technical language of the geologist which this reviewer found considerably difficult to follow. Such an article is almost unique in space literature and points out a field which obviously is going to be important not only in lunar exploration but in planetary exploration as well.

Moore and Greenwood in their article "Venus as an Astronautical Objective" argue that even though less is known about this planet than some others, it may yet be the first space-flight objective after the moon. All of the factual as well as speculative knowledge of Venus is carefully and interestingly reviewed. Similarly the following article by Hess on Mars as an astronautical objective covers the known facts about Mars as a planet, especially its atmosphere. Both articles indicate how sketchy our knowledge of these two nearest planetary neighbors of ours really is, and how necessary exploration of both by means of fully instrumented probes will be before manned flights can be undertaken. Newburn's article on Mercury, asteroids, major planets, and Pluto reviews the information on the remaining planets of the solar system. Manring considers the effects of interplanetary matter as well as means of detecting it in the next article.

"Structures of Carrier and Space Vehicles" by Alberi and Rosenkranz is an excellent and comprehensive survey of all aspects of this important technological problem. A very short survey of advanced nuclear and solar propulsion systems by Cooley serves to present the latest advances in this field. Similarly the last article on aspects of weightlessness by Campbell covers our present knowledge of this important factor in space flight.

As in the earlier two volumes, this latest one contains an excellent selection of topics, well written and emphasizing present knowledge and state of progress, attesting to the good judgment of the editor and his board of advisors.

The Third Law of Thermodynamics. By J. Wilks. 142 pp. Oxford U. Press, London & New York, 1961. 15s. *Reviewed by R. H. Asendorf, Hughes Research Laboratories.*

THIS book, the eighth in a series of monographs called the Oxford Library of the Physical Sciences, is generally descriptive and is designated as an introductory undergraduate text. It is intended primarily to give a comprehensive survey of the celebrated so-called Third Law of Thermodynamics and achieves its purpose well. Quoting from the introduction, the author says ". . . the Second Law merely postulates the *existence* of an entropy function, while the Third Law discusses its *behaviour*."

The author writes well and with assurance. The more mathematical parts of the book are the sections which deal with elementary statistical mechanics, and are very well presented. In broad outline, the book covers (not necessarily in this order) entropy and probability, statistics of a perfect gas, internal degrees of freedom, the third law and its statistical basis, nuclei and entropy, chemical equilibria, and the unattainability of absolute zero. The author covers a wide range of topics in physics and chemistry, particularly the study of phenomena near absolute zero; topics discussed include the behavior of orthopara hydrogen, liquid helium, magnetic cooling, the graphite-diamond transition, and others. The book contains 41 figures and is well documented with 112 references to the literature.

Physics of the Solar Chromosphere. By Richard N. Thomas and R. Grant Athay. Vol. 6 of Monographs and Texts in Physics and Astronomy, edited by R. E. Marshak. 422 pp. Interscience Publishers, Inc., New York, 1961. $15.50. *Reviewed by E. J. Öpik, University of Maryland.*

THE authors have published a great number of papers on the interpretation of chromospheric phenomena, especially those observed at the solar eclipse of 1952. The monograph summarizes and further develops these researches, making use also of work by others.

They are concerned only with the chromosphere, defined broadly as that part of the solar envelope comprised between photosphere and corona. The traditional concept of "reversing layer" is discarded, perhaps unfortunately; with the peculiar temperature distribution as described in the monograph, the concept could have been retained for the region "-500 km $\lesssim h \lesssim +500$ km" where the temperature is below that of the photosphere; in that case the chromosphere proper, from $+500$ to some 7000 km up, would be characterized by a temperature rising outwards from 6100 °K to values of the order of 5×10^4 deg K. The still undeciphered clue to the structure of the chromosphere and even the corona is seen in the spicules, jets of denser gas (magnetically contained?) intruding into the chromosphere from below with velocities of the order of 30 km/sec; they cover less than one percent of the solar surface, and are probably the source of chromospheric heating.

No attempt is made to trace the mechanism of the spicules nor of the source of heating. The treatment is restricted to the problems of radiative transfer and local equilibrium state of matter which is shown to depart considerably from local thermodynamic equilibrium, (L.T.E.) apparently as the result of mechanical heating. Of course, departures from L.T.E. in stellar atmospheres were known long ago and were termed "superexcitation" by H. N. Russell (whose name, however, is missing from the bibliography). The amount of detail in the treatment is contrasted by the large margin of uncertainty in the conclusions and proposed models; this, however, is the consequence of insufficiency of the observational data, and of an additional degree of freedom due to the spicules causing a deviation from spherically symmetric hydrostatic and radiative equilibrium which cannot yet be quantitatively assessed.

The book is written chiefly for specialists working in problems of stellar atmospheres. Even for them, reading is rendered unnecessarily difficult by the absence of a list of notations; instead of words, the text uses a great variety of mathematical symbols throughout, and the reader, if not of phenomenal memory, has to search for the only definition of a symbol, some 200 pages back from the passage he is just concerned with. Also, regular explanatory captions to figures and tables are completely missing, being substituted by symbols or other cryptic expressions, the meaning of which has to be found from dispersed portions of the text. This prevents an immediate access to the material; it is virtually impossible, even for a competent reader, to make direct use at inspection of the numerical data or formulae without a thorough study of the entire text, despite the straightforward nature of the data which could have been made easily accessible by a few simple captions. Confusing misprints in the very symbols often add to the difficulty.

Despite this, the monograph is an important contribution to the study of stellar atmospheres, especially from the standpoint of detailed balance in the distribution of the excited and ionized atomic states, their radiative output into discrete levels and continuum, with a non-zero source of mechanical energy which causes specific departures from local thermodynamic equilibrium without, however, departures from hydrostatic equilibrium being considered.

Advances in Catalysis and Related Subjects, Volume 12. D. D. Eley, P. W. Selwood, Paul B. Weisz, eds. 324 pp. Academic Press Inc., New York, 1960. $11.00. *Reviewed by Henry Wise, Stanford Research Institute.*

FOR twelve consecutive years, specialists in various fields of catalysis and related subjects have contributed to the *Advances*. Each volume has served both as a source book of scientific information and as a measure of scientific progress. As in the past, the editors have carefully balanced the six contributions contained in this volume. For the exploration of the physical properties of solid catalysts the reader is treated to an exposition of the application of magnetic resonance techniques (D. E. O'Reilly), and of the spectroscopy of the fine structure of x-ray absorption edges (R. A. Van Nordstrand). A more general review by D. J. C. Yates deals with the perturbations introduced into the solid surface as a result of physical adsorption, and the methods employed in the study of such phenomena. The empirical approach to an important and highly complex problem is demonstrated by Pines and Schaap in their chapter on "Base-Catalyzed Reactions of Hydrocarbons". The unique role of the carbanion intermediate is employed in the synthesis of mechanisms to explain the observed reaction products. The theoretical aspects of heterogeneous catalysis are presented in a chapter on "The Wave Mechanics of the Surface Bond in Chemisorption" by T. B. Grimley, and one on "The Electron Theory of Catalysis on Semiconductors" by Th. Wolkenstein. These two contributions differ widely in their approach. While one author attempts to apply molecular orbital theory to the problem of chemisorption on solids and points out the fundamental information yet lacking, the other erects a "building from which the scaffolding has not yet been removed". The foundation of this edifice is the concept that a chemisorbed particle may be treated as a structural defect of the semiconductor surface associated with localization of a free electron or hole. The qualitative conclusions derived from this theoretical development demonstrate the stimulating influence that the solid-state physicist has provided for a field of research which too long has been considered the province of the chemist.

An Introduction to Relativistic Quantum Field Theory. By Silvan S. Schweber. 905 pp. Row, Peterson and Co., Evanston, Ill., 1961. $13.75. *Reviewed by J. C. Polkinghorne, University of Cambridge.*

QUANTUM field theory displays a recurrent vitality which is the dismay of its obituary writers. Its birth was auspicious. Here was the formalism which synthesized waves and particles without a taint of paradox. In the late thirties, difficulties with infinities caused the subject to languish, until the postwar invention of covariant techniques of calculation and renormalization theory led to the triumphs of quantum electrodynamics. An inevitable aftermath of these triumphs was the appearance of several textbooks expounding them, among which Professor Schweber's earlier volume *Fields* has an honorable place. Since then, the discovery of the complex plane and the invention of dispersion relations have led to an even more widespread, feverish, and (so far) less completely successful activity, which continues to this day.

While the exploitation of these analytic methods is not complete and most of the problems of strong interactions theory remain unsolved, it is not inappropriate that a new crop of texts expounding these methods should begin to appear. The present volume serves two purposes: as a digest of the older ideas, and as an introduction to the new. It devotes most of its space to the former (the first 645 pages) and is understandably much more unreservedly successful in this part of its task.

Professor Schweber's treatment of field theory up to renormalization is very clear and thorough. This reviewer's only regret is that he only mentions in passing the use of counter-terms for charge renormalization. There is an excellent chapter discussing model theories such as those invented by Lee, and by Chew and Low, an important subject which has been missing from other texts. Altogether this part of the book forms a distinguished contribution to the exposition of field theory.

The account of modern developments begins with a