author in the Preface, he does not use the modern definition of heat (Born), and I found the introductory definitions on page 12 of heat and work imprecise. There is a good treatment of the second law of thermodynamics following the Carotheodory approach. There is essentially no chemical thermodynamics in the text. There are a number of interesting historical footnotes at least partly intended to give Russians credit for ideas which they are not generally credited with in the West.

In general, I found the text somewhat superficial because too many topics were treated in the 227 pages, and I do not think the book will be useful either for teaching thermodynamics or for those who want to refresh their memory of thermodynamics.

Order-Disorder Phenomena. By H. S. Green and C. A. Hurst. 352 pp. Interscience, New York, 1964. $15.00.
Reviewed by Carl Garland, Massachusetts Institute of Technology.

The title of this monograph would suggest a rather general review of the order-disorder problem, but the text is actually restricted to a few closely related theoretical topics with special emphasis on the Ising model for two-dimensional lattices. Indeed, there is only a very brief account of approximate theoretical methods, which seems to reflect the authors' own interest in exact solutions and their feelings about the uncertain character of inexact solutions. ("Generally, approximate methods give a poor and even misleading account of the transition between the ordered and disordered phases.") It is obvious that two-dimensional Ising models are very crude representations of physical systems. In spite of this, their mathematical tractability and the fact that they do simulate an order-disorder cooperative transition give them a special importance and interest. Within the restricted but challenging scope of exact solutions to the two-dimensional Ising problem, the authors have given a clear and authoritative presentation. In particular, they give an easily understandable derivation of the analytical results for a rectangular lattice with nearest-neighbor interactions.

About half of the text will be of interest to the general reader. Chapter 1 quickly reviews the principles of statistical mechanics and then formulates the Ising problem in detail. Although no experimental work is discussed, Chapter 2, on applications, does summarize in broad terms the interpretation of experimental results in ferromagnetism, antiferromagnetism, binary alloys, and melting phenomena as a background for the subsequent theoretical discussions. Chapter 3 is devoted to a detailed analytical treatment of the rectangular lattice. The evaluation of the Ising partition function is reduced to a combinatorial problem which is then solved by the relatively simple device of introducing for each lattice point a set of "terminals" and counting the number of different ways of pairing them. It follows that the partition function is directly related to a Pfaffian $\backslash D|$, and rules for forming the elements of $\backslash D|$ are given. The Pfaffian technique, which has been developed recently by Green and coworkers, makes possible a simpler presentation of the theory of this problem than does Onsager's beautiful, but complex, algebraic approach. Indeed, a simplification of Onsager's original method is reviewed in Chapter 6, together with the Kac-Ward combinatorial method as extended by Sherman.

The remaining chapters concern the generalization of the method to provide more powerful techniques of generating the Pfaffian and illustrate the general method by consideration of several special lattices, including triangular and hexagonal plane networks. Although the Pfaffian technique has been successfully applied to a wide range of two-dimensional problems, it appears to fail in a number of important cases (as do the Onsager or Sherman approaches). Chapter 7 shows that exact solutions cannot be obtained for a rectangular lattice with second-neighbor interactions, for a three-dimensional lattice, or for a lattice in a magnetic field. These outstanding problems show that while the Pfaffian technique is valuable for the more efficient formulation of soluble problems it does not reduce the class of currently insoluble ones.

For the reader who is not already familiar with Onsager's exact results but does know some of the approximate results obtained by the Bragg-Williams or Bethe method, this book has an unfortunate shortcoming. One is left to admire the solutions only in terms of analytical expressions. The graphical presentation of a few numerical examples of the variation of (say) energy and heat capacity with temperature for an exact solution to the Ising model as compared with various approximate solutions would dramatize the difference between these results in the transition region.

Radio Ray Propagation in the Ionosphere. By John M. Kelso. 408 pp. McGraw-Hill, New York, 1964. $17.50.
Reviewed by H. J. Hagger, Albiswerk, Zurich, Switzerland.

Ionospheric research is an old interest in radio physics and goes back to Marconi's days. For a long time these investigations could only be done from terrestrial ground stations, and radio ray propagation and reflection served as a tool to support theoretical work. In more recent years space stations have been used as unmanned experimental stations, providing data on geomagnetic fields, ionization density, and measurements of primary rays from outer space. The discovery of the Van Allen Belts has shown that the terrestrial atmosphere is of particular importance in space flight.

This book intends to bring the theory of the propagation of electromagnetic waves in the ionospheric layers closer to reality. After a short outline of the history, the author deals with electromagnetic propagation in a homogeneous medium to achieve a basis for the remainder of the book. In the next chapter the physics of the ionosphere is treated, considering also aurorae, meteors, and disturbances in these layers. The basic equations suitable for the propagation of radio waves in an ionized, absorbing medium are presented in several different forms adjusted to specialized uses. In this chapter the presence of the earth's magnetic field is assumed. In chapter 5, on ray theory, the magnetic field

is, however, neglected. It thus gives a first approximation to wave propagation in the ionosphere. In the last chapter the ray theory is extended to the case of a magnetic field.

Problems for each chapter are given, and the book finishes up with 300 very valuable references for more extensive research and with an index.

This book provides a good introduction to the whole field of electromagnetic wave propagation in the ionosphere. It is very comprehensive and may be considered a success in producing an introductory and reference tool for research workers in the field and as a text for an advanced university course on the topics, provided the reader or the student has had an introduction to electromagnetic theory. It is well suited both for engineers and physicists and can be recommended.

Cathode Processes in the Mercury Arc. By I. G. Kesaev. Transl. from Russian. 345 pp. Consultants Bureau, New York, 1964. $17.50.
Reviewed by Sanborn C. Brown, Massachusetts Institute of Technology.

Not infrequently when one has sent for a book by title alone one asks the question after reading it, "for what purpose was this book written?" Dr. Kesaev leaves no doubt in the mind of the reader as to why he wrote his book on "Cathode Processes in the Mercury Arc". He states in the preface, "At the present time in view of the extensive work being done to provide the national economy with new technology, it has become necessary to seek out new approaches and organize methods of investigating the arc discharge. These studies must be of the nature of a planned operation conducted according to a previously established broad program, and there must be a single guiding idea at the basis of the program to unite the individual aspects of the work . . . an attempt at just such a planned investigation of the cold arc . . . forms the basis of the present book."

Viewed as a collection of observations on cathode processes in the mercury arc, the book is successful in drawing together a vast amount of material. The difficulty with the presentation is that as much space is spent in reporting observations and explanations, which the author feels to be erroneous, as with those developments which he feels to be consistent with his view of the physics of this particular type of arc. The author leaves the reader in no doubt as to what he believes to be true, and it would be interesting to know if the blunt value judgments are a result of the translation or whether they appeared thus in the original Russian. Such statements as "in defiance of the elementary facts the authors neglect the effect of magnetic field on the motion of the electrons . . .", or "in attempting to substantiate his absurd arc theory, Smith called for help from the energy balance equation . . ." add a certain spice to an otherwise pedantic volume, but certainly it is not considered gracious journalism in a technical book.

The volume is advertised as having a foreword by Jerome Rothstein, which is in fact, only one page long but does highlight part of the problem with this work when Dr. Rothstein writes "One can raise an occasional eyebrow over the neglect of some references or about a few impressions given by the text with respect to historical priorities, and it is possible to disagree with the author occasionally in his assessment of previous work. . . ." About the only editorial comment which Rothstein has made is to be found in a single reference to his own work which he disagrees with: "The author errs in classing Rothstein's assumption with . . . ." This reviewer feels that many of the authors of referenced papers may object to Dr. Kesaev's evaluation of their work.

Technically the book is hastily done. It is a photo offset reproduction from a typed script using unjustified margins. The typography is poor with many typographical errors uncorrected, and in the cited literature, even books published in Germany and the United States are referred to only in their Russian translation.

The book is quite useless as a text since one must read it from cover to cover to find the logical presentation of the subject matter. It comes to little use for the research worker since the author quite correctly states in his own conclusion "The present work is only one of several parts of the investigation of the cold arc so that it would be premature to use these data to arrive at any conclusion concerning the mechanism of the cold cathode arc."

Torques and Attitude Sensing in Earth Satellites. S. Fred Singer, ed. 261 pp. Academic, New York, 1964. $9.75.
Reviewed by R. E. Street, University of Washington.

Some of the sixteen papers contained in this volume were first presented at the second Robert H. Goddard Memorial Symposium of the American Astronautical Society. Most of them are concerned with the important problem of determining what are the torques acting upon earth satellites and their relative magnitudes, while the last three papers, by Wark, Lunde, and Conrath, respectively, are concerned with horizon sensing by weather satellites.

No body is completely rigid, and because of this even spin-stabilized satellites will end up tumbling about their axis of maximum moment of inertia. The dynamics and control of this phenomenon is the subject of the first paper, by Reiter and Thomson. Since the earth's gravitational field is not uniform, there is a torque on nonspherical bodies called the gravity-gradient torque. This is the subject of three papers, the first, by Fischell, covering a passive type of gravity-gradient stabilization. The second, by DeLisle et al., discusses the use of gyrostabilizers to achieve internal dissipation and damping as well as control of the orientation, and the third, by Roberson, is a proof of some basic theorems concerning the torque on a body in a generalized gravitational field.

A paper by Evans calculates the torques due to aerodynamic and radiation pressures. This is followed by two papers by Singer and Lyttleton on the Coulomb forces and torques with special consideration of the West Ford needle experiment, giving an explanation for its failure that also includes internal energy dissipation. The next three papers consider the effect of the geomagnetic field on the angular motion of a satellite. After a short review by Wil-