minimize one or another parameter of the "mission" (i.e., the trajectory and the vehicle). As a result, new and interesting classes of problems present themselves, which justify a distinction from celestial mechanics.

After a discussion of basic astronomical notions, including Kepler's laws, and some fundamental properties of the solar system, particularly of the minor planets and comets, the major portion of the book is devoted to orbit determination, both from the analytical and observational points of view, including a thorough discussion of perturbative forces and their effects. The analytical and computational treatment is unusually complete, but would have made easier reading if the geometric aspects had been brought out more strongly. The book concludes with a description of interplanetary orbits, including a very illuminating treatment of the "re-entry corridor". The appendices include comprehensive glossaries of terms and symbols, a bibliography of 175 items, and two sets of interesting and relevant problems.

The approach of the authors seems strongly influenced by that of the observational astronomers. For many practical applications (including actual orbit determination and computation) this is probably most appropriate, since it enables the solution of something more than textbook problems. On the other hand, it does lead in a number of instances to apparent complications, at least from the notational point of view, which a reader trained in another discipline may find distasteful and not essential for understanding the basic facts.

This book fills an important gap in the astronautical literature, and can serve as a useful reference even in those areas where the introductory features may be heavy.

Planets, Stars, and Galaxies. An Introduction to Astronomy. By Stuart J. Inglis. 474 pp. John Wiley and Sons, Inc., New York, 1961. $6.75. *Reviewed by Otto Struve, National Radio Astronomy Observatory, Green Bank, West Virginia.*

IN a recent review in *The Observatory* (December, 1960) G. A. Wilkins deplores the almost simultaneous publication of three elementary textbooks on astronomy by three different publishers. Stuart Inglis' new book covers essentially the same material as do the three earlier texts, and it is not unreasonable to extend to it Mr. Wilkins' criticism.

At the same time it is also reasonable to recognize that the demand for descriptive books on astronomy is very great and is rapidly increasing, that new discoveries and theories come at a much faster rate than they did a decade or so ago, and that every teacher has developed his own style of presentation and tends to emphasize certain aspects of astronomy that may not be adequately covered by another author.

Inglis' book is a simple, straightforward, and enjoyable account of descriptive astronomy which should appeal not only to students of the liberal arts in a small college (for whom it was written), but also to a large number of amateurs and other laymen who have no prior knowledge of astronomy and mathematics.

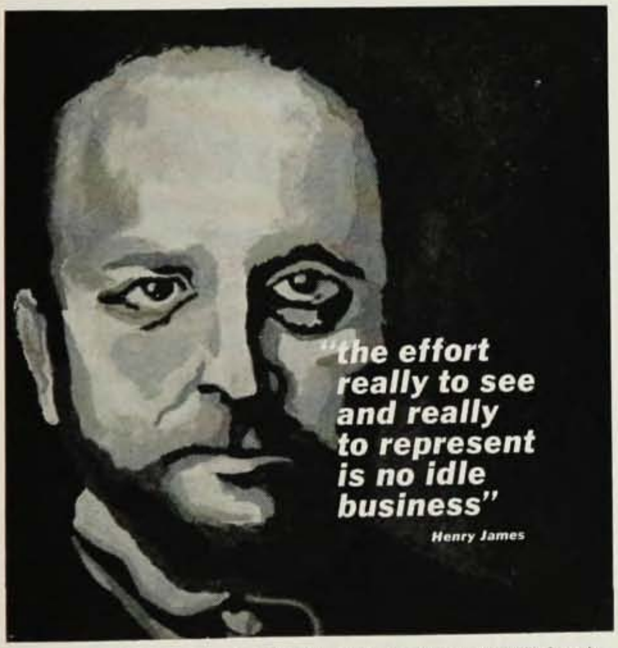
After a brief introduction describing the scope of astronomy, the author treats first the basic tools and methods of astronomers, including optical and radio telescopes, simple spectrographs, and photometric devices. Next follows a chapter devoted to the structure of simple atoms, including a very brief account of the principal nuclear reactions in stellar interiors.

Nearly one-third of the book is devoted to the solar system, including a chapter on its age and origin. The rest of the book is concerned with the stars, including a brief account of spectral classification, HR diagrams, spectroscopic parallaxes, and the mass-luminosity relation. The problem of stellar evolution is discussed in a separate chapter, and this is followed by an account of different types of multiple stars. The closing chapters are concerned with interstellar diffuse gas and dust, the structure of the Milky Way, and the physical properties of extraneous galaxies. The book ends with seven pages of questions, several of star charts, and an index of subjects and a few names.

Each chapter concludes with a "basic vocabulary for subsequent reading" and a list of references "for further reading". The fact that most of the latter are for articles that have appeared in the *Scientific American* serves to highlight the excellent quality of this famous popular monthly magazine.

The dust cover of the book contains a large, folded map of the moon, with identifications of many prominent lunar formations. It is regrettable that the publishers have found enough space on the outside of the jacket for the usual, rather meaningless, advertising claims, such as the following: "The exposition is not broken up into unrelated sections and subsections; rather, it proceeds logically from paragraph to paragraph, and from chapter to chapter, so that the discussion of each new topic represents a coherent development of the preceding material." As a matter of fact, the chapters are broken up into sections—as they normally should be in a textbook (Chapter 11 has twelve sections). If it is so difficult for the blurb writers to describe their products in more interesting terms, would it not be better to omit altogether such sentences as the following: ". . . presenting astronomy for the space-age reader." and let the prospective buyer make up his own mind from the list of contents and the preface by the author? Yet this book contains several outstanding features that are not found in other textbooks: for example, the large, folded drawing of the Milky Way by Martin and Tatjana Kesküla (facing page 396), etc.

It is perhaps appropriate to close this review by expressing the hope that either the present publishers, or one of the others, would bring out a more advanced textbook, intermediate in level between the purely elementary books (of which Inglis' is a good example)


"the effort
really to see
and really
to represent
is no idle
business"
Henry James

and the highly advanced monographs (such as L. H. Aller's *Gaseous Nebulae,* also published by John Wiley and Sons, Inc.). We urgently need in the English language a book (or even a translation) resembling the *Lehrbuch der Astronomie* by E. and B. Strömgren, or the *Astrophysique Générale* by J. C. Pecker and E. Schatzman, or the *Kurs Astrofiziki i Zvezdnoi Astronomii* by several Russian authors.

The Nature of Physical Knowledge. L. W. Friedrich, ed. 156 pp. Indiana U. Press, Bloomington, Ind., and Marquette U. Press, Milwaukee, Wisc., 1960. $4.50. *Reviewed by R. Bruce Lindsay, Brown University.*

PHYSICISTS with a philosophical turn of mind and philosophers with an interest in physics never cease to ask themselves what the physical researcher is really up to and what is the essential nature of this physical knowledge which seems so powerful and is increasing at such an accelerated rate. The book under review is the result of a symposium on this general subject held at the meeting of the American Physical Society in Milwaukee in the summer of 1959, largely at the suggestion of Henry Margenau. It consists of a series of brief essays by some well-known physicists and some philosophers not so well known to most physicists, a group of seven in all. A final chapter consists of a tape transcription of the discussion which followed the symposium presentations.

Though all the essays are in some measure related to the main theme of the nature of the knowledge which the physicist acquires and works with in his investigations, inevitably such a collection lacks coherence and organization, since each author has naturally followed his own interpretation of the subject and in certain cases has merely emphasized one facet of the whole theme of recent interest to himself.

The volume opens with an examination by P. W. Bridgman of the circumstances under which the word "knowledge" is used in connection with the activities of the physicist. After stressing the role of operational verification in the physicist's conception of "knowledge", he cites the great influence of quantum theory in altering earlier views. He winds up with the observation that to understand the nature of knowledge in the physical sense one must ultimately study the atomic structure of the brain.

The contribution by the philosopher, Frank J. Collingwood of Marquette University, is devoted mainly to a historical study of the place of mathematics and quantitative ideas in physics. He concludes that we shall never really get away from qualitative ideas.

Two of the essays, namely those of Henry Margenau and Adolf Grünbaum, explore the role of a priori elements in physical theory. Margenau raises the question: Are such elements really necessary? His answer is of the yes-and-no variety. If certain, unchangeable, and eternal explanations are sought in physics, the answer is yes: Everything then is based on a priori propositions. But if by such propositions we mean constructs