metaphysical debate on the nature of light, are not mentioned at all. This omission is decisive for the tenor of the book, and is rooted in the author's ambiguous philosophy of science: it does not seem to be clear whether he is a positivist or an antipositivist. This indecision blunts the edge of most of his arguments.

The preface promises a nonwhiggish history of science, and the emphasis on debates and on the critical discussion of metaphysical theories points in this direction. However, the treatment of most of the early 19th-century scientists implies that in the author's opinion some of them were speculative and "muddled" (Dalton) whereas others carefully separated between the empirically testable part of a scientific theory and the speculative part, and these are the real heroes (Davy, Wollaston, Thomson, Brodie, and the like). A positivistic bias in a historian of science is legitimate, and there are many great 19th- and 20-century positivistic histories to prove how fruitful such contributions can be. What is misleading here is the undecidedness of the author. Wollaston is called a hard-core positivist, although the very passage by him quoted on page 24 casts doubt on this assessment. Dalton is severely criticized all through the book as a metaphysical atomist who, unlike the others, did not know how to separate solid science from the empty speculation. Yet later we read that Dalton was "unclear as to whether his theory was a theory of matter at all or simply a theory of chemical atoms" (p. 146). Davy, on the evidence of his last dialogue on atomism, and on the authority of Pearce Williams, is treated as a Boscovichean metaphysician who "rejected the atomic theory, because in a sense it was not hypothetical enough" (p. 26), while a few lines earlier he appears as an instrumentalist who used hypotheses freely, "taking them up and dropping them as he went along." We are told that Thomas Thomson and Wollaston supplied the experimental proof to the testable part of Dalton's theory, but it is not stated that their researches were motivated by a commitment to Dalton's anti-Newtonian atomism. There is no attempt to distinguish between the official, positivistic philosophy of science of the 19th century, to which every scientist (except Faraday) paid lip service, and the different metaphysics of the various actors.

The physicists' theories of matter and their contributions toward a dynamical chemistry are briefly treated in the chapter called "Some theories of matter." [This subject is excellently treated by Knight in a recent article, "Steps towards a dynamical chemistry," in *Ambix*, vol. 14, p. 179 (1967).] Although this chapter emphasizes Whewell's role in the anti-Daltonian tradition, the fascinating controversy between Whewell and Herschel on the theory of matter is omitted. Here we also find an introduction to the vortex atom.

The most instructive parts of the book are the chapters on "Chemical molecular theories" and on the "Atomic debates" in the Chemical Society of the 1850's. These two chapters could have easily supplied the material for a whole book. The first is a straightforward history of chemistry, discussing in detail the theories of Dalton, Gay-Lussac, Canizzaro, and others, emphasizing the differences and controversies between them. The other analyzes the clash between the positivist and antipositivist interpretations of the newly introduced chemical symbolism. The views of and debates between Williamson, Brodie, Maxwell, Tait, and others are little known and here sharply focused on.

The last chapter, called "The end of the affair," is less a summary than a program for a further volume. All in all, *Atoms and Elements* is an important contribution but not a definitive one, and it is now clear beyond doubt that the topic treated justifies at least three full-scale monographs covering the 19th century.

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Interactions

Elementary Particles and Their Currents. JEREMY BERNSTEIN. Freeman, San Francisco, 1968. xiv + 322 pp., illus. $12. A Series of Books in Physics.

Within the past three years a reorientation has occurred in elementary particle physics. From a general point of view the most interesting consequence of recent progress is the resurgence of belief in the general principles of relativistic quantum field theory. As recently as five years ago disenchantment with the latter was so great as to foster a widespread belief that field theory was completely wrong, or at best, of only allegorical significance.

Perhaps the most puzzling empirical fact of particle physics is the disparity of strength between the strong, electromagnetic, and weak interactions (leaving aside the much weaker gravitational forces). Efforts to construct a unified theory of these interactions have always failed. While such a theory remains to be found, hopeful steps in this direction have been made. The decisive idea was the proposal of M. Gell-Mann that the operators for generalized weak and electromagnetic current densities of the hadrons (short for strongly interacting particles) possess a simple and elegant algebraic structure. The current densities in question carry not only electromagnetic currents but quantities such as isospin and strangeness. Strictly speaking this (Lie algebra) structure implies no commitment about the perplexing problem of whether some particles are more elementary than others. Nevertheless, the simplest interpretation of the situation is that three elementary "quark" fields exist.

Application of the "current algebra" technique has solved many previously unapproachable problems, an outstanding example being the calculation of the strength of the effective pseudovector current in neutron beta decay. Many new relations have been derived and experimentally verified for processes involving low-energy pions. These calculations make use of the *PCAC* hypothesis (Goldberger-Treiman relation), which relates the lack of conservation of the pseudovector current to the existence of a massive pion field operator.

These developments have been described with clarity and depth by Jeremy Bernstein. Although some very important advances concerning high-energy limits have not been included, the book is very contemporary.

The development of the subject matter is inductive but not reckless, leaving the reader with the (correct) impression that there is considerable flexibility remaining in the foundations of the subject. An especially attractive feature of the book is that many delicate conceptual points are carefully gone into without conveying an impression of encyclopedic heaviness. As could be expected, the price is somewhat high for the advanced graduate students who comprise the most likely readers of the book.

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