

the crystal growers do not place sufficient reliance on thermodynamics, which they consider to be "the cornerstone for discussions on theories of crystal growth." This is one viewpoint that merits attention, and it is appropriate that it is discussed by authors who have established their credentials in the field, as is the case here. The thermodynamicist's viewpoint is carried from an early section specifically labeled "Thermodynamics of Crystal Growth" to other topics in the book, such as inorganic chemistry as related to transporting agents, a treatment of the vapor-crystal interface (which includes adsorption, nucleation, and surface diffusion) and a discussion of vapor transport processes (which includes vapor diffusion, vapor transport and sublimation). Inserted in the latter section is an unusually detailed treatment of "Stefan's flow." Consideration is given to both chemical and physical vapor growth processes.

Also treated in some detail, but with considerably less emphasis, are topics on crystallography (structural crystallography, crystal imperfections). Rounding out the general picture are discussions of gas-flow dynamics, sequential processes in crystal growth, and experimental procedures. The authors state that they have chosen to emphasize well-developed basic principles. Using this approach, they run the risk of duplicating material found in standard texts. On the issue of the application of thermodynamics, they have succeeded in bringing new perspective through specific application to topics of particular interest to crystal growers. On the topics of crystallography and experimental techniques, it is not so clear that a new viewpoint is offered. It is useful, however, to have collected in one volume these topics that are of interest to crystal growers.

With the authors' orientation towards thermodynamics, it is not surprising that they have discussed almost exclusively vapor-growth systems in which the chemistry involved is close to equilibrium. There is a related emphasis on closed tube, or "almost" closed tube, vapor-transport systems. It is in such systems, of course, that the thermodynamic approach is most useful. This has led the authors into a detailed discussion (16 pages) of the transport of nickel as nickel carbonyl and the transport of carbon with sulphur. The interest of crystal growers in these systems is questionable. There is a briefer discussion (5 pages) on the transport of gallium arsenide. Silicon is not mentioned, even though the authors recognize the heavy involvement of the electronics industry in crystal growth from the vapor. Another obvious omission is a discussion of reaction kinetics. It is certainly the authors' prerogative to

emphasize what they wish; a more appropriate title, however, could have been chosen. Readers who would be most interested in this book would have been more alerted to a title such as: "The Fundamentals of Near-Equilibrium Vapor Transport Systems."

Despite the somewhat puzzling idiosyncrasies of this book, one cannot argue with the viewpoint that a firm grasp of fundamentals is good preparation for experimental activity in crystal growth from the vapor. This book should prove to be of value to individuals entering the field, and will serve as a useful reference text for the more experienced experimentalists.

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Theory of Elementary Atomic and Molecular Processes in Gases

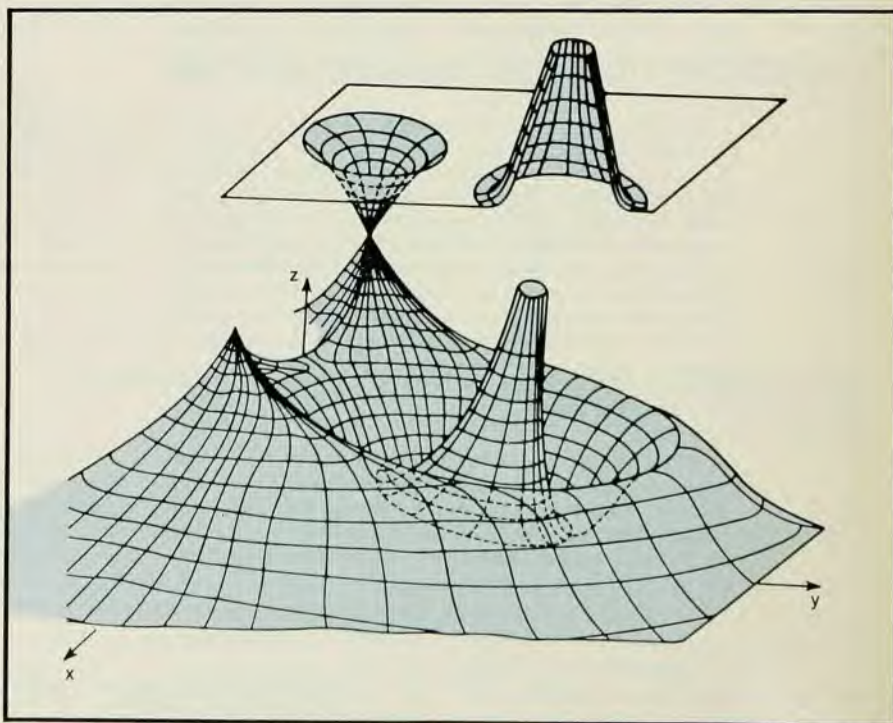
E. E. Nikitin
472 pp. Oxford U. P., New York, 1974.
\$42.50

Sometimes a book review in *PHYSICS TODAY* begins with "This is an excellent book." I could have made such a claim for *Theory of Elementary Atomic and Molecular Processes in Gases*, but now I shall go further: this may well become an important book. Rarely does one find such a clear and scholarly exposition, particularly of a field that nor-

mally lies beyond the level of conventional graduate courses. The book, in eight rather long chapters, covers a timely, fast-developing subject on the border between physical chemistry and physics, with a form of presentation that makes the material accessible to physicists and chemists alike.

Thorough understanding of the field of elementary reactions in gases is vital for anyone dealing with such device-oriented topics as gas lasers, plasmas and electrical discharges in gases. Evgenyi Nikitin's book is an ideal source from which any physicist can train himself in this subject almost to the level of the current research. Each topic is developed mathematically, and most important, each theory is discussed at length to expose its physical content and the limitations of its applicability. Nikitin makes extensive comparisons among alternative theories, shows how successive refinements have evolved, and unifies his book with frequent indications of the close relationships between theories that developed historically in different areas. Moreover each topic is illustrated clearly by examples of specific reaction systems.

The scope of the book reflects Nikitin's own range of interest, and the interests of his colleagues at the Institute of Chemical Physics at the Academy of Sciences, Moscow: exchange of translational, vibrational and electronic energy among colliding molecules; surface-crossing; the general theories of reaction including transition-state theory, statistical theory and diffusion theory;



Potential energy surface of the nonlinear H_3 system. This qualitative picture shows the rapid energy increase (within the saddle) due to Coulomb repulsion between nuclei. From the book.

the determination of effective potential surfaces and dynamics of particle motion on these surfaces, and the theories of dissociation (including "unimolecular reaction theory") and recombination.

The material is presented entirely in terms of the quantum-mechanical and classical-mechanical language learned by physical chemists; Nikitin never uses formal scattering theory or the alphabet of assorted scattering matrices. In this field, where one generally knows quite a lot about the potentials and the characteristic time scales of all the degrees of freedom, such an approach is easy to justify and has the advantage of making the material accessible to a broad audience. Although there have been important additions to the subject since 1970, when the Russian edition was published, there is remarkably little in the book that one would want to drop if it were revised for 1975.

If I were a physicist trying to enter an area such as fusion, atmospheric processes, laser isotope separation, or any other field that depends heavily on elementary atomic and molecular processes, I would use this book as my primary text. If the price were lower, I would encourage all my own students to go out and buy it as soon as possible. Apart from its high cost, every aspect of the book—style, range of material, physical insight, mathematical precision, aptness of topics, clarity of illustration and translation—argues for making it a standard part of every atomic-molecular physicist's library. It is truly in the tradition of the old Oxford University Press monographs, a scholarly yet entirely readable book that offers many insights to the skilled professional as well as a sound perspective to the intelligent novice.

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Statistical Thermodynamics, Vol. 2

A. Münster
841 pp. Academic, New York, 1974.
\$75.00

The title, *Statistical Thermodynamics*, as used here refers to the statistical mechanics of macroscopic systems in equilibrium, a subject to which mathematicians, physicists, and chemists have contributed. Detailed information on this subject has greatly increased in the past fifteen years through the application of experimental techniques that probe condensed phases at the atomic level, the development of theoretical methods (such as series expansions and the scaling hypothesis) to approximate many-body problems, the improved specification of atomic and molecular

interactions and the addition of some non-trivial theoretical models to the catalogue of exactly solved examples.

Such a rapid increase of information has stimulated the appearance of multi-author volumes on parts of the subject. This volume by Arnold Münster, professor of theoretical physical chemistry at the University of Frankfurt, goes directly counter to this trend. It and volume I, which appeared in 1969, constitute a 1500-page effort (with 400 figures) by a single author to present a comprehensive unified treatment of the subject. It is based on Münster's 1956 German-language text, and a major effort has been made to make it reflect current knowledge. It includes reference to work as recent as 1973, though the bulk of the text appears to have been completed by 1970.

Volume I contains a treatment of the general foundations of statistical mechanics and its application to the theory of gases. Volume II contains the theory of crystals and the theory of liquids. The chapter numbering continues from volume I and results are cited, frequently by equation number, from Volume I; that is, this volume is not self-contained. Parts of the treatment of the liquid state approach the level of separate monographs: There is a 260-page chapter on pure liquids and a 180-page chapter on liquid mixtures.

The presentation goes beyond a summary of results and opinions of the author on the prospects for improvements. Much of the theory is at the level of refined-mean-field theories and can be understood by the nonspecialist; there is frequent comparison with experimental results and discussion of the comparisons. Special features include a chapter on the vapor pressure curve and a chapter on electrolytes. There are treatments of solid solutions (where Münster has worked extensively), of magnetic critical points, of the dielectric properties of liquids and of the recent perturbation theories of liquids. There is a valuable treatment of light and x-ray scattering from condensed phases, in part based on Münster's own work; this is distributed over chapters on solids and liquids by subject rather than technique.

The two volumes contain no presentation of transport theory and nonequilibrium statistical mechanics. Some material on the time evolution of correlations in a condensed system is included through treatments of inelastic neutron scattering and of critical scattering. To my taste, the contributions of mathematical physics to statistical thermodynamics are skimmed, and work such as the establishment of the thermodynamic limit for Coulomb systems is not cited. The interest in tricritical phenomena and more-than-two component solutions came too late for inclu-

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