## Assessments and Reconstructions

**Historical Studies in the Physical Sciences.** Vol. 1. RUSSELL MCCORMMACH, Ed. University of Pennsylvania Press, Philadelphia, 1969. x + 318 pp. $8.50. Edgar F. Smith Memorial Collection.

Truly meritorious historical studies that begin by being something less than normal book length rarely stand to gain from being chopped up into smaller pieces or stretched out, parascholarly fashion, to several times their natural length. For this reason a new journal, in book format, that adopts a policy of no limitations on the length of the articles it accepts is a landmark for historians of science—as authors and as readers.

This annual journal, under the expert editorship of Russell McCormmach, incorporates *Chymia*, the history of chemistry annual which was published from 1948 to 1967 under the auspices of the University of Pennsylvania's Edgar Fahs Smith Memorial Collection. The new journal will be devoted to the history of the physical sciences from the 18th century on.

The admirable and clear guidelines that the editor has set forth for the journal reflect a number of consequential changes in the pattern of history of science scholarship that have been the object of considerable discussion and ferment within the discipline over the past decade. The editor intends to publish substantial articles that illuminate major issues. He seeks to avoid heroic biography, the tracing of chains of discovery, short notes and slight themes, and narrowly illuminating antiquarian finds. The journal will publish contributions that deal both with the internal development of the physical sciences and with their contextual relation to intellectual, cultural, political, moral, socioeconomic, and technological themes. Historiographic and review articles will reassess major historical issues and keep abreast of scholarship in the field.

Noteworthy are some specific directives the editor gives in order to encourage the application of the techniques of intellectual, social, and cultural history: preference for specialization by period rather than devotion to individual disciplines in isolation, concern with the interaction of related sciences, including the life sciences, the interdependence of the physical sciences and other aspects of modern history and civilization, the synthesis of the intellectual history of ideas and institutions, and the social function of the physical sciences and the associated problems of the professional and organizational role of their practitioners.

On the whole McCormmach's first volume is a great success. It contains eight articles varying in length from 22 to 80 pages and in quality from mediocre to *summa cum laude*, with the curve of approbation definitely skewed toward the latter.

Worthy of special comment is the paper by John Heilbron and Thomas Kuhn, "The genesis of the Bohr atom." This is a detailed, closely reasoned, and provocative attempt to reconstruct, from the published and manuscript documents and the secondary literature, the essential historical steps and arguments that led to Bohr's famous trilogy of papers "On the constitution of atoms and molecules"—to explain how the Bohr of 1911 (cultivator of the electron theory) became the Bohr of 1913 (developer of the nuclear atom). Various aspects of Bohr's work and thought enter into this reconstruction. We recognize an early and persistent uneasiness about the use of ordinary mechanical forces in atomic theory and a serious attempt to cope with Lorentz's statistical mechanics of free electrons, Langevin's electron theory of magnetism, and Planck's solution to black body radiation. Bohr spent six months in Cambridge with J. J. Thomson in hopes of acquiring new inspiration for studies on the electron theory of metals; he spent four months in Manchester with Rutherford with the intention of learning something about radioactivity but came away rather with a quantized version of Rutherford's atom.

Emphasized in the analysis are the crucial Rutherford memorandum of June/July 1912, the importance of C. G. Darwin's paper on the absorption and scattering of alpha particles, and Bohr's struggles with and eventual solution of the problem of mechanical (and to a lesser extent radiative) instability by positing external rings and stabilization of the orbit (selecting a quantum condition) by extramechanical fiat—while invoking ordinary mechanics for properties of the atom other than stability. In the last two parts of the 1913 trilogy we discover claims (galore) and trouble (more) as Bohr undertakes to work out the details for the dissociation temperature of $H_2$, the absence of infrared absorption bands for $O_2$, the periodic law of atomic volumes of elements, and other problems of atomic structure. Judicious it was of Bohr to concentrate on the question of chemical evidence, thus consciously avoiding (at first) the inscrutable, complex spectra and (almost) dismissing J. W. Nicholson's successes with spectroscopic evidence as mere numerology. Later he was concerned with models for spectral emission, ionization, and stationary states, and even managed to derive the Balmer formula.

The Heilbron-Kuhn paper raises old and new issues and settles some of them. The message which comes through most clearly is that Bohr's theory of the hydrogen atom was formulated as the result of his stubborn preoccupation with certain problems that grew out of his studies on the electron theory of metals. These problems ultimately served to focus Bohr's attention on the question of bound electrons as related to the problems of atomic structure, and this prepared his mind for the perception of a unique quantized model for the constitution of the atom. Thus Bohr's sound physical intuition allowed him to exploit ordinary mechanics in the service of his unmechanical model of the atom and to divorce mechanical from optical frequencies.

Commendable and informative as Heilbron and Kuhn's analysis may be, this subject is too alive and challenging for it to discourage future historians from sooner or later offering revised or alternative interpretations. More important for the future of the new journal, with its focused directives, is that this paper incidentally raises various general problems of considerable importance to historians of science. I would like to mention some of them.

It is most encouraging to discover that, even in a highly technical paper such as this one, the authors have managed to portray certain characteristics of Bohr's approach to physics without inserting "biography" or distracting from their larger objective. Thus within the context of analysis we readily recognize Bohr's gregarious and unruffled disposition, his slow, cautious, and repetitious style of refining ideas through conversation (even as monologue), his reliance on models, his sense for legitimate approximation, and his manner of criticizing the

work of others while holding in tension and resolute persistence to his own half-solved problems.

We also have in this paper an engaging illustration of basic differences in the interpretation of what happened historically. Here our historians of science have reconstructed, with unique documents in hand, one of the great accomplishments of physics; but in doing so they have provided an answer at variance (in some essential points) with the recollections of the man who did the actual work. In this case, the historians have set the discoverer straight—historically speaking—where tricks of the memory and certain retrospective overemphases are suspected. Such convincing evidence suggests that ex post facto oral interviews be examined carefully for the myths that scientists can perpetuate about their own work.

It should be mentioned, finally, that Heilbron and Kuhn make no attempt here to explore the 19th-century roots of the problem. That, of course, would be an incredibly difficult assignment. When the time period dealt with is so restricted, however, it remains to be seen whether the kind of analysis they have provided contributes more to our historical understanding than would, for example, a reprinting of the Bohr trilogy accompanied by an introductory essay, the crucial manuscript materials, and comprehensive historical notes. In fact, it might be said that the only effective preparation for reading Heilbron and Kuhn's paper is to study at least the three papers of Bohr and one or more versions of the famous "Rutherford Memorandum."

Space does not permit comment on other excellent papers in this volume except to call attention to a most perceptive and informative 60-page article on the origins of Lorentz's theory of electrons in relation to the concept of electromagnetic field. Its author, Tetu Hirosige, traces the process of formation of Lorentz's theory of electrons and shows that Lorentz's fundamental achievement in the development of electromagnetic theory is the separation of the electromagnetic field from matter, which renders the field an independent physical reality. Here again we discover that Lorentz was able to cast his ideas into the mature form of the theory of electrons and shape his microscopic views of the structure of matter and the concept of the electromagnetic field after having solved a number of specific problems which have lost their importance in present-day doctrines. This, in its recognition of the cardinal historical importance of issues significant in the scientific cognition of Lorentz's time, is internal history at its best. Thus Hirosige's paper is an elegant demonstration of how the limitations of 19th-century physics were dealt with and indeed were built into the new physics of the 20th century—how Maxwellian and Continental electrodynamics and the hypothesis of a stationary ether figured in relation to the several stages of development of Lorentz's theory of electrons. This theory prepared the way for a theoretical explanation of the Zeeman effect, the rise of elementary particle theory, electrical conductivity in metals as a stimulus for solid state physics, and the development of relativity theory.

There is considerable evidence, as this volume attests, of recent rapid growth in the history of the physical sciences in the post-Scientific-Revolution period. A new specialized journal, such as this one, which aspires to wide readership and high scholarly standards, deserves above all to be read and discussed by historians of science and scientists. It should be of interest as well to historians more accustomed to the nonscientific aspects of history. It would be of considerable value, in future volumes, to consciously work and strive ever so much more toward literary models that are drawn from historical rather than from scientific practice. Even scientists, I suggest, would welcome that.

ERWIN N. HIEBERT
*Department of the History of Science, University of Wisconsin, Madison*

## Personal Correspondence

**Rutherford and Boltwood.** Letters on Radioactivity. LAWRENCE BADASH, Ed. Yale University Press, New Haven, Conn., 1969. xxii + 378 pp., illus. $12.50. Yale Studies in the History of Sciences and Medicine, No. 4.

It is with a very pleasant sense of increasing personal involvement that one reads the correspondence in which Ernest Rutherford and B. B. Boltwood revealed, and to a significant extent developed, their warm friendship in the 20 years following 1904.

"This volume," as Badash notes, "is neither a history of radioactivity nor a biography of Rutherford or Boltwood. Rather, it consists of the source materials upon which such works are built." A number of the letters, especially certain of those of the first half-dozen years, are indeed important for the history of radioactivity. Readers interested in pursuing this history will be further indebted to Badash for his references relating these letters to the immediately appropriate published scientific literature (which constitutes the primary source material). It may simply be noted that the correspondence, particularly that from Rutherford, also constitutes a source for other specialized histories, such as that of atomic structure.

But the Rutherford-Boltwood correspondence may be recommended to a wider audience, largely because it seems to serve more as a primary source in the genre of biography and in providing general background material. Thus it happens that the personalities of Rutherford and Boltwood emerge to breathe life into the correspondence when their letters touch upon such features as Boltwood's isolation in the scientific hinterland at Yale (leading him even to "sometimes feel doubts as to whether it is really worth while working nights and Sundays"), his recuperative summer retreats to Munich ("beer beer glorious beer"), the relative virtues of chemistry and physics (Boltwood teasingly addresses Rutherford as "my dear friend and *chemist*" upon the awarding of the 1908 Nobel Prize in Chemistry, to which Rutherford replies, "I was very startled at my transformation at first but afterwards saw that it was quite in accord with the disintegration theory"), and above all when they consider the work and character of their scientific colleagues.

William Ramsay was the deserving target for much of the penetrating but not malicious wit of Rutherford and Boltwood. Rutherfood offers this "account of the Dublin Meeting of the B[ritish] A[ssociation] and of the troubles of that greatest of chemists whose names is sung through all parts of the earth":

> The ball opened with a paper by Ramsay on the atomic weights of the emanations based on holes in the periodic classification. . . . I got up & poked fun at his ar-