

emission, (5) emission (general), (6) instrumentation (emission), (7) instrumentation of absorption methods, (8) ultraviolet absorptiometry, and (9) infrared spectroscopy. The emphasis in all is upon the applications of spectroscopic methods to chemical analysis and taken together they give an excellent picture of the state of the art in this important field of spectroscopy throughout the world. These biennial meetings, of which the seventh was held in Liège in September 1958, constitute the most important opportunity for an international meeting of spectrochemists. It is of interest to note from the literature citations at the end of each article that spectrochemistry recognizes no national boundaries and that most of the articles indicate the familiarity of their authors with the work done in other countries. The volume is well edited and printed and constitutes an important reference work in the field of analytical spectroscopy.

Structure and Evolution of the Stars. By Martin Schwarzschild. 296 pp. Princeton U. Press, Princeton, N. J., 1958. \$6.00. *Reviewed by C. C. Kiess, National Bureau of Standards.*

The life history of a star, including our sun, begins with its genesis in distended nebular matter consisting of dust and meteoric material embedded in gas, chiefly hydrogen. As the nebula shrinks under gravitation, heat is generated and the temperature of the nebula rises from a few degrees above the temperature of interstellar space to one high enough to render the object visible as a red star of large volume, but of low density. Thus a supergiant star has come into being. As the internal temperature rises, through further contraction, there comes a time, not too long after the process started, when the temperature is high enough to bring into play another procedure for generating stellar energy, the transmutation of hydrogen into helium. As this process gains in yield the contraction slows to a halt, while the energy of hydrogen-burning takes over completely the job of maintaining the luminosity of the star and holding its size in balance against the loss of its energy through radiation. At this stage of its career the star will find itself among normal stars of luminosities and spectral classes determined by their masses.

The length of time during which a star is normal depends on the rate at which its internal hydrogen is consumed—faster for massive stars, slower for less massive ones like the sun. But there comes a time when the hydrogen is depleted; contraction sets in again; the temperature rises to a point at which helium-burning can take over the task of keeping up the star's appearance as a normal one. For a while the increase of energy will increase the luminosity of the star, with consequent expansion of its outer layers, and it will take its place among the red giants. Finally, however, when the sources of nuclear energy are exhausted and a series of cataclysmic events occurs, the star will descend to the white-dwarf stage, as one of small vol-

ume, of extremely high density, and of low luminosity, drawing on the thermal energy of its core to keep the spark of life going.

Is all this guesswork? The astronomer cannot dip into a star to get samples of its material for analysis. All he can do is to examine its light with photometer and spectrograph to determine its amount and quality, and then theorize as to the nature of the source. To do this he sets up model stars of assigned mass and composition, and by applying the physical laws relating to gas characteristics he determines the nature of the star's light. And the test of a model is the way it fits into the Hertzsprung-Russell and mass-luminosity relations.

All these matters are discussed in detail in Professor Schwarzschild's book. The first three chapters give the observational data available for the problem, the physical principles governing the behavior of gases at various temperatures and pressures, and the mathematical tools needed for the job. Then come four chapters in which the details are given for setting up and calculating model stellar structures for the initial and subsequent phases of the star's life cycle. In the last chapter the results of the previous chapters are summarized and their bearing on the problem of stellar evolution is described.

This is a good book. It is written in a simple and pleasing style, which at no time leaves the reader in doubt as to what the author is explaining. Mathematical formulae appear on almost every page, yet their physical meaning is explained and the results derived from them are illustrated with diagrams and tabulations. Although written for students of astronomy at the graduate level, the book may be read with profit by a wider group of readers with some preparation and interest in the physical sciences.

Foundations of Modern Physical Science. By Gerald Holton and Duane H. D. Roller. Edited by Duane Roller. 782 pp. Addison-Wesley Publishing Co., Inc., Reading, Mass., 1958. \$8.50. *Reviewed by James MacLachlan, Earl Haig Collegiate Institute.*

"Every Ptolemy is challenged by a Copernicus, every Kepler and Galileo must be made meaningful by a Newton, the insight of every Dalton eventually has to be transposed to a new plane by the work of a Mendeléeff or a Bohr . . . science is an unending quest for wider horizons." The pathways of the quest of physics are opened wide for freshmen in this text by Holton and Roller. An understanding of the developments cited in the quotation is unfolded in an accurate, readable account of physics.

The authors' approach is an effective antidote both to specialized, compartmentalized introductory physics courses and to broad, shallow physical science survey courses. It is all pure physics, though reference is made to aspects of astronomy and chemistry which are required to illuminate the structure of physics. The treatment is unified by the use of historical sequences—



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A basic and authoritative physics handbook covering the advanced mathematics of most importance in physics, and all branches of classical and modern physics. Outstanding experts in each field have collaborated in the writing of its 95 comprehensive chapters. The main section headings include: Mathematics; Electricity and Magnetism; Heat and Thermodynamics; Optics; Atomic and Nuclear Physics.

case histories—to show the birth and growth of concepts and theories. Six case history developments may be distinguished: planetary systems, concepts of heat, atomic-molecular theory, concepts of electricity, the invention of quantum theory, and nuclear physics. The book does not teach history, but uses it as a framework for the laws and theories of physics, following Duhem's dictum that this is "the legitimate, sure, and fruitful method of preparing a student to receive a physical hypothesis".

The text is designed primarily for students in the liberal arts, and in sciences other than physics. It seems to me that physics majors, too, would gain a great deal from such an introduction to physics. Holton and Roller have chosen a level of exposition that requires as much concentration from majors in the humanities as is expected of them in their own fields.

The seven basic concepts and principles that the Carlton College Conference of the American Association of Physics Teachers recommended for emphasis in physics courses are all given prominence here. The first section of the text, Motion, occupies 60 pages. Succeeding sections are: Forces, 44 pages; Planetary Systems, 108 pages; Conservation Principles, 98 pages; Early Atomic Theory, 98 pages; Electric and Magnetic Fields, 80 pages; Quantum Physics, 114 pages; Atomic Nucleus, 95 pages. An interesting feature is the inclusion of a valuable section of 54 pages: On Structure and Method in Physical Science. With its appended references this section provides a useful introduction to the philosophy of science. The text contains many worked examples and almost 600 problems and thought-provoking questions.

The techniques of measurement and accuracy in physical investigation are only alluded to here. They may properly be left to a laboratory course, and the instructor will refer his students to some other text. Yet even in the development of concepts this issue is avoided. To be sure, we are led to ask if Galileo could measure time accurately enough, but how accurate is "enough". Galileo's own words, "no appreciable discrepancy in the results", still leave us in doubt. How does a scientist decide whether to accept a margin of error of 10% or 1%? Our authors do not tell us. But they do a fine job of demonstrating the varieties of physical experience.

A number of reasons combine to suggest a consideration of this book as a second edition of Holton's pioneering *Introduction to Concepts and Theories in Physical Science*. It continues the traditions of Harvard's program of general education for freshmen. The general plan of the earlier book has been continued and expanded. Many sections have been repeated entirely, others have been revised. The major changes are: the extension of the case history technique; the revision and enlargement of the sections on light and electricity (electromagnetics and interference have been added); the great expansion of nuclear theory to show a contemporary frontier of physics; greater care in providing clear introductions to new concepts; a slightly less

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analytic treatment of theories; the omission of some mathematical applications like simple harmonic motion and vibrations; mks units are used throughout.

There are 130 more pages in this book than in the earlier one, but it is almost twice as thick. Although it may be a formidable burden, the book will more than repay the effort needed to carry it. Its wide adoption will do much to improve the quality of freshman instruction in physics. It will be a valuable addition to the reference shelves of professional physicists and of physics instructors at all levels from high schools to graduate schools.

Lectures on Ordinary Differential Equations. By Witold Hurewicz. 122 pp. The Technology Press of MIT and John Wiley & Sons, Inc., New York, 1958. \$5.00. Reviewed by Philip J. Davis, National Bureau of Standards.

This book is an outgrowth of a series of lectures which the late author gave at Brown and at MIT. Though the amount of mathematics presented is modest, the exposition is wonderfully clear and the book is attractively printed. Including material on the Cauchy-Euler approximation method, general linear systems, linear systems with constant coefficients, the singularities and solutions in the large of autonomous systems, and stressing existence theorems and geometrical methods, it makes an elegant introduction to the study of differential equations at the advanced level. There is an appreciation by Solomon Lefschetz of Witold Hurewicz' mathematical career and a bibliography of his work. Many people will want to own a copy as a remembrance of its distinguished author.

Die Physik in Einzelberichten. Edited by Carl Ramsauer. Part 2, *Praktische Akustik*, 68 pp. Part 3, *Wärmelehre I*, 84 pp. J. A. Barth, Munich & Physik Verlag, Mosbach/Bd., Germany, 1957. Paperbound DM 14.40 each. Reviewed by Ira M. Freeman, Rutgers University.

This series of review articles represents a resumption of the earlier *Physik in Regelmässigen Berichten* published by the German Society for Technical Physics between 1933 and 1944. At that time the publication policy called for a division of the entire field of pure and applied physics into 60 sections, with a recognized specialist in each subject reporting on progress in his field of interest at intervals of approximately three years. The idea of publication at regular intervals had to be abandoned, and it is planned that additions to the present series should appear whenever it becomes feasible to meet a need for updating a given topic.

Each contribution is intended to delineate the lines of development of a given field, with special attention to the synoptic and critical presentation of new results. Volume 1 was not on hand for review, but the remaining two volumes appear to fulfill this aim in an extremely satisfactory way. The individual authors.