theory to be considered deals with the interaction between matter and radiation and with the resulting radiative transfer of energy.

The book starts with the standard methods used in the theoretical analysis and continues with a discussion of special problems which arise because of turbulence, magnetic fields, stellar rotation, and associated nonthermal phenomena. The remainder of the book is devoted to a discussion of the various types of stars, and covers typical features of the observed spectra and model ideas which have been suggested for their interpretation.

The major aspects of the problem of interpreting stellar spectra were formulated in 1929 by Milne but radiative properties were then not known sufficiently well for a successful application of the theory. In recent years, the advances made in understanding the interactions between photons and stellar matter have triggered a renewed effort, and some successes have been achieved. There are, however, still many unanswered questions, and in the latter half of the book one is introduced to these questions and to the data from which they arise.

The book consists of 19 chapters which have been written by 20 contributors. To the reviewer, the more general, early chapters of the book were of greater interest than the ones dealing with specific types of stars. For someone working in the field of astrophysics this could easily be the reverse. I expect that this book will be a standard reference work for quite a few years.

Wave Propagation in a Turbulent Medium. By V. I. Tatarski. Transl. from Russian by R. A. Silverman. 285 pp. McGraw-Hill Book Co., Inc., New York, 1961. $9.75. *Reviewed by Nicholas Chako, Queens College.*

ONE could hardly overestimate the present-day importance of studying the problem of wave propagation in a turbulent medium, since the phenomena associated with acoustic-, light-, and radio-wave propagation and scattering are dependent to a great extent on the irregularities and fluctuations of the refractive index of the atmosphere caused by the state of turbulence of the air. These irregularities in the refractive index arise from temperature, humidity, and wind-velocity fluctuation, and, in general, also depend on the state of ionization and magnetic field of the medium. Therefore a knowledge of the basic laws governing the structure and behavior of these factors is necessary in any attempt to construct a theory which would explain in a quantitative way such phenomena as anomalous propagation and scattering of waves by the actual atmosphere, the quivering and twinkling of stellar images in telescopes, scintillation from radio stars and terrestrial sources, frequency fluctuation, and a multitude of other phenomena in this, as well as in related fields.

Such a comprehensive theory is still far away. How-

ever, a great deal of progress has been made during the last decade in forming a theory which gives fairly good results in interpreting experimental data. On the other hand, further work is needed along theoretical and experimental lines in formulating a quantitative theory of wave propagation in turbulent media.

In this monograph, the author has undertaken the difficult task of presenting a general account of the present state of the theory and those aspects which are connected with parametric fluctuations of short-wave propagation in a turbulent atmosphere. The results given here, although not fully quantitative, do give considerable insight into these phenomena and in some cases have yielded quantitative answers to this problem. Most of the material presented is drawn from Russian sources, although important contributions from non-Russian authors have also been included.

The opening chapter contains the essentials of the methods for the statistical description of continuous random fields. The Fourier-Stieltjes integral plays a dominant role for expressing the stationary random function, the correlation function, and especially the so-called *structure function* which is the basic characteristic of random processes with stationary increments. This function is a generalization of the correlation function. Whereas the spectral density function (s.d.f.) entering into the expression for the correlation function (c.f.) must be a positive function of the frequency, the corresponding s.d.f. associated with the structure function (s.f.) could be singular for zero frequency, i.e., the low-frequency components of the fluctuation spectrum are allowed to possess infinite energy. On this basis, the author analyzes homogeneous and locally homogeneous and isotropic fields, in one, two, and three dimensions. The second chapter deals primarily with the microstructure of turbulent flow, local homogeneity, and isotropy. Based on certain definitions related to the velocity and length scale of turbulence, expressions for the s.f. are derived. However, such criteria are of a rather qualitative nature. From dimensional considerations, the s.f. for local homogeneous random fields is found to be proportional to the two-thirds power of the distance. This is known as Obukhov's law. Below the critical length, where the energy carried by the small eddies is dissipated into heat, thus resulting in a stable flow, the s.f. varies as the square of the distance. For distances greater than the largest eddies, no precise expression for the s.f. could be found, but one assumes that it approaches asymptotically a constant value. In spite of the qualitative arrangement, Obukhov's formula has an experimental basis. These expressions for the s.f. form the basis of subsequent discussions. The author then proceeds to derive s.f. for conservative passive additive fields (temperature, humidity, and concentration fluctuations) and the corresponding spectral density functions. Expressions for the refractive-index fluctuations are obtained due to the fluctuations of the above-mentioned fields and pressure fluctuations.

Part 2 contains a treatment of scattering of acoustic

and electromagnetic waves in a turbulent atmosphere. By assuming the refractive-index fluctuation to be small, perturbation methods are used to solve the differential equation. Expressions of the first-order scattered field and energy flux are derived for an incident plane wave. In addition, the author gives a critical review of various scattering theories based on different forms of correlation functions and a comparison is made with the results obtained by using Obukhov's formula. The latter gives more realistic results than previous theories. A similar analysis is given for acoustic scattering for locally isotropic turbulence near the earth's surface.

Part 3 covers those aspects of propagation and scattering by quasi-stationary inhomogeneities in the refractive index which produce fluctuations in the amplitude and phase of the wave. The problem here is to determine the statistical behavior of the field at large distances from the scatterer when the source is placed outside the medium. The problem is first treated from the geometrical-optics approximation and afterwards from the wave picture using perturbation theory. The use of incident spherical waves by following similar procedures for plane waves is also considered. However, in deriving an expression for the mean-square fluctuations of the logarithmic amplitude distribution near an observation point, certain legitimate approximations are made as to the form of the incident spherical wave. Inhomogeneities on the order of the radius of first Fresnel zone play a full role in scattering processes, and if the inhomogeneities are large in comparison to $(\lambda L)^{\frac{1}{2}}$ ($L =$ length of the largest eddy where anistropic turbulence takes place, $\lambda =$ wavelength), the results agree with the geometrical-optics approach.

The experimental data on parameter fluctuation of light and acoustic waves and scintillation of terrestrial light sources are discussed in Part 4. The results of the theory are in good agreement with the experimental findings. Finally, a theoretical approach to the phenomena of twinkling and quivering of stellar images in telescopes, including a discussion of experimental data, is described in detail.

The numerous footnotes and remarks which appear in the appropriate places of the Russian text have been collected by the translator at the end of the book in the form of an appendix. A short note by Dr. Kraichman in connection with some points referred to in Chapter 5 of the text is also included. It is possible that such a transfer of footnotes may be convenient and even desirable for the printers, but it certainly will be inconvenient from the point of view of the reader, who must turn to the last pages every time the author makes reference to his footnotes. The same comment can be made regarding the reference list. Another disadvantage is the author's omission of a subject index.

Insofar as the reviewer is aware, this is the first book on the subject to appear in press. Dr. Tatarski is to be congratulated for writing such an important book on a newly developed and difficult field. The specialist can hardly afford to be without it, and the general reader possessing a moderate background of mathematics will find it of interest as well. The publishers, and especially the translator, should be commended for having rendered a great service in making available such a valuable book to non-Russian readers.

Physics for Engineers and Scientists (2nd ed.). By Richard G. Fowler and Donald I. Meyer. 553 pp. Allyn & Bacon, Inc., Boston, Mass., 1961. $9.25. *Reviewed by Walter G. Mayer, Michigan State University.*

UPON inspecting this book, the question arises immediately: What justifies the selection of the title which suggests that the engineer is not a scientist? Furthermore, the title notwithstanding, the subject matter treated does not give the reader a special kind of physics. Occasional statements like "the physicist calls this . . ." might only create the impression that physics for the engineer is different from physics for the physicist, and this should be avoided, especially at the sophomore level. The reader will soon realize that he has before him a book on college physics containing mostly material which can also be found in a great number of other introductory texts.

There is, however, a noticeable departure from standard textbooks. The authors feel that introductory physics should not be taught as a series of separated subjects such as mechanics, heat, light, etc., because, as is stated in the preface, "the strict traditional division, when viewed in the light of present knowledge, is both wasteful of time and distracts from the general methods of thinking that give physics much of its power." This pedagogical attempt to unify, although successful in places, has created its own problems of division, e.g., Chapters 3 and 14 are both entitled "Rotational Motion". The former stops with angular acceleration and the latter starts with the introduction of English units. Newton's laws are introduced after motion on curved paths. Discussions of energy and momentum are separated by about 40 pages on electricity.

These and other breaks with tradition occur whenever the authors had to make a choice of sequence and continuity. Their arrangement will probably not disturb the unbiased student, and he will, perhaps, see the conceptual relations between gravitational fields and electric fields since these topics are discussed in two consecutive chapters. But will he have an understanding of the significance of conservation laws in mechanics or the basic principles of mechanics, per se, if the treatment of these topics is presented in various isolated sections scattered over the pages?

It is a bit difficult to decide whether a student without some background in calculus should use the book. Although the authors state that the understanding of the text does not depend on the student's familiarity with various calculus manipulations, they use calculus notation throughout the book, explaining briefly some fundamental mathematical steps. It would appear that