore di secondo grado**
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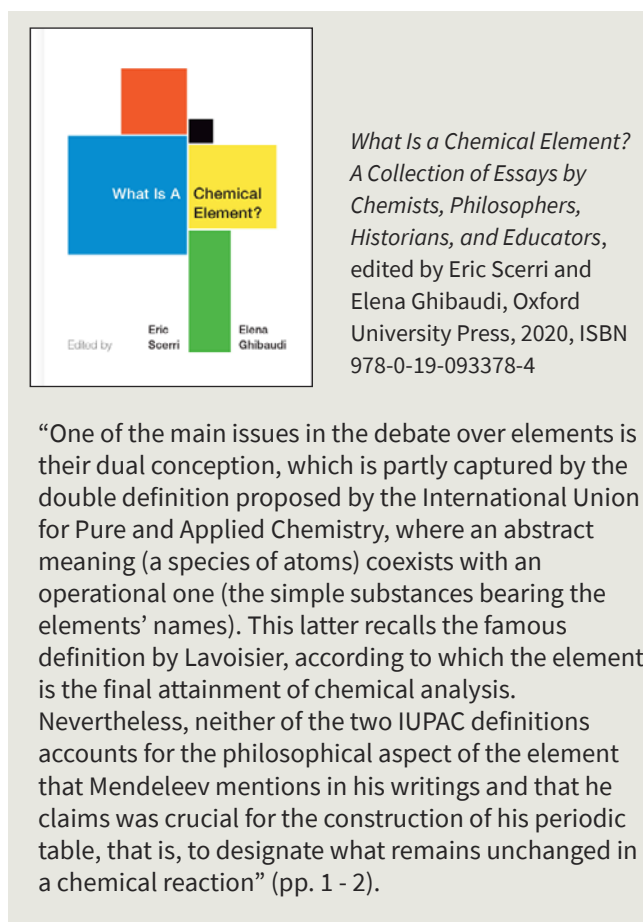
# Comments to *What Is a Chemical Element?*

*A Collection of Essays by Chemists, Philosophers, Historians, and Educators, edited by Eric Scerri and Elena Ghibaudi*

**A**s suggested by the subtitle, the authors of this collection of 14 essays dedicated to historical, philosophical, logical and epistemic issues related to the current, dual concept of chemical element as expressed by the 1997 IUPAC definition, are professionals in the fields of scientific research, higher education, history and philosophy of science and ideas. Thus, the 18 authors tackle the main scientific and philosophical questions concerning what an element is, how it has been defined through history and how such issues are relevant both for scientific and educational purposes.

The book opens with the chapter by Eric Scerri (pp. 5 - 31), among the most experienced and authoritative scholars in the relatively recent field of philosophy of chemistry. He presents the state of the art concerning philosophical and epistemological perspectives and conundrums on the definition of chemical element. With the exception of the four (mainly) historical essays, only one of the remaining ten provides for the possibility of interpreting the IUPAC definition of chemical element from a perspective of complementarity between its parts, while the other essays underline its approximation, logical contradictions, epistemological vagueness and inconsistency in the educational field.

As for the historical section, particularly worthy of mention are the contributions of Bernadette Bensaude-Vincent and Marina P. Banchetti-Robino. While the one (pp. 32 - 52) contests the still widespread, positivistic idea that with his conceptualization of *substance simple* Antoine Lavoisier introduced the modern notion of chemical element (a milestone that will only be reached about eighty years later thanks to Dmitrij Mendeleev), the other (pp. 87 - 108) summarizes the scientific and philosophical path that, from Lavoisier to John Dalton, lead from chemical 'simplicity' to the conceptual overlap of 'atomicity' and 'elementarity'. Nathan M. Brooks fo-



“One of the main issues in the debate over elements is their dual conception, which is partly captured by the double definition proposed by the International Union for Pure and Applied Chemistry, where an abstract meaning (a species of atoms) coexists with an operational one (the simple substances bearing the elements’ names). This latter recalls the famous definition by Lavoisier, according to which the element is the final attainment of chemical analysis. Nevertheless, neither of the two IUPAC definitions accounts for the philosophical aspect of the element that Mendeleev mentions in his writings and that he claims was crucial for the construction of his periodic table, that is, to designate what remains unchanged in a chemical reaction” (pp. 1 - 2).

cuses instead (pp. 53 - 68) on the conceptual evolution of the chemical element in the work of Mendeleev, with remarkable insights concerning the Russian chemist’s interest, prior to the creation of the periodic table in 1869, in the potential elementarity of subatomic particles (distantly echoing the 1815 William Prout’s hypothesis of hydrogen integral multiples). On the philosophical side of the proposed quest, most of the authors take into consideration, as a starting point for the discussion on the IUPAC terminology validity, its main source, namely the twofold notion of chemical element offered by Friedrich



Paneth. In an influential contribution dating back to 1931 unequivocally entitled *Über die erkenntnistheoretische Stellung des chemischen Elementbegriffs* ('On the Epistemological Status of the Concept of Chemical Element'), he in fact defined elements according to both their abstract meaning (*Grundstoff*, 'basic substance') and operational value (*einfacher Stoff*, 'elementary/simple substance'). Some authors, like Joseph Earley and Joachim Schummer (pp. 109 - 123, 167 - 187), point out how the IUPAC definition does not represent a necessary approximation but rather a sign of surrender. While the former rejects the idea of elements as indecomposable constituents of substances, the latter emphasises how the tension towards limitlessness characterising scientific endeavour is incompatible with an operational definition of a chemical element that prefigures the impassable nature of a practical boundary.

Other essays, enforcing broad multidisciplinary approaches, face the problem of chemical elements as pertinent to the history of ideas, epistemology, ontology and formal logic. For example, Farzad Mahootian (the only author suggesting the potential complementarity of the dual concept of element), resort to critical assessments and categorizations proper of Immanuel Kant and Ernst Cassirer's philosophical thought as tools to discuss substantiality and functionality of the chemical element as terms of a dialectic encounter (pp. 143 - 166). Jean-Pierre Llored, on his part (pp. 188 - 203), implements elements of mereology - the logico-philosophical discipline studying parts to whole relations - proper of Stanisław Leśniewski's logico-mathematical speculation. Thus, Llored treats the relationship between the abstract and the operational value of the chemical element's definition in a perspective of relational functionality. Finally, the chapter

by Guillermo Restrepo (pp. 225 - 240) focuses on ontology, bringing forth a redefinition of chemical element through a (quite tangled up yet convincing) analysis based on formal logic and mathematical chemistry. The volume concludes with

the chapter by Elena Ghibaudi, Alberto Regis and Ezio Roletto (pp. 257 - 279) in which the educational value of the IUPAC terminology is discussed and strongly criticised. Emphasis is put especially on problems inherent to the epistemic gap between a notion of chemical element which, according to the authors, is better to be intended as a pure immateriality, and a strictly material concept of chemical substance.

Unfortunately, only the last essay is dedicated to themes relevant to the debate on the relationship between philosophy and scientific education. Moreover, it is surprising that, among the rich and varied epistemic discussions of which the book is punctuated, no reference is to be found regarding the epistemology of science elaborated by Paul K. Feyerabend, which had and continues to have such a wide influence in the debate on the value of science - intended as a human enterprise aimed at obtaining quantifiable knowledge - and its educational significance.

Like any valuable philosophical work dedicated to foundational problems, *What Is a Chemical Element?* does not presume to provide any univocal interpretation or definitive solution, while thoroughly and expertly exploring its central question in all its breadth. Therefore, despite its undeniable complexity, this collection of contributions represents a profitable discussion and learning opportunity for both students and scholars of historical and philosophical subjects. ■