Book Reviews

Statistical Mechanics

Introductory Statistical Mechanics for Physicists. D. K. C. MacDonald. Wiley, New York, 1963. x + 176 pp. Illus. $6.75.

Statistical Mechanics. Kerson Huang. Wiley, New York, 1963. xiv + 470 pp. Illus. $10.75.

D. K. C. MacDonald's book, *Introductory Statistical Mechanics for Physicists*, is not so much a book on statistical mechanics as it is a book that tells about how to apply elementary statistical mechanics to simple problems. The treatment is based on the Boltzmann-Planck hypothesis which relates the entropy of a system to the number of microscopic states consistent with a given macroscopic state. The book is clearly written and has a pleasant flavor, seasoned here and there with interesting comments and quotations.

MacDonald seems to feel that the use of the grand ensemble lies "outside the immediate province of physics." In my opinion it would be regrettable for students of physics to acquire such a prejudice, since apart from the foundations of the subject a great deal of the modern work in statistical mechanics makes extensive use of grand ensembles.

The author's use of the term "real chemical gas" is somewhat misleading, since the term "real," as it is used in statistical mechanics, customarily implies that interactions between the constituent molecules are taken into account. When the same type of argument as that used by the author is applied to ensembles, it leads, of course, to results of general validity for "real" systems. There is an interesting appendix on intermediate statistics, which is based on the author's own work.

MacDonald's book can be recommended to those who wish to acquire quickly a working knowledge of elementary applications of statistical mechanics.

Frequently one hears the complaint that in this country the experts do not take time to write texts or treatises on their own subjects, or that when the expert does write, the result is incomprehensible to all but a handful of elite in the field. Kerson Huang offers as evidence to the contrary his book *Statistical Mechanics*. Huang, one of the leading experts on the subject, has written a clear and comprehensive book directed to graduate students in physics, but certainly highly worth reading by anyone who has any interest in statistical mechanics. The book is divided into three parts: (i) Thermodynamics and Kinetic Theory, (ii) Statistical Mechanics, and (iii) Special Topics in Statistical Mechanics.

The first six chapters are devoted to ". . . a brief but self-contained discussion of thermodynamics and the classical kinetic theory of gases . . . ." Huang argues that, from the pedagogic point of view, this presentation is imperative, since it is the aim of statistical mechanics to explain thermodynamics. On the other hand, the classical kinetic theory "nearly" explains, on a molecular basis, the approach to the equilibrium or thermodynamic state. The presentation is to the point, precise, accurate, and readable. This first section is concluded by a short but clear account of the Chapman-Enskog method for solving the Boltzmann equation.

The next nine chapters consider the fundamentals of statistical mechanics and provide enough examples and applications to illustrate the general principles. Here one finds the various ensembles, both classical and quantum, treated in a comprehensive and straightforward manner. The presentation is postulational, a method that seems appropriate for a text of this nature; as the author points out, the general laws of statistical mechanics, including the approach to equilibrium, have not yet been derived rigorously from first principles.

The last four chapters are devoted to the special topics: the Ising model, liquid helium, and the hard-sphere Bose gas. These topics are interesting examples of some present-day problems in statistical mechanics, and in this book they are presented in a way that makes it possible for the student to profit from a study of the current literature. One can hardly quarrel with Huang's choice of topics, but one could hope that a later edition would contain a chapter on the interacting electron gas.

With the exception of chapter 6, on the Chapman-Enskog method, the first 14 chapters have exercises to be worked by the student. There are appendixes on the N-body problem, the pseudopotential, and two theorems of Lee and Yang.

This book is recommended without reservation to students and scholars, to physicists young and old, and to those of sufficient maturity in other fields who wish to learn something in depth about this fascinating subject.

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Fourier Transformations

Direct Analysis of Diffraction by Matter. R. Hosemann and S. N. Bagchi. North-Holland, Amsterdam; Interscience, New York, 1962. xxi + 734 pp. Illus. $21.75.

In a penetrating paper written in 1940, P. P. Ewald observed: "For discussing x-ray diffraction the reciprocal lattice has found general application, but it is not generally realized that the reciprocal lattice is only an incomplete representation of the Fourier transform of the crystal and that much clearness of discussion can be gained by making full use of the conception of the Fourier transform." Despite Ewald's illustration of the potentialities inherent in this approach to structure analysis, the associated techniques have been used very little in research, and there has been no detailed formal presentation of diffraction from this powerful point of view. As the present authors note, "In recent years a large number of books have been published on the diffraction of x-rays by matter but, to our knowledge, none of them approaches the problem from the standpoint of the theory of Fourier transformation and convolution integral methods in an adequate way. Moreover, problems of diffraction by matter of all kinds have not yet been discussed from a single unified theory. We feel that a book is needed to fill this gap. This book is an attempt towards this aim."

The authors have written a book that more than fulfills their aim, a book whose rigor and thoroughness will make it an important source work for those with interests in x-ray diffraction extending beyond the standard methods of crystal structure analysis. All workers in the field of diffraction microscopy can profit from its presentation of the elegant Fourier transform formulation of diffraction theory.

Since a majority of the readers will not be sufficiently acquainted with the required mathematical methods, the authors have taken special pains to develop in detail the mathematical formalism, ". . . with the earnest desire that it will create the necessary confidence [in the reader]. . . ." The introductory chapter, "Fundamental equations of diffraction of wave fields" is followed by chapters on convolution operations, Fourier transformation, and convolution polynomials, which carefully define these operations and abundantly illustrate their application to pertinent diffraction problems. In order to provide a rigorous mathematical base for the Fourier transformations that have to be carried out, the concept of a function complex is introduced, and a chapter is devoted to the fundamentals of function algebra.

The main substance of the book occupies 13 additional chapters. These chapters are devoted to characterizing diffraction from a general structure and to specialization of the general equations to cases of single crystals, paracrystalline materials, polydispersed globular aggregates, micellar and fibrillar systems, and fluids. The analyses are based in part on the concept of a generalized Patterson function, the so-called Q-function introduced by the authors, and it is shown that, under certain conditions, structures can, in principle, be determined uniquely from this experimentally obtainable function. Unfortunately, this method has little practical application to actual crystal structure analysis. The large number of optical diffraction patterns that are analyzed to illustrate the implications of the theory are very useful. The authors, however, are occasionally carried away with the value of these models, as illustrated by the naive ideas presented on some biological structures. A detailed analysis is given of diffraction by paracrystalline substances, which will be of particular interest to workers concerned with the poorly-ordered colloidal and fibrous macromolecular systems.

This book is oriented primarily toward the theoretical analysis of diffraction, and will be most useful to those wishing to delve into this aspect from the point of view of Fourier transformation.

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Astrophysics

Astrophysical Quantities. C. W. Allen. Oxford University Press, New York, ed. 2, 1963. xii + 291 pp. Illus. $10.10.

One has only to glance at the list of references given in the current astrophysical literature to appreciate how widely the first edition of Allen's *Astrophysical Quantities* has been used. Allen has now prepared a second edition of this most useful compilation of tables, numerical constants, and formulae. The material is carefully arranged in such a way that needed information can be found quickly, the relevant units are clearly given, and each section lists the references from which the tabulated numbers have been extracted. In some instances—for example, infrared absorption of the earth's atmosphere—the complete data are so extensive that tabulation is not feasible and information must be presented graphically.

The practicing astronomical spectroscopist will find the tabulation of stellar continuum absorption coefficients very useful, although more accurate calculations could now be made and for different stellar compositions. The section on empirical transition probabilities has been greatly extended in this edition; published tabulations of theoretical line and multiplet strengths have not shown as marked an improvement. Some workers (for example, Garstang) have published useful results on line strengths for individual ions. Others preferred to publish erudite ideographs rather than urgently needed tables and data.

In some tabulations, it might have been preferable to select data from just one of the authorities quoted rather than to take averages. For example, the compilation of data for the solar interior given on page 163 represents means from the work of several theoreticians who attacked the problem with different assumptions and at different levels of sophistication. Hence the results are not truly comparable; they refer to different things.

Every reader will find places where he would have handled the data in a different way. In particular, one may be less enthusiastic about sections in which he considers himself to be an authority than about other parts. But this book was not written as a substitute for the astrophysical literature. Rather, it is a concise, handy, reliable compilation of the data needed by the practising astronomer, astrophysicist, and physicist or geophysicist working on astronomical problems. In this task Allen has succeeded admirably, and the scientific world owes him a great debt of gratitude for the patience, care, and good judgment he has exercised.

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Secondary School Biology

Research Problems in Biology. Investigations for students. Series 1 and 2. Prepared under the direction of the Curriculum Study, American Institute of Biological Sciences. Doubleday, Garden City, N.Y., 1963. Series 1, xxxvi + 242 pp.; series 2, xxx + 244 pp. Paper, 95¢ each.

The energy and imagination that those who work with the Biological Sciences Curriculum Study have put into developing new approaches to the teaching of secondary school biology is clearly illustrated in these two small volumes. Each consists of 40 research projects, contributed by research biologists, which cover a wide range of areas in animal behavior, animal physiology, ecology, genetics, growth and development, microbiology, and plant physiology. Each project is introduced by a skillful résumé of the pertinent literature so that the significance of