Book Reviews

HEGEL'S PHILOSOPHY OF THE CHEMICAL PROCESS: A REHABILITATION

JOHN W. BURBIDGE, *Real Process. How Logic and Chemistry Combine in Hegel's Philosophy of Nature*, Univ. of Toronto Pr., Toronto 1996, x + 274 pp., (ISBN 0-8020-0897-6)

Hegel's philosophy of nature and in particular his philosophy of the chemical process seemed to be antiquated soon after its appearance. Some of his statements were picked out and exposed as grotesque mistakes. This led to the bad reputation of the idealistic philosophy of nature and to the opinion that idealistic speculative thought should have no relevance to a science such as chemistry and could at best be regarded as an outdated historical curiosity. Not only natural scientists who principally opposed philosophy of nature but also philosophers who reproduced and paraphrased the obscure passages in Hegel's *Science of Logic* and *Encyclopaedia* contributed to that bad reputation. It was not before the 1970s that the prejudice against Hegel's putative incompetence in the natural sciences of his time was removed. In 1976, von Engelhardt published his pioneering book *Hegel und die Chemie*. He pointed out that the obscurity of those passages vanishes if it is shown how early 19th century chemistry is expressed in Hegelian texts and especially how Hegel combined experimental facts with contemporary developments in the philosophy of nature, particularly with those of Kant and Schelling. Through von Engelhardt's groundbreaking studies, philosophers began to understand Hegel's writing and what had remained *terra incognita* for 150 years.

Overlooking the following period of intensive research, John W. Burbidge presents the first monograph in English devoted to the chemical parts of Hegel's philosophy of nature. The title – *Real Progress: How Logic and Chemistry Combine in Hegel's Philosophy of Nature* – indicates Burbidge's program. In the *Science of Logic,* Hegel presents a systematic philosophy in which categories and patterns of reasoning are developed, allegedly only by the means of self-reflecting thought. In the *Encyclopaedia,* Hegel presents a philosophy of nature which provides a framework for natural sciences rather than being second-order reflections upon the results of natural sciences. The framework is derived from concepts of the *Science of Logic*, but does not coincide with the *Science of Logic*. According to Hegel, it is not the data of empirical phenomena that can be derived, but fundamental principles that are essential for undertaking natural sciences. As concerns chemistry, the principles come from two different parts of the *Science of Logic*; first, from the theory of measure and, secondly, from a series of syllogisms where 'chemism' follows 'mechanism' and precedes 'teleology'. Thus, Burbidge's question can be formulated more precisely (p. 4): why did Hegel discuss the chemical process in three systematically different parts? If the concept 'chemical process' were deducible *a priori*, it would not have been necessary to write a philosophy of nature that intensively refers to galvanism and combustion, acid and base, solution, and chemical compound; all that would be no more than a footnote to the *Science of Logic*. If, on the other hand, the concept 'chemical process' were taken from the natural sciences, it would be puzzling why chemical concepts such as neutralization, elective affinity *etc.* should be systematic concepts in the *Science of*

Logic and play a central role in two different parts of the reflection of thought upon itself.

In the first part of his book, Burbidge offers an *exposition de texte* of Hegel's theory of 'real measure' in the *Science of Logic*. Hegel considered this chapter, where he develops logical concepts concerning chemical and physical concepts, as one of the most difficult topics. Because 'measure' unites the two categories 'quality' and 'quantity', it is a key aspect for determining qualitative and quantitative objects and, hence, the decisive category for natural sciences. The category 'measure' corresponds to a process of and between real things, *viz.* the process of measuring. Therefore, the logic of 'measure' is at the same time the logic of measuring. Starting with the measurement of a length by a ruler, Hegel goes over to measuring velocity and then to measuring specific weight. In order to determine a substance more precisely, Hegel considers its chemical reactions. From these reactions, new measures can be gained that characterize a substance more intrinsically. Accordingly, he develops further as categories in his logic of measuring: 'distinct and fixed proportions of stoichiometric masses', 'elective affinity', and 'nodal line'. By doing that, Hegel shows that chemistry is to be considered a science, against Kant's claim that chemistry would never be a science and would remain only a systematic craft because it cannot be set out in mathematical terms. He also cites Richter's investigations about the proportions of elements involved when two salts in a solution exchange their radicals. At this point, the question arises as to how logic refers to chemistry, especially in Hegel's case since his lifetime coincided with the emergence of modern chemistry. Burbidge argues (p. 61 ff.) that thought by itself can develop its categories. According to him, Hegel's choice of chemical concepts (such as elective affinity) for the definition of logical categories of measuring was only for reason of didactic illustration, to make it easier to grasp the structure of the category.

In the second part, Burbidge offers an *exposition de texte* of Hegel's theory of 'chemism', placed in the third book of the *Science of Logic* between 'mechanism' and 'teleology'. A mechanical object is complete in itself and indifferent to whatever happens to it. Any movement or change comes from outside. In contrast, a chemical object has a *one-sided existence*; by its distinctive quality, it is oriented to another chemical object and *vice versa*. Furthermore, both objects are determined by a *comprehensive concept* that they share and that differentiates them as being directly complementary to each other – this Hegelian concept of 'chemism' anticipates the logical structure of the acid-base-definition by Brønsted one hundred years later. If, in such a way, a chemical object is determined by its affinity, the chemical process can be understood as the realization of what the concept 'chemical object' contains. In the following parts of the *Science of Logic,* Hegel argues that the chemical process itself must be differentiated to several types. Burbidge emphasizes that 'chemism' „involves a systematic development that is logical on its own account“ and that „there is no need to refer […] to actual chemical bodies or to discrete historian persons“ (p. 105). Therefore, 'chemism' could be applied not only to chemical phenomena.

In the third part, Burbidge approaches Hegel's philosophy of nature, especially of chemical phenomena. First, he provides a fairly literal translation of the eleven paragraphs of the *Encyclopaedia* devoted to chemistry, parallel to the German original. (The courage to present the translation parallel to the original should be an example for other translators of Hegel's texts.) Secondly, he provides notes on specific Hegelian terms, the difficulties of their translation, and on contemporary chemistry. Thirdly, he thoroughly expounds Hegel's view, especially considering how the data from chemistry are being combined with his systematic principles.

Finally, in the conclusion (p. 204) Burbidge ties the various strands together by answering the questions if Hegel's systematic philosophy provides an understanding of chemical concepts and how chemistry understands chemical phenomena. According to Burbidge, Hegel's approach in the *Science of Logic* and in the *Philosophy of Nature* should be distinguished. In the *Science of Logic*, philosophy analyses and develops concepts. If a concept proves to be inconsistent, thought is compelled to move to a more comprehensive concept that resolves the contradiction revealed in the former one. Thus, thought uses its own resources and refers to concrete material only as an illustration or example. On the other hand, in the *Philosophy of Nature*, philosophy takes a thoroughgoing empirical approach. One gathers everything experience tells us about nature, looks at all determinations discovered and, by recognizing their relations and considering them as a whole, "constructs the concept" (Hegel). The categories analyzed in the *Science of Logic* are conditions of the approach of the *Philosophy of Nature* that proceeds in a radically empirical way (p. 208). The latter turns out to be systematic, because the speculative concept arises if the empirical data are grasped in their synthesis. Ultimately, the Hegelian 'spirit' is the subject that combines logic and nature. 'Spirit' means the achievements of finite subjective spirits, as members of the universal intellectual community reflecting the 'real process' in which logical thought and empirical chemistry are united (p. 211). In these efforts, Hegel's philosophy has its place.

John W. Burbidge has written a remarkable book, essential reading to everybody who studies Hegel's philosophy of nature.

Ulrich Ruschig:
Institute of Philosophy, University of Oldenburg, Ammerländer Heerstr. 114-8, D-26111 Oldenburg, Germany; Ulrich.Ruschig@uni-oldenburg.de

ELISABETH CRAWFORD, *Arrhenius: From Ionic Theory to the Greenhouse Effect*, Science History Publications, Canton, 1996 (Uppsala Studies in History of Science, Volume 23), -xiii, 320 pp. (ISBN: 0-88135-166-0)

DIANA BARKAN, *Walther Nernst and the Transition to Modern Physical Science*, Cambridge University Press, Cambridge, 1999, -xii, 288 pp. (ISBN: 0-521-44456-x)

Svante August Arrhenius and Walther Nernst were two of the founders of the new physical chemistry. Arrhenius was one of the original triumvirate with Wilhelm Ostwald and Jacobus Henricus van't Hoff, Nernst one of a second generation of physical chemists, although only five years younger than Arrhenius. Importantly, Nernst was the first German chemist to become a disciple of the new physical chemistry. In 1886-7, Nernst and Arrhenius became close friends as colleagues in Friedrich Kohlrausch's Würzburg physics institute, and both spent an additional year together in Graz in Ludwig Boltzmann's institute. They later would become estranged, and Arrhenius would play a large part in preventing Nernst from receiving the Nobel Prize until 1921. These two recent biographies of Arrhenius and Nernst, relying heavily on extensive archival research, provide intriguing insights into the deteriorating relationship between Nernst and Arrhenius, but more significantly, the different factors involved in the emergence of the 'new' physical chemistry of the 1880s and 1890s. This biographical approach provides a convenient method for understanding the unique confluence of theoretical traditions in chemistry and physics – chemical affinity, electrochemistry, thermochemistry, conductivity, quantum physics – that occurred during the late nineteenth century. Were Nernst and Arrhenius chemists or physicists? As it becomes clear on reading both volumes, it is difficult to