

comes at a time when interest in this field is revived, and it fills a long standing void.

Batten's own research has been mainly in the field of spectroscopic binaries; his articles and reviews are important contributions to the literature on binary stars. He is perhaps best known for his compilation of the *Sixth Catalogue of the Orbital Elements of Spectroscopic Binary Systems* (referred to by many as "Batten's catalogue"), which contains orbital elements, references and extensive remarks for more than 700 stellar systems. (In it he has had the courage to give a quality rating for each orbit, even though many of the authors are still active in the field!)

Binary and Multiple Systems of Stars is written at about the same level as his review articles; they are suitable for graduate students with some astronomical background as well as the professional astronomer.

As Batten himself states, the depth of discussion varies tremendously from one topic to another. For example there is an excellent discussion of apsidal motion, including a critical review of the existing observations of systems most likely to have well determined apsidal periods. On the other hand one might expect a book on binary stars to have a chapter devoted to solution methods for orbital elements, but there is none. Instead the author gives references to the literature where the reader can find techniques for solving eclipsing, spectroscopic or visual binary orbits. In the case of a spectroscopic binary the reader is referred to R. M. Petrie's (1962) least-square method, which unfortunately has both typographical errors in the equations and numerical errors in the example. Batten might profitably have reproduced the corrected material for the reader's convenience.

The text contains a rather lengthy and up-to-date review of the frequency of binary and multiple systems among various groups of stars. A careful discussion of the problems of determining orbital periods and possible period changes is given. The author then shows how the physically important parameters (mass, radius and luminosity) can be derived given certain kinds of photometric, spectroscopic and positional data. Particularly valuable is the detailing of observational difficulties that can result in erroneous values of these parameters.

The author uses many specific examples of stellar systems in discussing such topics as stellar atmospheres in close binaries, circumstellar matter and evolution of binary systems. Chapter 8, "Observational Evidence for Circumstellar Matter in Binary Systems," is especially informative in the description of both photometric

and spectroscopic peculiarities in a variety of different types of systems. The index of stars is very helpful in finding page references to the discussion of individual binaries. Many informative tables and figures expand the text.

In a future edition the author will certainly want to add a discussion of some of the recent work on x-ray binaries and black holes. However, the text was completed in 1971 when only a small amount of material was available on these topics.

The book is a long-needed summary of the classical problems arising from the observations of binary and multiple stars and should be an exceptionally useful reference for many years to come.

ANNE COWLEY
University of Michigan
Ann Arbor

The Invariant Imbedding Theory of Nuclear Transport

J. O. Mingle
131 pp. Elsevier, New York, 1973.
\$11.50

With the present-day emphasis on improved reactor design and precision measurements of the low-energy neutron nuclear-interaction parameters, the problem of neutron transport through a medium is of considerable interest. John Mingle's book "The Invariant Imbedding Theory of Nuclear Transport" is a helpful contribution toward the understanding of neutron-transport phenomena.

The book's primary aim appears to set up and discuss the neutron transport through a slab type material. The first seven chapters are used in defining the basic parameters and developing the necessary equations for reflection and transmission cases. This remark should not, however, be construed as meaning that the space in these seven chapters has been wasted. On the contrary the material is carefully and systematically built up starting from the definition of the invariant imbedding approach to include albedo, scattering matrix, escape probabilities and generalization necessary to deal with multiple-neutron energy groups.

The second part of the book is the application of the preceding developments to the monoenergetic case. The discussion builds up from the simple case of a homogeneous plane slab, with and without absorption, to include internal sources within the slab, and the multi-slab problem.

The last part of the book introduces multiparticle problem photon trans-

THE BEST HELIUM DEWAR FITS YOUR TIGHT BUDGET

CTi-Cryenco Helium Dewars are unmatched in quality, reliability, and durability, yet they've been engineered and built to cost you less.

Available in 50, 100, 250, 500 and 1000 liter capacities (larger sizes for bulk quantities), CTi-Cryenco Helium Dewars offer maximum versatility, structural strength, and simplicity of use to reduce operating costs and conserve valuable liquid.

FEATURES

- Conduction-cooled shields. (no LN₂ needed)
- Stainless steel He container
- Accept 3/8, 1/2, 3/4-in. transfer tubes
- Low boil-off
50, 100 1.5%/day
250 1.0%/day
500 0.75%/day
1000 0.50%/day
- Truck, rail, ship, air* transportable

*With optional Absolute Pressure Relief Valve

Write or call for complete technical data and price information:

Cryenco

a Division of
CRYOGENIC TECHNOLOGY, inc.
4955 Bannock Street,
Denver, Colorado 80216
(303) 244-8691



Circle No. 32 on Reader Service Card

SOLID MATTER

**Four new publications
in the physical sciences
from Houghton Mifflin**

Physical Science With Environmental Applications

Arthur W. Wiggins, Oakland Community College,
Michigan

320 pages, with Instructor's Manual and Study Guide.
March 1974.

An engaging new introduction to physical science. Cartoons, humorous analogies, and clever dialogs apply principles of chemistry, physics, astronomy, and geology to the world we live in.

Relativity: A Series of Computer-Animated Films

Robert Ehrlich, State University of New York at
New Paltz

Eight Super-8mm silent/color films, with captions
and complementary film notes. March 1974

Each four-minute film describes a specific aspect of special relativity theory and can be used for lecture, laboratory, discussion, or independent study. Film subjects: The Speed of Projectiles, Sound, and Light. Simultaneity is Relative. The Michelson-Morley Experiment. Length Contraction. Time Dilation. The Doppler Effect and the Twin Paradox. World Lines. Coordinate Transformations.

Interstellar Communication: Scientific Perspectives

Edited by Cyril Ponnampuruma, University of
Maryland, and A. G. W. Cameron, Harvard University
Approximately 250 pages, paper. March 1974.

Intelligent life beyond earth: does it exist and how do we reach it? Ten articles develop current theories, probabilities, and research on the fascinating subject of extraterrestrial life. An interdisciplinary approach gives students a broad-based understanding, while editors' introductions, bibliographies, and footnotes help clarify each article.

Science, Technology, and Freedom

Edited by Willis H. Truit and T. W. Graham Solomons,
University of South Florida, with the collaboration of
Anne J. Truitt

288 pages, paper. December 1973.

This original collection of articles focuses on the role of science and technology in society. Writings from Dobzhansky and Dubos to Fromm and Riesman complement new perceptions of new themes to provide a range of opinions.

We packed a lot of substance into them

Houghton Mifflin

Boston 02107 / Atlanta 30324 / Dallas 75235 /
Geneva, Ill. 60134 / Hopewell, N.J. 08525 / Palo
Alto 94304

Circle No. 33 on Reader Service Card

port, curved geometry for transport media and some computational procedures.

Mingle sets two main objectives in writing this book; first to introduce invariant imbedding to the reactor theory group and shielding group of the nuclear engineering field, and second, to present sufficient results and details of invariant theory so that researchers in this field can use this book as a framework and general background reference.

I think the two objectives are partially fulfilled. The author's approach in introducing the necessary functions and equations is based on an intuitive appeal. This intuitive appeal is well supplemented by the interaction diagrams depicting the components of pertinent equations. The readers would have been better served if conscious attempts were made to show by examples how the ideas developed can be applied.

The book contains some helpful tables. The references to other works are adequate and should prove helpful in further use and study of the subject of the invariant imbedding theory.

SURENDRA S. MALIK
University of Rhode Island
Kingston

Semiconductor Opto-Electronics

T. S. Moss, G. J. Burrell, B. Ellis
441 pp. Halsted, New York, 1973. \$29.75

Ever since the invention of the transistor in the late 1940's, semiconductors have come under intensive study by physicists and other scientists throughout the world. The optical properties of these substances have aroused particular interest because, in addition to yielding useful basic information, they also contain the seeds for sensitive, fast-response optical devices. The efforts have been highly fruitful, and we now have amassed a great wealth of knowledge and successfully built a variety of semiconductor photoconductors, lasers and lamps that play an integral part in our current technology. Indeed some of these devices, like the spin-flip laser, may well play an important role in solving some of the environmental and communication problems confronting our society.

It is little wonder therefore that a number of books have appeared in recent years devoted exclusively to the optical properties and their applications in semiconductors. In this latest and most attractively titled addition, Trevor Moss and his colleagues, Geoffrey Burrell and Brian Ellis at the

Royal Aircraft Establishment in the UK, cover most areas of current interest in this rapidly expanding field. After two preliminary chapters on the optical parameters and dispersion relations, the book goes on to explore the absorption processes that occur in semiconductors. This is an in-depth discussion covering topics such as inter-band transitions (direct and indirect), exciton absorption, and impurity-to-band transitions. The emphasis accorded absorption processes, the primary theme of the book, is justified by the fact that these very processes determine also the dielectric properties, for example, the refractive index, via the well known Kramers-Kronig relations. Equally important from the practical viewpoint is the fact that these processes are directly responsible for most technological applications, such as photoelectric effects, lasers and lamps, which are taken up in considerable detail in later chapters of the book. There are also treatments of other modern topics such as magneto- and nonlinear optics.

The discussion throughout is authoritative and up to date (many of the results reported have been published in 1972), as one expects from three experienced and active researchers. The research physicist will appreciate the painstaking attention given to practical matters, such as the various techniques of measuring optical parameters, and the student will find instructive and lively illustrations of the theory he has labored so hard to learn in the classroom. I particularly enjoyed the numerous experimental graphs and tables distributed throughout the book. Many readers will certainly find the extensive reference list very helpful; it contains about 1500 items which often go beyond the area of optical properties. It is a pity that titles of articles could not be included.

In the authors' words, "the book is intended primarily for physicists in academic research or commercial device development and for honours students specialising in solid-state physics." Consequently, there is little discussion of the theory and the authors usually attempt to get to the final results, to be tested or exploited experimentally, in the quickest possible manner. This program places a heavy burden on the background of the reader. In order to derive substantial benefit, he should have had good courses in semiconductor theory and quantum mechanics, preferably on the graduate level. While it is not unreasonable to expect such a sophisticated background from a research physicist, it is very doubtful that the student would be able to digest the material given here without a great deal of effort and guidance.

1=500?



1 OMA = 500 Photomultipliers!

SSRI's OMA (Optical Multichannel Analyzer) takes a *digital electronic photograph* of your dispersed spectrum and displays it in real time. Quantitative access to 500 channels of spectral data is available immediately with OMA. Opens new horizons in such fields as: Multi-element Analysis; Flash Lamp Analysis; Laser Diagnostics; Astronomical Spectrometry.



New OMA brochure outlines other applications, operating modes, specifications, accessories and prices. Write for your free copy today.

See us at Pittsburgh Conference
Booth 116

- ☐ Call me for appointment
☐ Mail literature

My application is _____

Name _____

Firm _____

Address _____

City _____ State _____ Zip _____

SSR INSTRUMENTS CO.
a subsidiary of Princeton Applied Research Corp.

1001 Colorado Avenue, Santa Monica, California 90401
(213) 451-8701 Cable: Photon Telex: 65-2466

Circle No. 34 on Reader Service Card

PHYSICS TODAY / FEBRUARY 1974