law and the Rutherford-Bohr model of the atom to the Heisenberg and Schrödinger formulations of quantum mechanics. Later, brief discussions of such topics as linear and angular momentum are given, and approximation methods are outlined. The treatment of angular momentum is particularly sketchy, with not even a mention of Clebsch-Gordan coefficients. Applications are given to atomic problems involving one or more electrons, including the interaction of electrons with the electromagnetic field. Finally, there are sections on the classical and quantum theory of radiation and on the Dirac theory of the electron.

The book is clearly written and most of the applications are well-chosen. Unfortunately, either the number of topics treated is too large, or the book is too small. The result is that a number of topics are not gone into deeply enough for my taste. But the student may be encouraged to look for further details elsewhere (perhaps in the forthcoming Volume 3).

From the foreword to Volume 2, it is apparent that this volume owes more to G. Leibfried and W. Brenig than to Sauter. It is a pity that their names do not appear on the cover with the names of Becker and Sauter. De Teissier's translation is generally good.

**The Atomic Adventure.** Its Political and Technical Aspects. By Bertrand Goldschmidt. Transl. from French by Peter Beer. 259 pp. (Pergamon, Oxford) Macmillan, New York, 1964. Paper $4.50.
*Reviewed by L. Marton, National Bureau of Standards.*

The literature abounds in semi-popular books on atomic energy and the use of it, and until now the one which I liked best was Allibone's. I was not acquainted with the original French version of Goldschmidt's book, but I must congratulate Pergamon Press and the Macmillan Company for releasing a translation in English. It is not that the technical information is very much different from other similar presentations, but that it is written from a different viewpoint. As the subtitle indicates, it lays more emphasis on the political aspects than previous books which I have read, and at the same time does not neglect the technical aspects. Another rather important characteristic of this book is that it represents, contrary to all other books which I have seen, the French viewpoint.

The French viewpoint is manifested in two different aspects. One is the emphasis on the early French accomplishments in the discovery of fission, and all the circumstances surrounding it. Almost all textbooks and other publications devote a few lines to the contributions of Joliot-Curie and his wife, as well as some of the other French contributors of the same time. These contributions are much better presented here and more space is devoted to them; however, not an undue amount. Fortunately, the writer is very objective and thoroughly familiar with his subject, having been one of the contributors ever since the initiation of nuclear work through its development. A second aspect of the French viewpoint is that he explains very lucidly the recent work leading to the French nuclear program and nuclear armament. This I hadn't seen before, and the presentation certainly helps to understand what were the considerations leading to the present intensive effort toward possession of nuclear and hydrogen bombs.

The presentation is not only lucid, but also as objective as it can be under the circumstances. The author has apparently definite western sympathies, which do not prevent him from sketching very adequately the efforts of Soviet physicists. His remarks on the work done in Soviet Russia as compared with the US effort make very good reading. The translation is excellent, and I can recommend the book very warmly.

**Anaxagoras and the Birth of Scientific Method.** By Daniel E. Gershenson and Daniel A. Greenberg. 63 pp. Blaisdell, New York, 1964. Paper $1.45.
*Reviewed by David A. Katcher, Institute for Defense Analyses.*

Philosophers like order and scientists like explanation and if you reverse or confuse the priorities you can get into trouble. I fear this is what has happened in this little book. An attempt has been made by a team comprising a classical scholar and a

theoretical physicist to fit Anaxagoras into the role of prophet of scientific method. This is an exciting possibility, given the span of two thousand years over which influence—or prognostication—must hold; but it proves, on reading, more likely a misunderstanding—if not of Anaxagoras, then of scientific method. It could possibly be of both.

Anaxagoras was a teacher of Pericles and it was he who "brought" philosophy to the Athenians. Perhaps more important, for the purpose and the meaning of this book, he employed both observation (including demonstration) and logical analysis in his scientific inquiry and he is generally given credit for this though the great philosophers who followed him found dependence on the latter more fruitful and satisfying.

This brief, well-printed paperbound book, with an Introduction by Ernest Nagel, contains the conclusions only of "Anaxagoras and the Birth of Physics", a much larger three-part compendium by the same authors, which led them to what they present here. But since this small volume is without the backup, one sees only the conclusions. Proof, under these circumstances, is not to be expected but plausibility is, and it is on these terms one must examine the argument.

There are ten chapters; each one deals with a particular scientific or philosophic topic. In each of these the authors connect what Anaxagoras thought with what we know now and thus often imply relation, if not prophecy. Of course no causal connection is stated or to be inferred but if caution about jumping to conclusions is voiced in the main work, it is notably absent here. And I read the authors' implication throughout that the relation of Anaxagoras' ancient theories to modern thinking is one of concept, not of words.

For example: In their chapter, "The Constitution of Matter," Gershenson and Greenberg explain that Anaxagoras used both "careful and meticulous observations" and "the newly formulated methods of logical analysis" both "important and distinct methods, each of which was undergoing separate development in

his day." They state that "it was he who first demanded that observation *and* logic join hands in natural philosophy . . . that Anaxagoras never allowed his physics to fall wholly into the realm of abstraction and fantasy, or to be found entirely by the appearances perceived by the senses."

Well and good and proper for a credo even today. The question is how this demand was met and whether indeed it led Anaxagoras to concepts which are not only similar in sound, but also in meaning. Anaxagoras, for example, conceived of infinitesimals that were not too far (in size at least) from those we know today. The question is whether this conception approached (if you will pardon the expression) today's meaning. Here is a résumé of the argument: Observation (of the infinite variety of nature and its "never-ending change") led Anaxagoras to a construct in which everything is infinitely divisible and everything contains at least some of each element, its nature being determined by what element in the mix predominated. And to allow for other conditions (such as stability) the authors say:

> The only way however that an infinite variety of stable entities can exist in a finite object is for the entities to be *infinitesimal in size, because an infinite number of entities* can be contained in a finite volume only if they are infinitely small. Anaxagoras realized that this is so and was thus led to postulate explicitly that the basic units of matter—the fundamental building blocks out of which all objects are made—are infinitesimal in size.

Then, explaining it was well known that an infinite number of points could not make an object of finite size, and that an infinite number of finite objects would occupy an infinite volume, the authors go on to say:

> The entities Anaxagoras called infinitely small were infinitesimal in precisely the sense in which the word has been used since the seventeenth century; they were magnitudes whose measure is larger than zero but smaller than any arbitrarily small number. Anaxagoras was to the best of our knowledge the first to introduce infinitesimals into a physical theory.

This is the same straining which associates Democritus' atoms with ours. They are related in name not in concept; they are the children of logic, not of experiment. In fact the authors even seem to "admit" this in the sentence which follows immediately—

> It might be added that the difficulties which he and his successors encountered when using these new quantities were in no small measure responsible for the complete abandonment of infinitesimals in science and in mathematics for some two thousand years after his time.

I do not wish to belabor this point but this example of labeling the ancient and the modern positions and then assuming by hindsight that Anaxagoras *could* have meant what connects them occurs throughout the book. If Anaxagoras really had officiated at the birth of scientific method perhaps we would, today, have had the experience of where it might lead us.

There was science before there was scientific method, and it is unfair to Anaxagoras to dim his lustre as a natural philosopher, as an observer and as an experimenter by indicating he anticipated modern concepts over a vast range of subjects when it is so highly improbable.

**Atomic Collision Processes.** Conf. Proc. (University College, London, July 1963). M. R. C. McDowell, ed. 1165 pp. (North-Holland, Amsterdam) Interscience, New York, 1964. $38.50.
*Reviewed by C. E. Kuyatt, National Bureau of Standards.*

The enormous growth of research on atomic collisions in the last decade is amply demonstrated by the size of this volume, which contains the complete proceedings of the Third International Conference on the Physics of Electronic and Atomic Collisions, held at University College, London, from July 22 to 26, 1963. Nearly all of the prominent groups in the field, both theoretical and experimental, are represented among 140 papers.

Nine review papers were given at the conference and all are reproduced in full: "The Present State of the Study of Atomic Collisions" by H. S. W. Massey, "The Excitation