Books

Elementary Theory of Angular Momentum. By M. E. Rose. 248 pp. John Wiley & Sons, Inc., New York, 1957. $10.00. *Reviewed by B. T. Feld, Massachusetts Institute of Technology.*

A thorough knowledge of the quantum mechanical properties of angular momentum—the effects of its combinatorial properties on the nature of the stationary states of complex systems, on the angular and energy distributions and correlations in reactions, on the transition and decay properties of nonstationary systems, etc.—has become an indispensable member, if not the core, in the arsenal of the present-day experimentalist. Unfortunately, this is a subject usually rather inadequately covered in the standard texts on Elementary Quantum Mechanics and in most graduate courses at this level. Consequently, the graduate student of experimental leaning, if he does not go beyond such elementary courses, is frequently inadequately prepared to cope with the interpretation of the increasingly precise and detailed experiments made possible by the phenomenal improvements in technique of the past decade.

For the experimentalist desirous of bridging this gap the task is rendered more difficult by the scarcity of books and review articles on a sufficiently elementary, yet complete, level to introduce him into the field. Almost everybody, theorists included, who is today conversant with the manipulation of the Clebsch-Gordan coefficients first acquired this skill through study of the classic text of Condon and Shortley (*Theory of Atomic Spectra*, Cambridge University Press, 1935); but this book is hard sledding and the subject matter no longer commands the universal interest among physicists that it did twenty years ago. The very short monograph of Feenberg and Pake (*Notes on the Quantum Theory of Angular Momentum*, Addison-Wesley Publishing Company, 1953) contains applications to subjects of greater current interest; but it is all too brief.

Thus, the student who wishes to become acquainted with the elegant generalizations by Racah to systems containing more than two angular momenta and their applications in the spectra of complex atoms, with the pioneering applications by Wigner of the combinatorial properties of angular momenta to the systematics of light nuclei, with the recent triumphs of the shell model, in all of its ramifications, to nuclear spectroscopy is forced to rely almost entirely on the periodical literature, or on brief summaries of techniques given in texts on more general subjects. Since the treatments in these sources are usually far from elementary and certainly not uniform in approach, the reader is usually confused, frequently discouraged, and all-too-often ends by deciding to leave these complicated questions of interpretation to the "theoretikers".

This book will contribute greatly to the alleviation of the situation described above. The first half develops the general theory of the coupling of two or more angular momenta and the properties of tensor operators. The derivations and proofs are detailed and complete and, in some of the more important proofs, alternative approaches are developed. The second half contains a variety of applications mainly, but not exclusively, to nuclear structure and reactions. Three appendices give the properties and some tables of Clebsch-Gordan and Racah coefficients, the Rotation Matrices, and the Spherical Harmonics. These contain much useful material, but the inclusion of more extensive tables would have added much to the usefulness of this work.

In general the discussion is physically motivated and clearly developed. The examples are all interesting and cover a good fraction of the main fields of current research. However, it would have been perhaps pedagogically useful to include some simple examples, in which the extremely elegant and general techniques are not needed and sometimes even superfluous. Indeed, a thorough treatment of what, adopting the standards of this text, might be called "Elementary Theory of Angular Momentum" would still be a useful addition to the literature. Nevertheless, this is a badly needed and long awaited work, and one which is likely to broaden the horizons of many a physicist.

Causality and Chance in Modern Physics. By David Bohm. 170 pp. D. Van Nostrand Co., Inc., Princeton, N. J., 1957. $5.00. *Reviewed by R. B. Lindsay, Brown University.*

The theory of quantum mechanics has been well established for the past thirty years. Its great success in introducing order and predictability into atomic physics has made its position in modern physics a secure one in spite of the difficulties the extension to field theory and nuclear structure have encountered. Since the quantum mechanical concepts and postulates marked a radical departure from those of classical physics, it is not surprising that there has been a continuing interest in the logical structure of the theory; this applies not only to the philosophers of science but to physicists themselves. Any new and strange formalism is bound to stimulate a desire to interpret it in terms of macroscopic experience. Ever since the formulation of Heisenberg's indeterminacy principle the accepted interpretation of the quantum mechanical state function has been in probability terms, with the implication that the behavior of atomic systems follows statistical rather than deterministic rules. Since statistical reasoning has for a long time been acceptable in physical theorizing and has had notable success in providing a reasonable basis for such parts of classical physics as thermodynamics, this situation would hardly seem to call for raised eyebrows, were

it not for the fact that most atomic physicists believe that there is something much more fundamental about the use of statistics in quantum mechanics than in the classical kinetic theory. In the latter application it appears as a convenient device, whereas in the former case it is considered as a necessity: in common parlance chance irrevocably replaces causality in quantum mechanics and there is nothing that human beings can do save accept the situation gracefully.

This probability interpretation, though strongly held and expressed by physicists like Bohr and Born, is not universally accepted. It is fair to say that L. de Broglie has never liked it and Schrödinger both in his early work on wave mechanics and in his more recent writings has done his best to avoid the necessity of accepting it. David Bohm, the author of the volume under review, in a series of papers extending over the past five years has presented an interesting program for restoring determinism to quantum physics. His purpose in the present volume is to give an essentially nonanalytical review of his point of view. This is coupled with a general discussion of the philosophy of physics, particularly with reference to the nature of physical law and theory in the light of the ideas of causality, determinism, and chance.

After a brief preliminary chapter on the general ideas of causality and chance the author proceeds to study the conceptual structure of classical physics with reference to both particle and field theories. He then examines the quantum theory and its statistical interpretation. This is followed by a discussion of possible alternative interpretations which would maintain the deterministic point of view. There is a descriptive presentation of a specific scheme differing indeed from the author's earlier "hidden parameter" approach, which has been adversely criticized in the literature. Professor Bohm makes what seems to the reviewer to be the perfectly valid point that the objections which have been raised against his method are really based on the assumption that the indeterminacy principle is not merely a logical conclusion from present-day quantum mechanics but a basically necessary adjunct to any more general theory that might replace quantum mechanics in the attempt, for example, to get a better understanding of phenomena occurring in regions of order less than 10^{-13} cm. This would appear to be a gratuitous assumption even though it is strongly suggested by our present ways of doing and describing experiments in the microscopic domain.

Bohm's ideas deserve careful study if only to insure that we do not succumb to a subtle dogmatism which rather easily arises when a theory has been conspicuously successful and makes many people feel as if the whole "truth" must somehow inhere in it. At the same time there are features of Bohm's general ideas which this reviewer finds hard to understand. Throughout most of the book there appears to be an unfortunate identification of causality with determinism, though in his discussion of what he calls "indeterminate mechanism" the author does seem to introduce a distinction. But he unfortunately fails to clear up a confusion which has bedeviled the whole subject in the minds of the general public for a long time in spite of the efforts of men like Cassirer and Margenau to set things straight. Bohm's principle of the "qualitative infinity of nature", which he develops at some length in his final chapter, suggests that there is no foreseeable limit to the creation of new experience by scientists and this most open-minded physicists will accept; but when this also is extended to imply the necessity for an unlimited number of different concepts in the description of experience, one begins to have doubts about what is to become of science as a method of human understanding in this process. Infinity is a dangerous concept for scientists and must be handled with care.

Through the stimulus it will provide for the thoughtful investigation of some of the most searching questions of modern physical science this book serves a very useful purpose and will be read with profit by both physicists and philosophers.

Non-Stable Stars: Internat'l Astronomical Union Symp. No. 3 (Dublin, Sept. 1955). Edited by George H. Herbig. 200 pp. Cambridge U. Press, New York, 1957. $5.50. *Reviewed by C. C. Kiess, National Bureau of Standards*

Nonstable stars are those whose luminosities and spectra fluctuate in no predictable manner. Although for some decades individual stars have been known to display erratic behavior, yet it is only within the past decade that enough of these objects have been recognized to justify grouping them together for comparative analysis and further investigation. By the late summer of 1956 the information concerning them was sufficient to warrant a get-together of workers, in this new field of astrophysics, on the occasion of the Ninth General Assembly of the International Astronomical Union at Dublin. The results of their discussions now appear in a collection of 23 papers by leading astronomers from eight countries, of the third symposium to be sponsored by the IAU.

The papers fall into six categories or groups. In the first there are six papers dealing with dwarf stars of low luminosity, having spectra belonging to the later classes, but with superimposed emission features. These stars occur in association with bright and dark nebulae and are believed to be young stars, in their early childhood, just emerged from the nebular matrix. Another set of six papers forms the second group, dealing with hot stars of low luminosity, with novae, and with planetary nebulae. Two papers in the third group are devoted to instability in hot stars of the early spectral classes, while two in the fourth group discuss instability in the regular variable stars of the later spectral classes. The five papers of the fifth group describe the phenomena of instability in binary systems, particularly in close systems in which tidal forces distort the shapes of the stars and induce ejection of matter from