In sum, this elementary treatise of Prof. Bocheński is a little masterpiece. There is no branch of learning, scientific or humanistic, into which methodology does not enter. Here is a specific contribution to the unity of knowledge.

F. I. G. RAWLINS

THEORY FOR EXPERIMENTALISTS

The Physics of Elementary Particles

By H. Muirhead. Pp. xv+737. (London and New York: Pergamon Press, Ltd., 1965.) 140*s*. net.

EXPERIMENTAL workers in elementary particle physics are almost always conscious of never having been able to devote the time they would have wished to mastering the basic theory of the subject. This is partly due to the inadequacy of the typical first degree course, which does not bring them to the stage where they can readily progress naturally to an understanding of the theory without the help and stimulus of formal postgraduate courses. Happily, these latter courses are now becoming more and more common. Also, in such a competitive and rapidly moving field where the student is invariably working in a fairly large team, there is a tendency for many students to be involved immediately in the development of advanced techniques and, at an early stage, to make an immediate contribution to an often complicated experiment, the choice of experiments being determined by the more senior members of the team.

It is therefore an event of great interest when a comprehensive treatise, written by an experimentalist for experimentalists, is published. It will be hoped that here is a book which can be used as a basis for postgraduate courses, and as a reference book by the students and indeed by their mentors. How far does Dr. Muirhead's book meet these expectations? As may be expected from the sheer size, it could certainly be called comprehensive. In addition to dealing with topics with which the fresh research student will be unfamiliar, an excellent résumé of the special theory of relativity is given and also the Euler-Lagrange equation and Hamilton's equations are derived starting from the Principle of Least Action. The bold statement of this principle, as the starting point of dynamics without further discussion, illustrates one of my main criticisms of the treatment. Other examples of an unstated axiomatic approach in which physical requirements follow from the mathematical formalism instead of determining that formalism are "Thus the invariance of the Lagrangian under gauge transformation of the first kind can lead to charge conservation", and "The linearity of the space also implies the principle of superposition. . . . This properly is of great importance in quantum mechanics". How different from Dirac! The principle of superposition is the physical reason for choosing the mathematical formalism of linear vector spaces.

Of the more difficult, less familiar parts of the theory, the author's stated intention to keep mathematics as simple as possible has not, despite some sacrifice of mathematical elegance, made for easy reading, and most experimental readers will have to work hard to master the subject. I have a slight feeling that an apparently more demanding, but more elegant approach may have been easier for the reader. This is not to imply that any effort made by the student will not be amply rewarded. I have learnt much from this book, not without some effort; the conservation of energy implies a minimum expenditure of effort to reach a given height, and free airline tickets are not easy to come by. To counteract the criticisms made above, the merits of the book should be clearly stated. Not only are there many excellent parts (Chapter 6, for example), but also the completeness of the treatment offers an excellent reference to the whole subject. Many parts are sufficiently self-contained to make for easy reference to, and brushing up of, particular topics. The book is relatively free from typographical errors, considering the size. A second edition could remove the more glaring and irritating of these and also the few examples of confusing English.

All in all, Dr. Muirhead is to be admired and congratulated on the industry and knowledge which have added such a useful volume to the literature.

E. H. BELLAMY

MODERN GAS DYNAMICS

Atomic Theory of Gas Dynamics

By John W. Bond, Jr., Kenneth M. Watson and Jasper A. Welch, Jr. (Addison-Wesley Series in Aerospace Science.) Pp. x+518. (Reading, Mass., and London: Addison-Wesley Publishing Company, Inc., 1965.) 136*s*.

IT is almost certain that a review of *Atomic Theory of Gas Dynamics* will betray, by its criticisms, the allegiance of the reviewer, for it is still usual to identify oneself by exhibiting a label of some kind, 'aerodynamicist' or 'physicist' or 'chemist' or 'applied mathematician', for example, even though such labels no longer define the occupation and interests of their owners with any degree of precision. Indeed, the book by Bond, Watson and Welch provides an illustration of the necessity nowadays for a good measure of expertise in all the disciplines mentioned here, since they have become so closely interwoven as a result of the exigencies arising, principally, from flight through the atmosphere at super- and hypersonic speeds, although, to be sure, the subject matter has many applications in other fields. The thirteen chapter headings will perhaps illustrate the point; they are, in order: "Thermodynamic Properties of a Gas"; "Shock Hydrodynamics"; "Continuum Hydrodynamics"; "Atomic and Molecular Physics"; "Equation of State"; "Kinetic Theory of Gases"; "General Theory of Transport Processes and Hydrodynamics"; "Dissociation and Ionization in a Gas"; "Kinetic Theory of Transport Processes in Multi-component Gases"; "Radiation Transport Theory"; "Opacity"; "Radiation Transport Applications"; and, finally, "Shock-Front Structure".

It is quite clearly not possible, within the compass of only five hundred or so pages, to satisfy all of the people all of the time where such a wide variety of topics is concerned. The specialist practitioner in one or other of the foregoing arts is almost sure to find some omission or imprecision in a book of this kind which will upset him, and it is sometimes necessary to exercise a more-than-average degree of tolerance in order to avoid criticizing the authors unfairly. Indeed it would be difficult to criticize those parts of the book which deal with the more physical aspects of the problem. The description of a wide variety of particle interactions and their cross-sections and of the associated rate processes constitutes a most useful and readable contribution to the subject. The same is true of the later chapters, which concentrate primarily on the problems arising in radiating gases, although, inevitably, the rapid advances being made in this area must leave the information contained therein rather dated. From my point of view, then, the exercise of tolerance was not necessary here. A mild application was required for the discussions of kinetic theory, since I felt that these were rather disjointed and would have benefited from a more unified treatment. This is especially true of the derivation of the equations of change from the Boltzmann equation. It is possible to carry this through with a very high degree of generality without ever entering into detailed discussions of the collision terms in the latter equation and without any implied restriction to binary collision processes, or implied approximation if ternary and higher-order collisions actually are involved. A matter of rather more importance is the quite unnecessary confusion of Δ, δ and d operators which