make the measurement unless he has read and understood the material. Because of this, the student finds the laboratory hard, and some resent its demands on their time. The laboratory, which is designed for three hours per week, requires about the same preparation a student would give to two lecture hours. Throughout the text, Portis has used figures lavishly, and they are excellent. The presentations are clear but sophisticated; the format is attractive, and wide margins are available for scribbling.

The laboratory, however, has many pitfalls for the unwary instructor. One of the greatest disadvantages is the lack of an adequate instructor's manual. An instructor's manual is published separately by Hickok, but one published by McGraw-Hill and distributed with the laboratory manual would thwart many a case of professorial apoplexy. Those attempting Part C should be adequately forewarned before purchasing equipment; for example, an oscilloscope better than the one marketed with the laboratory is needed for experiments C1 to C4. Another disadvantage is the lack of any experiment giving a precise measurement. The student gets no feeling for the satisfaction of precision. This reviewer has found it imperative to include an introduction to experimental measurement and errors in the beginning of Part A.

The laboratory is very flexible, and the instructor will easily discover variations and extensions of the experiments. Portis has included some interesting appendix experiments; for example A1, electrostatic focusing, A9, the varactor diode and B4, operational amplifiers. The experiments, or groups of them, can be presented in different order than that in the manual. However, the cost of each manual is $2.25. The laboratory would gain wider acceptance if certain groups of experiments could be sold separately, A, numbers 1 to 4, and C, numbers 5 to 8, for example. Those considering teaching the laboratories would be advised to consult two articles by Portis, *Am. J. Phys.* **34**, 1087 (1966) and **32**, 458 (1964).

The main advance of the laboratory that outweighs all other advantages and disadvantages is that in both its selection of topics and equipment it bears some relation to experiments that one performs as a research scientist. The student suffers the same frustration that a neophyte experimentalist experiences. He learns to check contacts, continuity and the scope sync function. Professors who use the laboratory or substantial parts of it in the freshman and sophomore year will find that the junior and senior physics laboratories can be considerably upgraded. Portis has deliberately created a sharp break with traditional laboratory assignments. Certainly time is needed for it to gain acceptance. For this reviewer, however, having taught parts of the laboratory for three years, the cry is HURRAH !!!

* * *

The reviewer is associate professor of physics at the George Mason College of the University of Virginia. Her research interests are in solid-state physics.

Macro and micro evolution

RED GIANTS AND WHITE DWARFS: THE EVOLUTION OF STARS, PLANETS AND LIFE. By Robert Jastrow. 188 pp. Harper & Row, New York, 1967. $5.95

by R. Hobart Ellis Jr

Through a curious development, science appears to be closing a circle on itself. A few decades ago the subject became respectable and was labeled "natural science" in university curricula. Then it broke up into fragments like chemistry, physics, biology, geology, archeology. Now the gaps between fragments are filling in; boundaries are growing too vague to be recognized, and the renaissance man—the scholar who sees all knowledge as his province and responsibility—is coming back to the lecture platform.

This book, which started as a series of television lectures, is by and for the renaissance man. "The path of evolution," says its concluding sentence, "stretches back into time—from man . . . into the parent cloud of hydrogen." In his text the author has traced this path for us, proceeding in the other direction: origin of stars and planets, development of amino acids and DNA, biological evolution and the ascent of man. Would you expect the size of the task to compel in a short book either shallowness or ponderosity? In my opinion Robert Jastrow, a master of the concise sentence, the appropriate metaphor, the order that commands attention, has fallen into neither trap.

Jastrow is perhaps uniquely qualified to accomplish the mission he set out on. The road that took him to his present position as director of the Goddard Institute for Space Studies in New York City was varied and scenic. At an unusually early age he took a Columbia PhD degree and went off to Washington to work at the Naval Research Laboratory on nuclear theory. Then Sputnik I went flying, and Jastrow made calculations on its orbit that revealed unknown properties of the upper atmosphere. Next came a more general interest in atmospheric

Reviewed in This Issue

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By FRANK S. CRAWFORD, JR., University of California, Berkeley.

Volume III of the well-received Berkeley Physics Course covers the standard material on optics, waves, and oscillations in a new and refreshing manner. A home-study optics kit is included. Table of Contents: Preface to the Berkeley Physics Course. Preface to Volume III. Teaching Notes. Note to the Student. Notation. **Chapter 1:** *Free Oscillations of Simple Systems.* Introduction. Free Oscillations of Systems with One Degree of Freedom. Linearity and the Superposition Principle. Free Oscillations of Systems with Two Degrees of Freedom. Beats. Problems and Home Experiments. **Chapter 2:** *Free Oscillations of Systems with Many Degrees of Freedom.* Introduction. Transverse Modes of Continuous String. General Motion of Continuous String and Fourier Analysis. Modes of a Noncontinuous System with N Degrees of Freedom. Problems and Home Experiments. **Chapter 3:** *Forced Oscillations.* Introduction. Damped Driven One-dimensional Harmonic Oscillator. Resonances in System with Two Degrees of Freedom. Filters. Forced Oscillations of Closed System with Many Degrees of Freedom. Problems and Home Experiments. **Chapter 4:** *Traveling Waves.* Introduction. Harmonic Traveling Waves in One Dimension and Phase Velocity. Index of Refraction and Dispersion. Impedance and Energy Flux. Problems and Home Experiments. **Chapter 5:** *Reflection.* Introduction. Perfect Termination. Reflection and Transmission. Impedance Matching between Two Transparent Media. Reflection in Thin Films. Problems and Home Experiments. **Chapter 6:** *Wave Packets.* Introduction. Group Velocity. Pulses. Fourier Analysis of Pulses. Fourier Analysis of Traveling Wave Packet. Problems and Home Experiments. **Chapter 7:** *Waves in Two and Three Dimensions.* Introduction. Harmonic Plane Waves and the Propagation Vector. Water Waves. Electromagnetic Waves. Radiation from a Point Charge. Problems and Home Experiments. **Chapter 8:** *Polarization.* Introduction. Description of Polarization States. Production of Polarized Transverse Waves. Double Refraction. Band-width, Coherence Time, and Polarization. Problems and Home Experiments. **Chapter 9:** *Interference and Diffraction.* Introduction. Interference between Two Coherent Point Sources. Interference between Two Independent Sources. How Large Can a "Point" Light Source Be? Angular Width of a "Beam" of Traveling Waves. Diffraction and Huygens' Principle. Geometrical Optics. Problems and Home Experiments. Supplementary Topics. Appendix. Index. Tables. **Spring**

A CONTEMPORARY VIEW OF ELEMENTARY PHYSICS.

By SIDNEY BOROWITZ and LAWRENCE A. BORNSTEIN, both of New York University.

This introductory text provides the student with a solid knowledge of the really fundamental ideas and theories of physics. It further develops an awareness of their range of applicability (and their limitations), provides background for such additional work as will reinforce the basic concepts, and shows how to use them in a wide variety of situations. The book is written primarily for a two-semester program, introducing only essential topics such as conservation laws and the wave-particle duality. **Spring**

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By B. J. ALDER, Lawrence Radiation Laboratory, Livermore and F. REIF, University of California, Berkeley. Produced with the aid of LARC computer at Lawrence Radiation Laboratory, Livermore, operated by U.S. Atomic Energy Commission.

This film illustrates the most fundamental ideas of statistical physics, discussed in Chapter 1 of F. Reif's book, *Statistical Physics* (Volume 5, Berkeley Physics Course, McGraw-Hill, 1967). The film shows the motion of N hard-disk particles inside a two-dimensional box with rigid walls. An electronic computer was programmed to use classical mechanics in order to calculate the particle trajectories starting from specified initial conditions. Successive positions of the particles were then displayed on the computer output oscilloscope and photographed by a movie camera. The film is available in standard 8mm form (2 Technicolor cartridges) or 16mm form (1 reel). It is in black and white, and it runs 7:15. **$30 set or reel (approx.)**

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By LEONID V. AZAROFF, University of Connecticut.

This is the first introductory text to discuss x-ray diffraction in terms of the reciprocal-lattice concept. First developed geometrically, the concept is then derived in the more advanced treatment of the diffraction theory. The more difficult chapters can be omitted without limiting the book's utility of completeness. Thus an instructor can select subject matter to suit his needs. The problems at the end of each chapter are intended to extend arguments presented in the text and to test practical understanding. Suitable for elementary or more advanced courses. **Approx. 608 pp., $15.75**

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By M. STANLEY LIVINGSTON, National Accelerator Laboratory, Weston, Illinois.

McGraw-Hill Paperbacks in Physics Series

This introductory survey provides the student with a feeling for the excitement attendant on scientists' sense of an imminent breakthrough in our understanding of the particles of nature. It deals primarily with concepts and the experimental observations which have justified these ideas. Technical terminology is introduced for those who wish to delve more deeply into this field. Designed for a sophomore-junior level first course in modern physics. **240 pp., $3.25 (soft-cover); $5.50 (hard cover)**

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physics, then space exploration, cosmological evolution and biological evolution. The cement that made a meaningful mosaic of it all was Jastrow's curiosity about anything capable of stimulating the intellect.

The reader will, I think, enjoy the style of the book. Its words are those of someone who knows he must hold his audience. In addition many chapters end with collections of photographs presented in picture-magazine style. The pictures illustrate the preceding prose; long captions repeat the message in abbreviated, summary form.

While many of the people watchers in and around physics are worrying about failing interest and declining registrations, they might learn from a good look at this book. Its success on the bookstands may tell us that we are underestimating our audience.

* * *

The reviewer is editor of PHYSICS TODAY.

Basic processes in the sun

A GUIDE TO THE SOLAR CORONA. By Donald E. Billings. 323 pp. Academic Press, New York, 1966. $14.00

by Jules Aarons

A very delicate balance is achieved by Donald E. Billings of the University of Colorado in his *Guide to the Solar Corona*. The volume stresses a physical understanding of processes in the solar corona, but current observations always buttress and supplement the basic physics. The balance allows the graduate student and research worker in allied fields to move from the basic physics of solar processes to current references that emphasize observations.

The book was planned by Billings and many members of the staff of the department of astrogeophysics of the University of Colorado. The author, a member of that staff and a prominent researcher specializing in coronal optical measurements, has turned out a very readable advanced text, with references at the end of each chapter and a good appendix.

The volume starts with a historical summary and moves into a description of optical and radio observational methods. The theories of emission and radiation processes are excellent; they are developed at the graduate-school level without moving into the rarified air of the theoreticians. A brief discussion of the extent of the corona and its transition into the solar wind complete the book. The solar wind, with its literature and its measurements expanding at very high accelerations, is correctly discussed only sparsely since it is best treated in current review articles and in the periodicals.

This addition to the small list of books on the sun is slanted towards audiences different from those of recent books such as *The Solar Corona* edited by J. Evans, which is a conference proceedings oriented toward the solar physicist and the new edition of *Our Sun* by D. Menzel, which is slanted towards the undergraduate.

The volume emphasizes optical coronal measurements and to some extent (possibly because of the reviewer's bias) omits the contribution of the radio measurements. For example, although the techniques are outlined, the observations of the angular diameter and apparent temperature of the radio sources are not discussed. This, however, is a minor criticism since the volume does describe the basic processes and mechanism for emission of the active regions.

Well written and clear, amply illustrated, delving into theory and outlining important observations, *A Guide to the Solar Corona* is recommended both for the astronomer and for the geophysicist.

* * *

Jules Aarons, chief of the radio astronomy branch at US Air Force Cambridge Research Laboratories, Bedford, Mass., is editor of a recent volume Solar System Radio Astronomy.

Nonequilibrium systems and surroundings

THERMODYNAMICS OF STEADY STATES. By Ralph J. Tykodi. 217 pp. Macmillan, New York, 1967. $10.95

by Ralph J. Nossal

In recent years significant success has been achieved in formulation of the molecular basis of irreversible thermodynamics. Kinetic expressions have been established for many of the linear transport coefficients, and the origin of various "phenomenological" transport equations is increasingly better understood. However, most investigations of the properties of nonequilibrium thermodynamic systems have been presented for assemblies of infinite ex-

CORONAGRAPH SPECTRUM of green coronal line at 5000-km intervals above solar limb. A curved slit, with solar-image diameter, is parallel to the limb. The absorption lines are Frauenhofer lines in the spectrum of scattered sunlight.

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