perimental results in terms of chemical reactions. A chapter by T. A. Litovitz and C. M. Davis complements that of Lamb by treating structural and shear relaxation processes in liquids, in which discussion of theory is accompanied by detailed comparison with experimental results. The last chapter, by J. Stuehr and E. Yeager, discusses the use of ultrasonic velocity and absorption measurements in providing information concerning the arrangement of matter in electrolytic solutions, emphasis being placed on ultrasonic relaxation effects in these solutions.

Typical of the volume is a profusion of graphs, diagrams, and tables which add a great deal to the presentation. References are appended to each chapter, and there are both author and subject indices for the entire volume. The book bears the mark of careful editing; where overlapping treatments occur, these appear to be intentional, and free (and helpful) use is made of cross-references among the six chapters. This volume constitutes an excellent, up-to-date, scholarly review of the use of ultrasonics in determining the properties of and the interactions between molecules of gases and liquids.

D. I. BOLEF
*Department of Physics, Washington University, St. Louis, Missouri*

## Recent Research in Marine Meteorology

**Physics of the Marine Atmosphere.** H. U. Roll. Academic Press, New York, 1965. 434 pp. Illus. $15.

This book provides an organized summary of recent research in marine meteorology. There is no comparable book, so this one will serve a useful purpose in permitting research scientists and students to survey efficiently many limited subjects within the broad field. Discussion of research covering about 600 papers and books is organized under observations, chemistry and electricity, wind field and sea surface, and distribution of temperature and humidity. The book represents an admirable piece of scholarly work, and the author's extensive contributions to marine meteorology qualify him uniquely for his task.

The best parts of Roll's book are those devoted to interpretations of observations of the wind, temperature, and humidity above the sea. References to all observations and interpretations relevant to these subjects are included, and all significant aspects are discussed.

The emphasis given to data is consistent with Roll's belief, stated in the final chapter, that greater understanding of the physics of the marine atmosphere is to be achieved through more and better data. If this means more and better *generalized* data, it seriously misses the mark, in my opinion. The critical data requirements arise from theory; they are for the instrumental capability and observations needed to answer certain specific questions.

Theoretical works are referred to in the book, but in most cases so briefly that the accounts are of little value. For example, the theories of surface wave generation of J. W. Miles, O. M. Phillips, and K. Hasselmann represent probably the most significant advance in the last decade in marine meteorology. Brief qualitative accounts of some aspects of these contributions are given, but the reader cannot learn the present state of the theory of wave generation from this book. At one point we read that "we shall abstain from going into detail but merely present the resulting formulae"; unfortunately, this reluctant brush characterizes the author's treatment of much theoretical material.

Roll's book fills the need for an organized summary of recent research in marine meteorology; the need is also great for another kind of book, a creative book that simplifies and unifies the subject, a book that is capable of infecting the reader with stimulating insights. Such a book should be organized around clear statements of the fundamental problems, and it should contain illuminating analyses of complex problems. It should draw sharp distinctions on the basis of quality of research and fertility of ideas, and its effect should be to prepare capable students to strike out enthusiastically on fruitful paths. It is disappointing to have to note that in marine meteorology, such a book has not yet been published.

ROBERT G. FLEAGLE
*Department of Atmospheric Sciences, University of Washington, Seattle*

## The Growth of Microbiology

**Three Centuries of Microbiology.** Hubert A. Lechevalier and Morris Solotorovsky. McGraw-Hill, New York, 1965. viii + 536 pp. Paper, $4.95.

The authors have "attempted to reconstruct the growth of microbiology, stressing the main lines of its development" by summarizing the work of Pasteur and Koch, and by outlining the development of knowledge in nine fields. Of these, seven are largely or exclusively concerned with the interrelation of microbiology and medical science, and two, "From soil microbiology to comparative biochemistry" and "Genetics," with what some call "basic microbiology." The themes are developed by the use of frequent and extensive quotations from the original literature, with orienting comments and interpretations by the authors serving as cement to bind the fragments into a logical and cohesive whole. Thumbnail biographical sketches of the major, and many of the minor, figures are generously interlarded in the text. These are replete with choice tidbits on the genealogy, disposition, character, financial circumstances, and sins (venial) of the protagonists.

If not considered as a critical contribution to the history of science, which it is not, the book for the most part is eminently successful. The authors have done a fine job in selecting the material to be quoted and in providing a smooth, readable text. They perhaps make value judgments too facilely and deal too superficially with complex individuals, but this is a book not to argue with but to enjoy. I spent as much time in the library as in the laboratory during my student days, but I was nevertheless introduced to papers somehow passed by or never pertinent to my work. It was a pleasure, for example, to read excerpts from Raulin's "Chemical studies on growth," or the cold, precise case histories of Reed and Carroll's human volunteers. It was amusing to learn that Behring and Höchst euchered Ehrlich out of his share of the royalties from diphtheria antitoxin, or that Erwin Smith's second wife was "strongly versed in Latin and Greek." The book should prove enjoyable to all microbiologists and to many laymen as well. It should be particularly valuable as a gift to the young enthusiast for whom any article not in the current issue of the *Proceedings of the National*

*Academy of Sciences* is already outdated.

Despite the book's overall excellence, the two chapters that treat nonmedical topics are weak. Beijerinck's contributions are certainly given inadequate treatment, and not a single line of Kluyver's work is quoted. The development of knowledge of alcoholic fermentation subsequent to Buchner's contribution, the key problem from which modern microbial biochemistry developed, is completely ignored. The prehistory of modern microbial genetics, starting with the controversy between pleomorphists and monomorphists and passing through the argument between the Darwinians and Lamarkians among the bacteriologists, is unmentioned. The names of important figures in general microbiology —T. W. Engelmann, Marjorie Stephenson, S. Orla-Jensen, C. B. van Niel, and E. G. Pringsheim, among others— are missing from the index. This criticism is not aimed at omissions; in my opinion the book would have been improved by more omissions— the two chapters in point. Though perhaps it is better as is, because some general microbiologist with damaged ego may feel compelled to repair the hiatus and present us with a companion volume.

SYDNEY C. RITTENBERG
*Department of Bacteriology, University of California, Los Angeles*

## Science Surveys Series

**Analysis and Synthesis of Linear Time-Variable Systems**. Allen R. Stubberud. University of California Press, Berkeley, 1964. viii + 108 pp. Illus. $4.75.

This book, the first in a series called *Science Surveys* prepared under the general editorship of Edwin F. Beckenbach (University of California, Los Angeles), is based on the Ph.D. dissertation of Allen R. Stubberud at the University. The principal results reported in the book appeared in 1962 and 1963 in journal articles by Stubberud. However the book is an integrated treatment and includes some background material.

The book is clearly written and easy to follow. The reader is presumed to have a working knowledge of elementary differential equations, which most engineering and science undergraduates do have. However, the actual application of the methods developed involves a substantial amount of arithmetic and calculations.

The emphasis is on preliminary synthesis, which in this instance consists of obtaining the analog computer diagram corresponding to a differential equation or weighting function. All initial conditions are assumed to be zero so that input-output relationships of systems are of primary concern. A key to the development of analysis and synthesis of linear systems is an algebra for treating arbitrary interconnections of such systems. Such an algebra is developed by the author. Among the possible subsystem or component representations, the author chose the single $n$th order differential equation relating input and output variables. Owing to the noncommutativity of linear time-varying differential operators, the problem of obtaining the overall, single differential equation relating the system input to the system output is computationally involved. The author's algebra systematizes manipulations of systems of equations corresponding to the subsystems. However, the arithmetic is still enormous.

In this book Stubberud does not consider the algebra for system interconnections when each subsystem is represented by a set of first-order, linear differential equations rather than a single high order linear differential equation. Using the alternative representation (W. R. Perkins, "Synthesis of interconnected linear time-varying systems," to be presented at the National Electronics Conferences, October 1965, Chicago, Ill.) results in a vast simplification of the algebra and arithmetic over the one used by Stubberud.

If one is forced to use the single $n$th order representation, then Stubberud's algebra is quite helpful, but if there is no pressing reason for this choice, the $n$ first-order representation should be used because much less computation is involved. Because the book contains other background material it should be worthwhile reading for students of system theory.

J. B. CRUZ, JR.
*Department of Electrical Engineering and Coordinated Science Laboratory, University of Illinois, Urbana*

## Astrophysics

**Dynamics of Stellar Systems**. K. F. Ogorodnikov. Translated from the Russian edition (Moscow, 1958) by J. B. Sykes. Arthur Beer, Translation Ed. Pergamon, New York, 1965. xii + 359 pp. Illus. $15.

The first half of *Dynamics of Stellar Systems* presents the classical material dealing with kinematics (velocity ellipsoids, velocity centroids, and the like), the Oort-Lindblad theory of galactic rotation, irregular forces, and integrals of the motion (with a discussion of isolating integrals). Students will find that this is a valuable treatment which complements other books on stellar dynamics. The second half is concerned wihh a number of dynamic problems and strongly reflects the author's approach to an understanding of the present structure of stellar systems. The book is not highly mathematical, and emphasis is placed on discussion of the physical concepts.

The so-called synthetic method is the foundation of Ogorodnikov's theory, and this begins with the assumption that there are strong relaxation mechanisms working in galaxies which lead to a statistically unique quasi-steady state. This mixing is assumed to be the result of the existence of a large number of star clouds in the mass range $10^5$ to $10^6$ suns, which constitute about 10 percent of the total mass of a galaxy. The author uses the hydrodynamic equations for a description of the dense inner regions of galaxies, with velocity dispersions obtained from the single-valued integrals of the motion. In this way closure of the hydrodynamic equations is formally obtained. The synthetic method combines the continuum and statistical approach to the problem.

Not all of those who work in the field of stellar dynamics will agree with some of the author's ideas and techniques—for example, some will be worried by such a large number of postulated massive star groups (and massive clouds). Others will express some concern over the use of the hydrodynamic equations without an examination of the magnitude of the next higher order moments of the Boltzmann equation. And it is not a strong test of any theory that agreement can be obtained with some observed luminosity profiles of galaxies.

If this book is used as a textbook,