severely practical interest in low-temperature phenomena. For his benefit the graphs and tables, though expressed in the metric system, are given auxiliary scales in more familiar units (temperatures in degrees Rankine, thermal conductivities in B.T.U./ft. hr.°R, and so on). A. H. Cooke

ORBITALS IN ATOMS AND MOLECULES

Orbitals in Atoms and Molecules

By Chr. Klixbüll Jørgensen. Pp. v+162. (London: Academic Press, Inc. (London), Ltd.; New York: Academic Press, Inc., 1962.) 35*s*.

THIS volume attempts to bring together so far as possible the treatment of electronic configurations in atoms, molecules and ions in crystals. This is a task which has not been attempted at such a high level before and it is very lucky indeed that Dr. Jørgensen has been persuaded to publish this expansion of his lecture course.

The treatment begins with a discussion of the configurations of spherical systems and can only serve as a reminder and introductory chapter for those who already know something of the subject. The treatment of the origin of the term schemes for many-electron atoms is very compact and makes an excellent introduction to a subject which previously has been very difficult to get into. (The magnificent book by Condon and Shortley will always be necessary but is just a little frightening to the beginner.) After this introduction via atomic systems in full spherical symmetry, the problem of octahedral symmetry is dealt with in detail as an example of what happens when the symmetry is degraded from spherical. The means of constructing the lowest molecular orbitals for systems of this symmetry are discussed and the origin and use of variable crystal field splitting diagrams is explained. Particularly notable is a well-balanced chapter on the concept of electro-negativity in chemical bonding. This concept has perhaps been at one and the same time the most valuable and most perplexing one in the chemistry of inorganic solids, and many of us will find his discussion useful. It is still a long way from easy for a physicist to get at the core of the concept, but Jørgensen at least poses some of the questions which crowd, ill-formulated but insistent, into one's mind when dealing with 'ionicity'. Discussion of spin-orbit coupling effects serves to complete the formal discussions of the terms required in spectral analysis and then all the terms are brought together in a discussion of the energy-levels of crystals and of rare earth and five-*f* elements.

The book is written in a refreshing style, as is often the case with the first publication of a series of lectures. I feel sure it will run to a second edition and that that second edition will be expanded in a number of respects. I particularly hope the index will be expanded.

To sum up, then. This book is rather strictly about its title. It does not seek to teach the fundamentals of quantum mechanics and indeed relies on a good deal of background knowledge both of solids and of the spectroscopy of atomic and molecular systems. I am sure the book will be very useful to a wide group of physical chemists and of solid-state physicists. W. M. Lomer

ELEMENTARY PARTICLES

An Introduction to Elementary Particles

By W. S. C. Williams. (Pure and Applied Physics: a Series of Monographs and Textbooks, Vol. 12.) Pp. ix+406. (New York: Academic Press, Inc.; London: Academic Press, Inc. (London), 1961.) 88*s*.

NO field of physics has undergone more rapid and widespread development in the past decade than that of the so-called 'elementary' particles, and, as a result of this development, one is now led to ask: Which particles can, if any, be meaningfully termed 'elementary'? This monograph, while not answering this question, does set out to show us some of the reasons for asking it, and deals with the necessary theoretical background to an understanding of particle physics. Experimental results are included mainly as supporting evidence for theoretical predictions, or as evidence from which a theory of the phenomenon could be developed.

The book is concerned with the subject up to about mid-1959—what might be termed as the 'pre-higher-pion-resonances-and-Pomeranchuk-theorem-era'. In some respects this (with hind sight not available to prospective authors) is a pity because a considerable wealth of new and exciting experimental and theoretical material, involving strong interactions, has come to light in the intervening period and the last real excitement in this book is the non-conservation of parity (1956).

Much of the subject-matter relates to some of the most complex concepts in modern physics and the author's aim is to introduce us to these in a logical manner. The word 'introduction' in the title certainly does not apply to the basic theoretical ideas involved, for example, relativistic field theory and quantum mechanics, and a good grounding in mathematical physics and a knowledge of these theoretical aspects will be of advantage to the student coming to study this book. In writing it, the author is at once faced with a dilemma: on one hand, the pure theorist will prefer a basically theoretical approach to everything, while on the other, the experimentalist may only wish to know in what respects his experiment is likely to influence the theory and why it does so. In facing the dilemma, the author has written essentially for experimental physicists and they will find much in his book for which to be grateful. It is commended to graduate students who propose to undertake research in this field, since one of its main aims is to lead them to think of the theoretical implications of their experiments and to reduce their possible reluctance to resort to more theoretical papers dealing with these implications. Theoretical physicists will also find it valuable as a reference book since it is a good review of the field.

The book is well written in an easy (not over-conversational) style. There are parts which might have been shortened or re-arranged. For example, those parts dealing with Pauli spin matrices and developments leading to the two-neutrino hypothesis might have been better had all the material been gathered together in one chapter. As it is, one deals with pertinent aspects in Chapters 2, 9, 10 and 11 and not until p. 265 is the interrelation between the Pauli and γ matrices clearly stated. In Chapter 7, dealing with π-mesons, there is a slight lack of balance, indicated by the inclusion in considerable detail of pion photo-production, and by the exclusion of any discussion on pion production in nucleon–nuclear collisions and the role of isobars in determining the pion energy spectrum. An opportunity was missed in Chapter 8 to illustrate the various types of nucleon-nucleon scattering experiments (including the production of a beam of longitudinally polarized nucleons) by three-dimensional sketches. There is a somewhat odd selection of references to experimental work in connexion with the charged K-meson (para. 12.7); for example, while three references are given enabling one to see how the lifetime is measured, those relating to the 'considerable evidence' as to how a zero spin assignment was ascribed appear to be missing. While the Lamb–Retherford shift is described in Chapter 9, it is not named as such until Chapter 13.

If one were asked to single out one chapter as an example of an excellent blend of theory and experiment, then I would select that on beta decay. One point here, however, is not clear, and that is (p. 278) why the intermediate 'boson would have to be very much heavier than the proton'.