Book Reviews

New Turnings

Reappraisals of the Scientific Revolution. DAVID C. LINDBERG and ROBERT S. WESTMAN, Eds. Cambridge University Press, New York, 1990. xxviii, 551 pp., illus. $59.50; paper, $22.95.

The discipline of the history of science is in a state of flux as a variety of methodologies and interpretations vie for dominance. Since the emergence of modern science in the 16th and 17th centuries—that is, the Scientific Revolution—is central to the discipline, it was inevitable that it would be subject to reassessment. When David Lindberg and Robert Westman conceived *Reappraisals of the Scientific Revolution* nearly a decade ago, they sought to provide new "coherent organizing principles" for research and an overview for teaching. They recognize that their volume does not offer a comprehensive synthesis and reappraisal, since the field itself does not agree on its first principles. Nonetheless, as all good scholarship does, many of the 13 papers do present reappraisals of particular areas.

The traditional focus of the Scientific Revolution has been the revolution in astronomy inaugurated by Copernicus when he set the earth in motion about the sun. This had enormous consequences: the development of classical mechanics and celestial dynamics at the hands of Galileo and Newton; the mathematization of nature; the demise of Aristotelian natural philosophy and the rise of the mechanical philosophy. Few would deny that science and its place in society had changed radically between the publication of Copernicus's *De revolutionibus* in 1543 and Newton's *Principia* in 1687. Yet there is no consensus on the nature and causes of those changes.

In the 1920s and 1930s Edwin A. Burtt and Alexandre Koyré set forth what is still the prevailing interpretation, though it has since been modified and elaborated. They held that the Scientific Revolution involved a new set of metaphysical assumptions that allowed for the mathematization of nature. The essential element of their interpretation is that it explained the Scientific Revolution as a sequence of conceptual transformations and not as a series of empirical discoveries. It is in this most general form, positing a conceptual revolution, that the Burtt-Koyré thesis has guided research in the field for about half a century.

Gary Hatfield in the longest essay in the volume, "Metaphysics and the new science," directly confronts the Burtt-Koyré thesis that there was a common metaphysical foundation in the mathematization of nature and finds it wanting. He rejects as ahistorical Burtt and Koyré's conception of metaphysics as unquestioned, nonempirical assumptions and adopts instead the classical definition of metaphysics as "first philosophy," or the study of being itself. After a thorough analysis of the role of metaphysics in the work of Copernicus, Galileo, Kepler, and Descartes, he concludes that the latter two were legitimate metaphysicians (though of very different sorts), whereas the former were simply mathematical scientists unconcerned with metaphysics.

There are problems with Hatfield's approach. This becomes apparent when he subsequently adds Newton to the mathematical camp of Copernicus and Galileo, for Newton did in fact have an explicitly formulated metaphysics underlying his mathematical physics. The real issue, however, is not whether the mathematical scientists of the Scientific Revolution possessed a common metaphysics in the classical sense, but whether they possessed any common conceptual framework. Virtually no one any longer accepts the original formulation of the Burtt-Koyré thesis. At several points Hatfield suggests that the philosophical foundation for the new mathematical sciences may lie within the nature of mathematical science itself, but he does not pursue this insight. I strongly suspect that looking to epistemology and beliefs in the efficacy and certainty of mathematical knowledge rather than to classical metaphysics would be a more fruitful approach.

In any case, I believe that the book opens with too much emphasis on the Burtt-Koyré thesis. The Scientific Revolution was a far more complex historical event than the Copernican Revolution and the rise of the mathematical sciences, which were what that thesis was designed to explain. There is in the first place the turn to observation, experiment, and collecting and away from the Scholastic concern with texts and authorities. In the second place there is the changing social structure of science. There was a vast increase in the numbers of scientists and "practioners" (cartographers, instrument-makers, navigators, and so on), and the consequent creation of institutions and networks for communication and cooperation such as scientific societies, journals, and observatories. A single, philosophical explanation is unlikely to account for a historical phenomenon of such broad scope. The editors could have contributed further to a future reappraisal had they more fully delineated the various aspects of the Scientific Revolution that contemporary scholars agree must be accounted for in any history of that revolution, even if they cannot agree on a comprehensive explanation.

In one of the most original papers in the book William Ashworth treats the development of natural history from the mid-16th to the mid-17th centuries. He argues that modern historians have ignored and distorted much of the natural history of that century. Rather than being concerned with physiology, physical description, and taxonomy—as in modern botany and zoology—natural historians of the period were concerned with determining the associations of plants and animals with history, mythology, etymology, stars, and whatever. Ashworth terms this approach "emblematic natural history," which he characterizes by "the belief that every kind of thing in the cosmos has myriad meanings" and connections to everything else (p. 312). These meanings were discovered primarily by interpreting images, symbols, and texts and not nature. This world view of the late Renaissance is familiar to historians from Kepler's attack on Robert Fludd's espousal of similar ideas (described earlier in the volume by Brian Copenhaver in his paper "Natural magic, hermetism, and occultism in early modern science"). Ashworth marks the demise of this approach with Joannes Johnston's *Natural History* (1650) and Thomas Brown's *Pseudodoxia epidemica* (1646). His paper enriches our understanding of the turn to nature in the Scientific Revolution and shows how this movement became dominant only in its last phase.

John Gascoigne offers a genuine reappraisal and new synthesis of the role of the universities in the Scientific Revolution. Historians have accepted the judgment of participants in the Scientific Revolution that the universities were scholastic backwaters inimical to the new science. Gascoigne presents much evidence, drawn from a large number of localized studies, to demonstrate that the universities played an active role in the dissemination, if not the creation, of modern science. Utilizing the *Dictionary of Scientific Biography*, he has compiled revealing data on the universities and scientific careers. For example, almost all of these eminent scientists were university-educated, and nearly half held university positions.

Seventeenth-century natural philosophers devoted much of their energy (and rhetoric) to developing new scientific methodologies to replace the Aristotelian. Ernan McMullin approaches this development by examining the conception of knowledge that the participants in the revolution thought they were providing and how it changed through the course of the 17th century. He shows how the usual neat, modern categories of induction, deduction, and hypothetico-deduction break down when applied to such thinkers as Bacon and Descartes. Most of his long paper is devoted to the first half of the century. It would have been still more valuable had he presented a fuller account of the methods that emerged from the practice of the working scientists of the second half of the century, the Hookes, Boyles, Huygenses, and Mariottes.

The science of the Scientific Revolution, and especially the canonical core of astronomy, mechanics, and the mathematical sciences, gets shunted to the side in *Reappraisals*. Presumably the editors judged this aspect of the history to need only minimal reappraisal. Westman contributes a paper in which he endeavors to place the preface to Copernicus's *De revolutionibus* in the context of humanist rhetoric and patronage. In the last two papers, Michael Mahoney presents an interesting analysis of the changing criterion of intelligibility in 17th-century mathematics and Alan Gabbey argues convincingly that Newton's achievement in celestial mechanics has defined our conception of mechanics and blinded us to other contemporary revolutions in mechanics. Gabbey illustrates this with the rigid-body problem of determining the center of percussion, which was solved before Newton's *Principia* appeared and left untouched by him.

Reappraisals certainly rises above most collections of papers by diverse authors. My only disappointment comes from measuring it against the editors' original goal of providing a new synthesis for the Scientific Revolution. Finally, it should be noted that the volume contains nothing from the increasingly popular perspective of the social constructivists, the school that holds that science is socially constructed like any other body of knowledge and holds no privileged status. Such an approach demands a far more radical reappraisal than that contemplated here.

ALAN E. SHAPIRO
Program in History of Science and Technology, University of Minnesota, Minneapolis, MN 55455

Lives of Chemists

From Cologne to Chapel Hill. ERNEST L. ELIEL. American Chemical Society, Washington, DC, 1990. xxii, 138 pp., illus. $24.95. Profiles, Pathways, and Dreams: Autobiographies of Eminent Chemists.

The Right Place at the Right Time. JOHN D. ROBERTS. American Chemical Society, Washington, DC, 1990. xx, 299 pp., illus. $24.95. Profiles, Pathways, and Dreams: Autobiographies of Eminent Chemists.

From Design to Discovery. DONALD J. CRAM. American Chemical Society, Washington, DC, 1990. xxii, 146 pp., illus. $24.95. Profiles, Pathways, and Dreams: Autobiographies of Eminent Chemists.

These books are the first in a new series that is to comprise autobiographies of 22 prominent organic and other chemists. The series is edited by Jeffrey I. Seeman, who selected the contributors on the basis of "seminal contributions over a multi-decade career," with the overall intention of delineating the scientific development of organic chemistry during the past 30 to 40 years and of documenting the "hows and whys." The authors of these first three books include one Nobel Prize winner (Cram) and two who must be strong candidates for future Nobel Prizes.

All three books are valuable in two ways: they give condensed but integrated accounts of their authors' scientific contributions, and they tell something of the personal circumstances and attitudes that contributed to the authors' success. Their treatments of their scientific work will be useful not only to historians of chemistry but also to students wishing to learn the chemistry discussed.

The books nevertheless differ in character. Eliel was born in Germany, and his book includes his story of escape from Hitler's clutches. He mentions that his Ph.D. adviser, Harold Snyder of the University of Illinois, taught him the importance of clear and organized writing. Even though English is his adopted language, Eliel's book shows that this lesson was taken effectively to heart. Eliel's career has involved a larger component of public service, especially to the American Chemical Society, than those of the other two authors. I wish he had said more about that service; as it stands, his book concerns mainly his research in stereochemistry and authorship of an important book in that field.

Welcome in Roberts's book are the thumbnail sketches he gives of his coworkers, telling something about their personal characteristics and their subsequent careers. His book's title, *The Right Place at the Right Time*, is too modest, for there were other scientists in the same or similar places and times whose careers did not blossom as Roberts's did. His scientific presentations are not recommended for bedtime reading, simply because understanding the topics dealt with requires careful, rigorous thought. Roberts probed very deeply into the intricacies of nature. An interesting feature of the book is the considerable space Roberts devotes to his objections to Herbert C. Brown's position concerning solvolysis mechanisms and the participation of nonclassical carbocations as intermediates. Without reviving an old battle, let me observe that Roberts would not have given Brown so much attention had he not considered Brown's role in those debates to be significant.

Cram's book is remarkably short given his many important contributions. As the series editor remarks in a note at the beginning, the part of the book that deals with Cram's research in host-guest chemistry, which started in 1970 and was the basis of his Nobel award, is a "very serious description," whereas the account of all that went before is more anecdotal and detached. Cram's treatment of his host-guest research is a beautiful presentation of the ideas and the experiments involved, and is recommended to those who wish to learn about the concepts of host-guest chemistry. The early part of the book is terse but lucid, reading something like an integrated, illuminated (with structural formulas) abstract of the research performed. Actually, it is better than Cram's journal paper abstracts, which tend to bury the reader in detail. An attractive feature of the book is that Cram cites work by others that extended or corrected conclusions he had reached.

Surely these three mature, productive scientists have come to appreciate certain principles that pertain to the profitable conduct of research and to successful interaction with coworkers. But they don't overtly express much of that wisdom. To be sure, bits of it pop out as asides here and there. I think chapters concerned expressly with such matters would be desirable for the series.

During my years as editor of *Accounts of Chemical Research*, it was occasionally suggested at meetings of the editorial advisory board that *Accounts* should publish articles in which a famous scientist would recount the story of a major discovery, telling something of the thoughts and behavior of the people involved as well as the scientific tale. The suggestion, however, always met some resistance. Human memory of events long ago often requires mental reconstruction, and the plausible reconstructed story may subconsciously favor the rememberer. Some