Review of Stephen G. Brush, ed., History of Physics: Selected Reprints (College Park, Md.: American Association of Physics Teachers, 1988

By: Kenneth Caneva

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covered. He also notes that if we make the system large enough, then in some "practical" sense the introduction of this cut makes no predictive difference. However, Bell is not satisfied with this. Some of his reasons are what might be characterized as aesthetic, but he also stresses the fact that this essential reference to the observer creates a difficulty for cosmology. Where are we to place the observer in a theory that attempts to account for the universe as a whole?

In spite of his dissatisfaction with this aspect of orthodoxy, Bell nonetheless accepts one of the fundamental presuppositions that lie behind it. More than once, he quotes Bohr approvingly to the effect that no matter how nonclassical the phenomena, our description of the evidence and experiments must be classical. Thus, Bell talks of the need for "beables." In spite of the prominence that this notion has in Bell's writing, he provides very little analysis of it. Beables are "classical" and "are there" (p. 53); they "correspond to elements of reality," and "observeds and observers must be made out of beables" (p. 174). In spite of the lack of precise analysis, he does provide us with a concrete example: the "de Broglie/Bohm" theory, as Bell calls it—or B&B, as I shall call it. Here the division between quantum and classical is sharp. The quantum variables are represented by the wave function, the classical variables—or "beables"—by the instantaneous position of the localized particle. This position is always well defined and evolves deterministically. And as Bell insists at various points, B&B shows us that "vagueness, subjectivity and indeterminism are not forced on us by experimental facts, but by deliberate theoretical choice" (p. 160).

Bell's deployment of this theory is fascinating. He draws out some illuminating comparisons with the Everett many-worlds interpretation (see especially essays 11, 14, 15, and 20) and applies it to the delayed-choice double-slit experiment (essay 14). The treatment of the double-slit experiment is especially instructive. It makes clear that we are in no way forced to believe that we somehow make the past by our experimental choices.

In spite of all the good that comes from focusing on B&B, it does produce a certain blind spot in Bell's thinking. In B&B, as Bell points out, there is a gross nonlocality: local results depend on distant instrument settings. Further, as Bell has shown us, any "reasonable" hidden variable theory will be nonlocal *in some sense*. Indeed, we can even go so far as to say that quantum mechanics is nonlocal *in some sense*. The question is, In *what* sense? Bell conveys the impression (e.g., pp. 85–86) that the nonlocality will have to be of the sort embodied in B&B. But as Jon Jarrett has pointed out (e.g., *Nous,* 1984, *18*:569–589), this need not be so. In fact, what we find in quantum mechanics itself is that local results are *not* dependent on distant settings per se, even though for given settings local results depend on distant *results*.

There is no index to the collection, and that is a definite annoyance. Nonetheless, Bell is an engaging writer with a dry wit, and his work has had immeasurable influence on the philosophy of quantum mechanics. Philosophers and historians of physics, as well as philosophically minded scientists, will find this a welcome volume.

ALLEN STAIRS

Stephen G. Brush (Editor). *History of Physics: Selected Reprints.* 235 pp., figs. College Park, Md.: American Association of Physics Teachers, 1988. $16 (paper).

This anthology reprints in facsimile thirteen significant articles in the history of modern physics: on medieval mechanics, Galileo, and Newton (William Wallace, Stillman Drake, and I. B. Cohen); on the wave theory of light, Hans Oersted, and James Clerk Maxwell (Frank James, Robert C. Stauffer, and M. Norton Wise); on the kinetic theory (David Wilson); on Max Planck and Erwin Schrödinger (Martin Klein, Thomas Kuhn, and Linda Wessels); on atomic transmutation (Marjorie Malley); and on Einstein and special relativity (Gerald Holton and Arthur I. Miller). Even in such brief compass one finds "classical" pieces and old favorites, articles one never quite got around to reading, plus others undeservedly unfamiliar. Stephen Brush's selections nicely wed important matters of substance with a representative sampling of major historiographical issues. One should be thankful that what he includes is good and not lament the inevitable and obvious omissions. Brush also reprints his 1987 "Resource Letter" on the history of physics, which provides a rich annotated bibliography of 224 secondary sources, mostly on the nineteenth and twentieth centuries. This book will be useful to all interested historians except those with an improbably large collection of offprints and photocopies. Most selections are too advanced or specialized for all but a few undergraduates, though the collection is well designed to stimulate and expand the interests of advanced or graduate students in the history of science.

KENNETH L. CANEVA

William J. Danaher. *Insight in Chemistry.* viii + 150 pp., index. Lanham, Md./London: University Press of America, 1988. $24.25 (cloth); $12.25 (paper). (Photo-offset from typescript.)

This is a book that reveals a reviewer's ignorance. To do it justice would require a grounding in physics and chemistry, history and philosophy of science, and Thomist philosophy. The book aims to point up the unsolved problems in scientific methodology and to present the applicability of the views of the Canadian philosopher Bernard Lonergan, particularly those presented in his *Insight* (1958), which focuses on knowledge as a human attainment and explores the nonlogical steps that are part of the process of knowing. William Danaher's book presents these views with a particular focus on chemistry. The book begins by examining the positions of Imre Lakatos, Karl Popper, Paul Feyerabend, and Thomas Kuhn and also looks at attempts at unifying the sciences via reductionism and general systems theory. A brief survey of Greek thought is followed by a discussion of Robert Boyle's initiation of a "mechanical chemistry" that culminated in the work of John Dalton. The section ends with unsettling recent developments—isotopes, radioactivity, the resurgence of transmutation, and the chemical application of quantum mechanics.

The crucial role of insight in its various manifestations is proposed as the missing factor in our current understanding of both the method of science and the practice of chemistry. Without it we arrive at Feyerabend's famous "Anything goes." Although insight is nonlogical, it is nevertheless real, providing links between data and formulations and grasping relations in data prior to enunciation of a law. August Kekulé's daydream that led to his structural theory is used as the first detailed example.

Lonergan seeks an understanding of that interior process largely considered to be beyond comprehension—the flash of genius, the creative process. Unfortunately the next example, illustrating the step from insight to a generalized concept and using geometric isomerism, presents the wrong pair of isomers. Instead of the two forms of 1,2-dichloroethene, the 1,2- and 1,1-isomers, whose difference was understood before geometric isomerism was developed, are shown. The discussion of periodicity erroneously states that atomic and covalent radii increase across a row in the table. The noble gases are still described as virtually unreactive. In view of the small number of chemical examples discussed in the book, these flaws are discouraging for readers hoping for clarification as to what goes on when they practice chemistry.

Insight in Chemistry is welcome because few philosophers of science approach this field from the chemist's viewpoint (see the 1981 review "On the Philosophy of Chemistry" in *Philosophy Research Archives* by van Brakel and Vermeeren). Surprisingly, a major figure who does, Michael Polanyi, is mentioned only briefly by Danaher, and not in connection with his *Personal Knowledge,* which similarly emphasizes the subjective aspect of chemical methodology.

Granted these reservations, Danaher's approach is probably the only way for most chemists to be introduced to Lonergan's thought and thereby become more aware of the complexity of what goes on when they practice chemistry. The book leaves to a later date the question of how to implement Lonergan's insights. How knowledge of our inner process when practicing chemistry would advance the science of chemistry is not clarified. The recent denial, until endorphins were discovered in the brain, of the possibility of acupuncture anesthesia shows how mental preconceptions can lead to the dismissal of well-documented data.

THEODOR BENFEY

Ernst Mach. *The Principles of the Theory of Heat, Historically and Critically Elucidated.* Edited by **Brian McGuinness.** Introduction by **Martin J. Klein.** (Vienna Circle Collection, 17.) xxii + 456 pp., illus., bibl. index. Dordrecht: D. Reidel, 1987. Dfl 256, $124, £82.

This is the last of the major works of Ernst Mach (1838–1916) to appear in English translation. *The History and Root of the Principle of Conservation of Energy* of 1872, *The Science of Mechanics* of 1883, *The Analysis of Sensations* of 1886, and