Book Reviews

Chemical Explanation: Characteristics, Development, Autonomy, ed. by JOSEPH E. EARLEY, SR., New York, 2003 (*Annals of the New York Academy of Sciences*, Vol. 988) xiii + 377 pp. [ISBN 1-57331-456-0 cloth, 1-57331-457-9 paper]

Chemical Explanation: Characteristics, Development, Autonomy is a collection of 40 articles presented at the Sixth Summer Symposium on the Philosophy of Chemistry and Biochemistry held by the International Society of the Philosophy of Chemistry and Biochemistry at Georgetown University on August 4-8, 2002. The proceedings include a Foreword and Introduction followed by papers grouped according to categories: General Considerations (11 papers), Specific Applications (9 papers), Representation and Instrumentation (8 papers), and Development and Social Impact (12 papers). An Index of Contributors is included. As with many conference proceedings, the quality of contributions ranges from complete, polished papers to rough works in progress. The collection provides a nice snapshot of the state of the philosophy of chemistry in 2002 and will make a nice addition to your institution's library.

The first 11 papers in this collection consider questions central to the philosophy of chemistry. They address the nature and development of structural explanation, the relationship of chemical explanation to other sorts of discourse, and disciplinary identity. HARRÉ and FISHER begin the process by questioning the relationship of structure and shape and the use of models in chemical explanation. This work is nicely summarized by "the ubiquitous use of 'visual' models that characterize chemistry demands an account of explanation with an extra-linguistic basis." (p. 20) Significant advances in the graphical capabilities and accessibility of computational chemistry programs highlight this point. The distinction between a model and reality is often ignored by students during their studies. As chemical pedagogy further embraces molecular modeling and integrates it into the undergraduate curriculum, this blurring of reality and our graphical representation of current quantum mechanical theory represents a potential stumbling block. There is ample room and need for continued work in this area.

Two other highlights of the first section include HENDRY's overview and comparison of the Heitler-London-Pauling-Slater valence bond method with the Hund-Mulliken molecular orbital approach. Readers who teach undergraduate or graduate chemistry courses are encouraged to consider this for inclusion on their reading list. Finally, a heeding of VAN BRAKEL's plea, "What is needed are very detailed case studies and further discussions about them, instead of bickering about whether chemistry can be reduced to physics, supervenes on it, can be unified with it, and similar metaphysical concerns." (p. 38) will enable the philosophical studies of chemistry to have a broader impact on the chemical sciences.

The second group of paper deals with Specific Applications of the philosophy of chemistry. Contributions cover the mechanistic explanation of chemistry, autocatalysis, self-organization, chirality, thermodynamics, gauge theory, and symmetry breaking among others. While at the heart of van Brakel's wish to see a greater concentration on specific issue, the contributions in this section varied the greatest in quality. Papers by

GOODWIN, "Explanation in Organic Chemistry", KING, "Chirality and Handedness: The Ruch 'Shoe-Potato' Dichotomy in the Right-Left Classification Problem", and others address questions central to the chemical sciences and make excellent contributions to the collection. Unfortunately, the contributions of MATTINGLY, "Gauge Theory and Chemical Structure", and KÜHL and LANKAU, "Symmetry in Basic Physical Law", seem to address chemical issues as a mere after-thought.

I thoroughly enjoyed JOB and LANKAU's discussion of the harmful effects of the First Law of Thermodynamics in light of modern (mis)emphasis on the conservation of energy in contrast to Clausius' emphasis on the equivalence of work and heat. Their conclusion that heat was no longer an independent quantity and thus "The place formerly occupied by heat is now filled with an abstract quantity, the entropy S – a phantom without macroscopically relevant properties" (p. 171) is intriguing. It is such articles where the philosophy of chemistry can significantly impact our interpretation, and teaching, of chemistry.

A second gem in this section was OSTROVSKY's "Physical Explanation of the Periodic Table". His discussion of the periodic table from both qualitative and quantitative perspectives reminds us that, "Explanation, as distinct from purely quantitative agreement, requires some overall understanding of the phenomenon – even if accuracy in treating details is sacrificed in favor of revealing basic trends." (p. 184) Readers who agree with this sentiment might enjoy Peter Atkins' *The Periodic Kingdom* where the periodic table is explored using a topological/geographical analogy.

The third section of the proceedings, Representation and Instrumentation, focuses upon the use of causal language, metaphors, and representation in addition to the significance of instrumental techniques and instrument design and development. BROWN argues that the use of molecular models and chemical structures are unique chemical modes of explanation. While this contribution is certainly at home in the third section, it also nicely ties into the opening works by Harré and Fisher.

The fundamental role of instrumental methods to the chemical sciences is discussed by ROTHBART and KOHOUT in their paper entitled, "Justifying Instrumental Techniques of Analytical Chemistry". While many working chemists take electronic data collection for granted, "Knowing that data are valid is inseparable from knowing how data-gathering instruments operate" (p. 250). As chemical instrumentation increases in complexity, we must fight against accepting instruments as black boxes, lest we lose the ability to design instruments for use in probing our questions of interest. It is important to remember that theory, experiment, and instrument design form a feedback loop with advances in each spurring the others.

Development and Societal Impact, the fourth and final section of the book, focuses upon the "historical development of chemical thought and practice and the interrelationship of chemical ways of thinking and wider social concerns." (p. xi) As with the second section, certain contributions were at best tangential to the theme of the proceedings and the philosophy of chemistry in general. This is an area where a firmer editorial hand might have proven favorable. I took exception to components of one article, KHURI's "An Organic Framework for Philosophical Appreciation of Chemical Phenomena". One specific area of concern stemmed from the following passage, "The hysteria over the seeping of some benzene molecules through a faulty filtration process in 'Perrier' bottled some years ago is a stark reminder of the health risk posed by benzene" (p. 328). Here, Khuri implies the hysteria was justified when the actual health threat was minimal. A similar example is that of breast implants where significant legal action has occurred while the science suggests that minimal,

if any, detrimental health effects have occurred.

A second point of concern arose when the author stated, "The effect of a chemical on human health implies an influence at a higher level than mere chemistry (in our contemporary sense) suggests. Defined in our strict sense, in other words, a chemical has no business affecting human health. Yet it does. How so?" (p. 329). Clearly the problem lies in a faulty definition of 'chemical'. Most readers would agree that a mutated protein qualifies as a 'chemical' and yet to imply that such a species "has no business affecting human health" is absurd. This brings to mind sugar packets that are labeled 'Chemical Free'.

A notable contribution in this section is BOGAARD's discussion of the distinction between quantum chemistry and quantum physics arising from the work of G.N. Lewis. The idea that quantum chemistry must account for both the stability of a molecule and its structure while quantum physics is concerned only with energy (stability) issues is a salient one.

In conclusion, *Chemical Explanation: Characteristics, Development, Autonomy* is a worthy addition to your institution's library. My only major complaint is the lack of a comprehensive subject index. This is inexcusable given current electronic publishing capabilities. The utility of this volume as a resource will be severely limited by this omission – an unfortunate consequence given the high quality of many of the papers. With the ever-growing interest in the philosophy of chemistry, these proceedings will act as a mile marker to gauge how far we have progressed from the summer of 2002.

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WILLIAM R. NEWMAN & LAWRENCE M. PRINCIPE: *Alchemy Tried in the Fire: Starkey, Boyle, and the Fate of Helmontian Chymistry*, The University of Chicago Press, Chicago, 2002, xiv + 344 pp. [ISBN: 0-226-57711-2]

"In this study, we have also tried to provide a view of chymistry in terms of an independent, long-term, and continuous development." This sentence from the final chapter encompasses much of what is analyzed in detail in this book, particularly the "continuous development". The volume is actually a kind of *syntaxis megale*: although readers learn much from it alone, those who seek a deeper study of the topics should first acquaint themselves with the previous books of both authors – Newman's *Gehennical Fire* (Harvard University Press, 1994; reprinted by University of Chicago Press, 2003), and Principe's *The Aspiring Adept* (Princeton University Press, 1998), dealing with Starkey and Boyle, respectively. Those who are even more demanding should consult Newman's critical edition of the *Summa Perfectionis* (Leiden, 1991) because the continuous development mentioned above has its roots in the High Middle Ages. The progress during the 17th century can be further studied in Debus' *The Chemical Philosophy* (Science History Publications, 1977; reprinted by Dover Publications, 2002). This enumeration of Newman's and Principe's books also illustrates the continuous development of both authors.

Apart from a broader historical perspective, the reviewed book is composed in such a way that it forms a closed entity in which several key personalities of the 16th and 17th centuries appear as living beings with specific ideas and personal interactions that are fleshed-out and emphasized. Sometimes the protagonists' personal features appear within the discussion of seemingly different topics, such as with the style of their works. Although the text involves numerous figures of the 16th- and 17th-