versions of the Copenhagen interpretation of quantum mechanics is extremely polemical, though it must be admitted that among the passages which he criticizes are some that are undoubtedly obscure. Actually, in spite of violent dissent regarding wave-particle dualism, Landé agrees with some fundamental elements in Bohr's position, particularly his insistence that quantum mechanics is concerned with the results obtained by different experimental arrangements, and his comment "There is no quantum world."[2] Perhaps both Landé, in his program of demystification, and his opponents, who maintain that the key to the mystery is complementarity, have underestimated the strangeness of microscopic reality which quantum mechanics has revealed.

I am grateful to Howard Stein for discussions of a number of the crucial points in this review.

References

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Molecular interactions

MOLECULAR BEAMS, Vol. X of Advances in Chemical Physics. John Ross, ed. 419 pp. Interscience, New York, 1966.

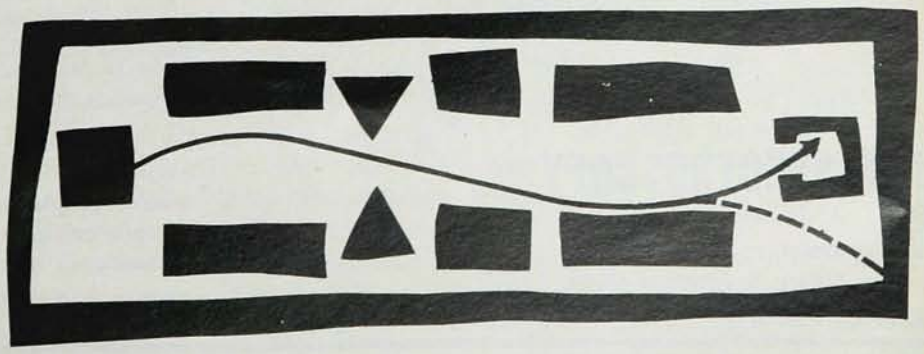
by Kurt E. Shuler

The present volume of Advances in Chemical Physics is devoted entirely to the subject of molecular beams. This idea of focusing a given volume of these series variously entitled: Advances in, Progress in, Studies in, Reviews of, etc., on a particular subject is an excellent one which deserves a much wider practice. What is particularly important in producing a successful focused review volume is the careful choice of an editor and his careful choice of authors with the concomitant selection of live topics in the forefront of research.

Molecular Beams is a success on all counts. The editor, Professor John Ross of Brown University, is one of the pioneer workers in the field of molecular beams and has made important contributions to the subject. The authors are all active and productive workers in the area of their contribution and must certainly be counted among the real experts in their specialty. The subject matters of the individual articles are well chosen for their importance and timeliness. Finally, the articles are well written; they are informative, detailed and authoritative.

The articles in this volume deal with current molecular-beam research in the general area of chemical physics. As mentioned in the preface, the common theme throughout the volume is *molecular interactions*. In principle, molecular-beam experiments involving such interactions provide one of the best, and certainly one of the most direct means for measuring molecular properties including cross sections for chemical reactions. In practice, as can be seen from a study of the articles in this volume, we are now firmly on the road of carrying out such measurements and converting what were once only Gedanken-experiments into data and graphs.

The menu of this delectable and nourishing meal is as follows: As an appetizer, B. Bederson and E. J. Robinson of New York University discuss the use of molecular beams in the measurement of atomic polarizabilities. I. Amdur and J. E. Jordan of MIT present a critically evaluated review of the work on elastic scattering of high-energy neutral beams for the determination of interaction potentials at small internuclear separation. This is followed by a chapter on quantum effects in elastic molecular scattering by R. Bernstein of the University of Wisconsin, which gives a detailed comparison between the classical and quantum results for various cases of inelastic scattering. Scattering in chemically reactive systems is discussed by Greene, Moursand and Ross of Brown University who show how their and other workers' results on the elastic scattering of chemically reactive species can be used to obtain information on inelastic reactive cross sections. E. E. Muschlitz of the University of Florida discusses the production and detection of molecular beams of electronically excited species and the measurement of elastic and inelastic cross sections of electronically excited metastable species in interactions with various neutral molecules. R. F. Stebbings of General Atomic, San Diego, presents a selective review of recent work on charge transfer, that is, elementary interactions involving the transfer of an electron between an ion and a neutral particle. This theme is continued and carried forward by C. F. Giese of the University of Chicago who discusses low-energy charge-transfer reactions and ion-molecular reactions in beams with particular reference to mass-spectroscopic measurements. As



a change of pace, the paper by Anderson, Andres and Fenn of Princeton University gives a welcome detailed discussion of the problems and promises (so far, alas, not yet fulfilled) of supersonic nozzle beams. Finally, for dessert, we have the thorough and critical review of D. Herschbach of Harvard on reactive scattering in molecular beams, including methods, results and interpretations with a useful table of chemical reactions studied so far in molecular beams and many references to the literature.

The reviewer recommends this volume most highly to his brethren in the chemical physics fraternity, as a valuable and thorough review of molecular beams and molecular scattering. It is also recommended to the physics tong (atomic and nuclear scattering subdivision) to show them that us chemists are finally catching up.

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The reviewer, who is a Senior Research Fellow at the National Bureau of Standards, has for years acted as a self-appointed missionary preaching the gospel of molecular beams in the study of chemical kinetics.

Thermodynamical instruction

METHODS OF THERMODYNAMICS. By Howard Reiss. 217 pp. Blaisdell, New York, 1965. $8.50.

PRINCIPLES OF GENERAL THERMODYNAMICS. By George N. Hatsopoulos and Joseph H. Keenan. 788 pp. Wiley, New York, 1965. $15.00.

by Stuart A. Rice

Despite the enormous number of textbooks dealing with thermodynamics, new books continuously come onto the market. In this process many very ordinary books are published, and only rarely does an outstanding work appear. It is my opinion that *Methods of Thermodynamics* by Howard Reiss is one of these outstanding contributions. The author has managed to treat the fundamental theorems of thermodynamics with a precision and vigor that is remarkable for its clarity and ease of comprehension. While there has been no compromise with accuracy, the text can be easily read by an undergraduate student. In this sense I disagree with the publisher's blurb, namely, I believe this book should be the primary text in a first course and not merely an auxiliary text for first year graduate students.

The subject matter of the book is conventional: The laws of thermodynamics, thermodynamic potentials, phase equilibria, surface phenomena and elastic phenomena, systems in gravitational and centrifugal fields, and stability theory. What is perhaps the finest feature of the text is the transparent manner in which the fundamentals are exposed and the careful attention paid to the avoidance of conceptual errors (for example, the treatment of virtual variations, of constraints, of the nature of the entropy function). I intend to recommend Reiss' book to all of my students and sincerely hope that it will be very widely used in the teaching of elementary thermodynamics.

Principles of General Thermodynamics by Hatsopoulos and Keenan is also a valuable contribution to the literature, but in a very different sense. This massive text attempts a rigorous formulation of thermodynamics using very careful definitions and with much greater than usual emphasis on the nature of work processes, the meaning of stable states, etc. The treatment is very extensive (there are 52 chapters) and includes discussions of flow phenomena, some statistical mechanics, some relativistic thermodynamics, and many other topics. There are two large subdivisions: Elementary Thermodynamics (chapters 1-30) and General Thermodynamics (chapters 31-52), with a division of material roughly in accord with the titles given. Since many of the arguments and definitions used are new, I cannot claim to have completely digested and appreciated all the material in the text. There are, of course, very strong links between the formulation given and the classical representations of thermodynamic theory, but there are also a number of significant differences in emphasis. In this sense the Hatsopoulos-Keenan monograph differs from that of Reiss. Whereas the great strength of the Reiss text is in the precise treatment of the conventional formalism of thermodynamics, the major virtue of the book by Hatsopoulos and Keenan is in the careful consideration of alternative and generalized fundamental concepts (for example, a different definition of heat) thereby demonstrating that despite its age, thermodynamics still serves as a stimulus to creative thinking.

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Partial differential equations

DIFFERENTIAL EQUATIONS OF APPLIED MATHEMATICS. By G. F. D. Duff and D. Naylor. 423 pp. Wiley, New York, 1966. $11.95

by George Weiss

Books on partial differential equations appear to be divided into two groups. The first includes recipe manuals which give the solution to a certain number of problems but allow little insight into the general theory. The second category includes books heavily loaded with classificatory properties of partial differential equations and existence proofs with few applications to provide any physical motivation. Neither type of book really suffices as an introduction to the subject for a beginning course in mathematical physics. It is a pleasure to report a text which comes close to being ideal from the pedagogic point of view, avoiding the recipe approach yet not slipping into unmotivated abstract complexities.

Considerable attention in this book is given to the three principal equations of mathematical physics—the heat and wave equations, and Laplace's equation. Nevertheless, the treatment of these special cases is given in enough generality so that extension to other problems should not be difficult. Liberal use is made of the delta function, introduced by the authors in a careful mathematical manner which does not obscure any of the techniques in its application. Worthy of particular mention is the chapter on spherical eigenfunctions which has the clearest exposition of the subject that I have seen, and the chapter on wave propagation in space which contains a good discussion of