interested in spectroscopy, lens design, electromagnetic theory, electron optics, linear or nonlinear optics, geometrical optics, etc. Luneburg in his 1944 Brown University lectures dealt with the mathematical approach to the study of light propagation through various media. This book is a reprint of the lecture notes of that course, which, although much in demand, has long been out of print.

One has here a highly sophisticated approach to geometrical optics and instrument design, very much in the tradition of Hamilton. Also there are additional new discoveries and applications (ca. 1944), as well as a treatment of the scalar wave theory of the propagation of light, which is tied in with geometric optics.

At the outset, the author connects the solutions of Maxwell's equations in the dipole approximation to geometrical optics in terms of the hypersurfaces of discontinuities of these solutions rather than only using the short-wavelength approximation. After this has been accomplished he produces a very elegant mathematical approach to the theory of geometrical optics and instrument design. One might sometimes get the feeling that all that Maxwell's equations do is to provide a starting point from which the author can go on and exhibit his virtuosity. One also can get this feeling from his treatment of the scalar wave equation with applications to optical instruments. This is not meant to criticize the book. On the contrary it is meant to point out that many of the mathematical devices employed can have wider application and that there is much one can learn from the author's approach.

The book is divided into six chapters that cover the broad categories: Maxwell's equations and geometrical optics, Hamilton's theory, first-order optics, third-order aberrations, applications, and diffraction theory of optical instruments. These chapters are divided into more than fifty sections with an average of about five subsections, each of these separately treating interesting topics. There are two appendices and also supplementary notes on electron optics by Chako and Blank and three supplements by Herzberger on optical qualities of glass, mathematics and geometrical optics, and symmetry and asymmetry in optical images.

There are two shortcomings, neither of which is the fault of the author. The first is the lack of an index. Although the table of contents is rather detailed, an index would have greatly increased the usefulness of the book. The second is that the type and format used are similar to those in some of the new lecture-note series; they may give one the feeling of timeliness and hurry but a lack of permanence. This is not the way I would present a classic. It might be argued that a change in type and format would have made the book prohibitively expensive. I am not convinced. In spite of these criticisms of the publishers, the University of California Press has done a service to the scientific community by publishing this classic.

Mathematical Analysis of Observations. By B. M. Shchigolev. Transl. from the Russian by Scripta Technica. 350 pp. (Iliffe Books, London) American Elsevier, New York, 1965. $12.50.
Reviewed by Jacques E. Romain, Centre de Recherches Routières, Sterrebeek (Brabant), Belgium.

An unspoken law about translated books says that any such book has a low probability of being irreproachable simultaneously with respect to style and contents. The book under review is one of the happy few that belong to the tail of the probability distribution, what is commonly called an exception to the rule. Indeed the book is written in so clear and agreeable a style that it would seem hard to guess it is a translation, were that not stated on the first page. Moreover, this reviewer has not spotted any error, except two inadvertent substitutions of "conditional equations" for "normal equations" in one paragraph, a minor slip of the pen that could happen to any author.

Due credit being thus given to the anonymous translator, the praise goes to the author for care and clarity of exposition, adequateness of explanatory remarks, and numerous worked-out examples (mostly taken from astronomy) that illustrate the methods described. The book is fully self-contained and requires no previous knowledge (not even the concept of probability) except standard mathematical techniques. The presentation is meant for students and starts from an elementary level.

Topics included are theory of errors involved in the use of approximate numbers (including point interpolation from numerical tables), essentials of probability theory and of the theory of random-measurement errors (whether the single measurements are equally precise or not), determination of parameters by the least-squares method, choice and testing of empirical formulas to be fitted to data, elementary statistical analysis of observational material (including correlation of two variables). The book does not include intermediate or advanced statistical methods (systematic use of Student's and chi-square tests, multiple and partial correlation, analysis of variance, analysis of time series, planning of experiments, etc.).

To summarize, in view of its prominent qualities the book may be commended for teaching and self-study to a reader who needs a detailed and readable explanation of the topics covered. It may also serve as an introduction to more advanced statistical treatises, but it can in no way replace such treatises.

Temperatures Very Low and Very High. By Mark W. Zemansky. 127 pp. Van Nostrand, Princeton, N.J., 1964. Paper $11.50.
Reviewed by M. E. Straumanis, University of Missouri at Rolla.

This small book is the sixth of the series of Van Nostrand Momentum Books, published for the Commission on College Physics. The book contains the following sections: (1) temperature as a property of matter; (2) temperature, entropy, and disorder; (3) the approach to absolute zero; (4) the approach to infinite temperature; and (5) beyond infinity to negative temperatures. The book concludes with a bibliography (on one page) and a three-page index. There are four plates in the book.

Sections 2, 3, and 4 are written in an interesting way and are quite readable. They supply new information (for example that the Rankine scale is used in engineering, page 16)

even for those who know a little bit about very low and very high temperatures. However, sections 1 and 5 are less enjoyable. Especially the introduction of the Kelvin temperature scale without even mentioning Gay-Lussac's law of 1802, makes it difficult to understand the arrival at the absolute zero point. If the author thinks that Gay-Lussac's experiments are too elementary, why then does he mention other simple things in the book? For instance, on page 47 he explains what a sodium ion is. There is also some misleading information, for example on page 8, ". . . the optical pyrometer may be used at temperatures above the melting points of metals" (!). We know that there are metals which melt at 156°, 30°, and even at −39°C.

Only elementary mathematics is used in the book; and the derivations of some equations, for example that of Boltzmann (pages 31-35) and that of Planck (pages 83-85), are given. Nevertheless, the reviewer disagrees with the opinion of the author (see preface) that the book can be used by a high-school student, especially as we know that one can graduate from high school without taking any course in chemistry or physics. The book could be useful only for those who already have some good knowledge in physics.

Physical Acoustics, Principles and Methods. Volume 2, Part B, Properties of Polymers and Nonlinear Acoustics. Warren P. Mason, ed. 383 pp. Academic, New York, 1965. $14.00.
Reviewed by Walter G. Mayer, Georgetown University.

The detailed description of relaxation processes, which formed the main theme of Part A of the second volume (*Physics Today*, September 1965, p. 74), is concluded in Part B. The first three chapters are concerned with relaxation in various forms of polymers and to some extent with its relation to physical acoustics. The first section (W. Philippoff) treats shear deformation in polymer liquids and gels, and only the harmonic aspects of stressing are considered in terms of acoustics. The next two chapters on relaxation in solid polymers and glasses (I. L. Hopkins and J. E. McKinney) concentrate on physical chemistry and the mechanical behavior of these polymers. These sections leave the realm of acoustics to some extent but the authors appear to be aware of this departure, judging from a statement in Chapter 8: "We are not overly concerned by this, particularly since we have never found any wide agreement on the definition of 'acoustics'."

Re-entry into the more familiar atmosphere of "acoustics" takes place by means of a rather brief chapter on nonlinear acoustics (R. T. Beyer). This section gives a description of the various parameters that lead to harmonic distortion of an initially sinusoidal wave. A number of experimental verifications is given here with more emphasis on results than on experimental methods. The application of optical methods, that is, light diffraction by ultrasonic waves, to problems of nonlinearity in liquids is treated in the first part of the last chapter (L. E. Hargrove). These two sections on nonlinear acoustics present a well rounded treatment of finite amplitude distortion in liquids.

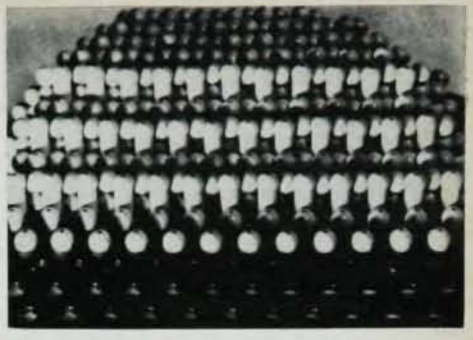
The second part of the last chapter (K. Achyuthan) deals with optic-ultrasonic methods in determination of photoelastic constants of solids.

Finally, the book contains a section on acoustics streaming (W. L. Nyborg) which presents much more information on this particular subject, both theory and experiment, than one finds in the usual textbook.

Every chapter is written with the authority and clarity that one now expects to find in every new volume of this series. Anybody who has appreciated the contents of the previous volumes will not be disappointed with this book.

An Atlas of Models of Crystal Surfaces. By John F. Nicholas. 229 pp. Gordon and Breach, New York, 1965. $27.50.
Reviewed by H. M. Otte, Martin Co.

At the list price this book is a horrendous overindulgence by the publishers. The volume is one of a series of eclectic books gathered under the title of Materials Science and Engineering Program for which J. [F.] Nicholas is listed as an associate editor. One is tempted to inquire whether, in that position, he is at the mercy of the publishers, or in cahoots with them. In either case, the result is to make the dissemination of whatever useful information may be contained in this atlas so prohibitively expensive as to question whether there is in fact any desire to communicate with fellow scientists or merely with bibliophiles. The book is most attractively produced.



Model of diamond (311). From: An Atlas of Models of Crystal Structures.

"An Illustrated Catalogue of Selected Models of Crystal Surfaces" would be a more apt description of the contents. A total of 191 halftone photographs ($4\frac{1}{2} \times 6$ inches) have been assembled under one cover together with a 21-page explanatory and descriptive introduction written primarily for the practising surface chemist or physicist. The introduction summarizes not only the mathematical foundations for calculating the positions of atoms on "atomically-flat surfaces" but also the construction of the models. For details the reader is referred to several publications by the author.

In the FCC, BCC, NaCl and diamond structures 22 surfaces, ranging from the (100) to the (851) were photographed. For the FCC and BCC this was done with the surfaces in two orientations, one with reference to the (100) plane and the other with reference to the (111). For the NaCl, the diamond, and the HCP structures the surfaces were recorded in only one orientation; however for certain hkl, two possible surfaces could exist, and in this case both were photographed. Thus there are 44 photographs for each of the FCC and BCC structures, 27 for NaCl, 33 for diamond and 43 for HCP. (For