Book Reviews

Nuclear Reactions

Direct Nuclear Reactions. G. R. SATCHLER. Clarendon (Oxford University Press), New York, 1983. xxii, 834 pp., illus. $110. The International Series of Monographs on Physics, 68.

Direct Nuclear Reactions. NORMAN K. GLENDENNING. Academic Press, New York, 1983. xviii, 378 pp., illus. $62.

It has been well over a decade since the publication of a book summarizing the subject of direct reactions in nuclear physics. Now, two books on the subject have appeared, both with almost up-to-date expositions of the methods of quantum scattering theory and the application of the theory to nuclear physics. The two books treat methods at a high mathematical level, although they generally have excellent discussions of the results from an intuitive point of view. In addition, both books are illustrated with many figures showing results of calculations and comparisons with the data. Of the many techniques and models in the field, both books emphasize those that have enhanced our knowledge of nuclear structure.

The bombardment of atomic nuclei with light nuclei is an important source of information concerning many nuclear properties. Direct reactions are those whose interaction times are comparable to the transit times of the projectiles across the nucleus. These interaction times are thus short, usually limiting the projectile interaction to only a few degrees of freedom of the system of nucleons that make up the nucleus. Direct reactions also take place at high enough bombarding energy that the projectile is unlikely to amalgamate with the target nucleus.

Since nuclear reactions most often involve the scattering of particles, both books begin by discussing scattering theory, using an optical potential to describe the elastic scattering of nucleons from nuclei. The books stress the methods commonly used in practical computation of observable quantities, such as angular distributions of particles emitted during the reaction. Techniques are presented that are amenable to efficient computation by digital computers. Satchler has also included some important cases in which analytic forms have given insight into a reaction process that might have been overlooked had the same quantity been calculated by a computer.

The books go on to discuss the distorted-wave approximation of nuclear reactions and its applications to inelastic scattering and particle-transfer reactions. This very useful approximation takes into account the refraction and absorption of the initial and final waves of the particles during the reaction process. Both authors then discuss the natural extension of the first-order theory to a treatment using coupled channels. Here, processes involving more than a single direct step may be calculated but at the expense of solving sets of coupled equations. Satchler gives an extensive analysis of the modern extension of this theory to coupled reaction channels. In this theory the nucleons of the projectile and target are partitioned in several ways and then coupled in a set of equations. Since the different systems are not orthogonal as is the case in the inelastic coupled-equation theories, theoretical and calculational difficulties emerge. Some of the usual approximations are no longer valid and comparison with the data is more obscure. Satchler discusses this topic well and points out the subtleties and pitfalls the unwary may fall into. Researchers engaged in this area will find the complete coverage of it particularly useful.

The two authors diverge at this point in their choice of topics. Satchler assigns a full chapter to the symmetry properties of the transition amplitudes and another to polarization phenomena. The latter is particularly useful since observable spin quantities are becoming increasingly important as a tool in distinguishing between different theories. Glendenning, on the other hand, devotes two chapters to particular aspects of collisions between heavy ions, a subject of great interest to many laboratories. Neither author treats theories of macroscopic or hydrodynamical reactions in heavy ions.

Although each book reflects the interests and tastes of its author, the volume by Satchler presents a more balanced view of direct-reaction theories. The book contains a clear and detailed presentation of the methods, echoing the Satchler's papers. The reference lis the end of each chapter, though complete, are invaluable as a sta point for further investigations. Glen ning's book treats fewer topics with detail and discussion, and it tend emphasize the work of the author an collaborators. Nevertheless, Glen ning gives a concise overview of field, and his book would be of int to researchers in heavy-ion physics.

Both books are expensive and will their primary use in libraries, alth the specialist will profit from investi them.

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Particle Physics

Concepts of Particle Physics. Vol. 1. K GOTTFRIED and VICTOR F. WEISSKOPF. endon (Oxford University Press), New Y 1984. xvi, 189 pp., illus. $22.50.

The volume under review summa the basic theory of modern particle p ics without using sophisticated ma matics; a second volume (not yet lished) will cover the same material deeper and more sophisticated level. pedagogic value of this multiple co age is obvious. Most of the stan physics curriculums are taught in way.

The present volume is aimed at vanced undergraduates and begin graduate students. A knowledge of q tum mechanics and some acquaint with atomic and nuclear physics is sumed, though a lightning revie these fields is provided in the firs pages. Particle physics itself is there compressed into about a hundred pa One would think that such a con treatment would be impossible un the book were either a marshma popularization without much conte a mathematical treatise without m explanation. Amazingly, the book is ther.

It is an extremely efficient discus of the modern understanding of str weak, and electromagnetic interacti Right from the start leptons, quarks, vector bosons are identified as the fu mental particles. Meson and ba spectroscopy is presented in consi able detail from the combinatoric four quark flavors (later six) posses spin, orbital angular momentum, color. Color gluon dynamics is give