spirited battles over contested patents, and a full account would tell about them.

Particularly interesting to the general reader are the accounts of Langmuir's trip to Russia in June 1945; these are given in chapter 22 of the Rosenfeld biography in volume 12 and also in Langmuir's own account which starts on page 379 of that volume, and again in his "Discussion of Science Legislation," which was his testimony in October 1945 before a Senate committee about bills to establish a national science foundation. His testimony on atomic energy control starts on page 365; but there must be an error in the date, there given as 30 September 1945, because the McMahon committee did not get organized until about the first of November. (In the complete list of papers, which is noted in each of the 12 volumes, this paper, entry Number 202, is dated 30 November 1945.) In any case, this testimony is noteworthy for his having said, "If, in this way, an atomic armaments race develops, I believe the Russians will produce their first atomic bombs in about 3 years." This was at a time when General Leslie Groves was saying it would take them 20 years. It actually took four. The testimony also contains Langmuir's story of the bumbling efforts of Groves to prevent the scientists from going to Russia. This extended to interference with British participation in the conference which aroused indignation in England, where Langmuir says, "I also heard the opinion expressed that this action must have been taken at the request of the American Government because no one outside of the American Army could be so stupid."

Finally let it be recorded that for books priced at $15 a volume, the printing and binding are disgraceful. There are so many misprints and confusing, misspelled names that one wonders if anybody read proof. The printing abounds with broken and misaligned type. Each volume repeats the general introduction by Guy Suits, and each contains the *same* portrait of Langmuir as a frontispiece, in spite of the fact that there must be many photographs of him that could have been used, for Langmuir was a handsome photogenic personage.

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Instruments and Techniques

Stars and Stellar Systems. Gerard P. Kuiper, General Ed. vol. 2, *Astronomical Techniques.* W. A. Hiltner, Ed. University of Chicago Press, Chicago, 1962. xxi + 636 pp. Illus. $16.50.

Almost all of our knowledge of the stellar universe comes from the analysis of electromagnetic radiation that is collected by optical or radio telescopes, detected by the eye, the photographic plate, the spectrograph, or the photoelectric cell, and then measured and analyzed by a variety of techniques. This volume is concerned with the techniques of the instruments of detection, with the measuring devices, and, finally, with the reduction and analysis of the observations. Volume 1 of the series dealt with the telescope itself. The present volume is limited essentially to optical, earth-bound techniques, and little is written of solar, rocket, or satellite instrumentation and nothing of radio astronomy.

The book is enthusiastically recommended to the professional astronomer and graduate student. The 24 chapters are written by 26 different authors. Although some of these chapters will soon be outdated in the rush of technological progress, probably half of them should remain classics for years to come. There are chapters on the spectrograph and the photoelectric photometer, photomultipliers and the photographic plate, the measurement of faint sources, radial velocities, magnetic fields, and polarizations. There are four chapters on photometry and spectrophotometry; three on television tubes and image orthicons and converters; three on the reduction of photoelectric observations; four on astrometry. The final three chapters are concerned with orbit methods for visual, spectroscopic, and eclipsing binaries. The only serious omission is that of interference filter photometry, which has been developed so successfully by Strömgren and his students. By fixing photoelectric attention on spectral lines and regions that are not only sensitive to temperature and absolute magnitude effects but also to effects of chemical composition and age, this method holds tremendous promise of quickly giving us deeper insight into the basic facts of stellar evolution. Undoubtedly the technique should be modified so that numbers of slots of proper width and spacing are placed in the focal plane of a coudé spectrograph. Strangely enough, observatories in this country are lagging behind those abroad—Cambridge University, for example—in this kind of development and its very exciting possibilities.

This book gives strong testimony to the great stimulation given to new instrumentation by the existence of large telescopes located in excellent climates. An even greater stimulation will soon come when orbiting observatories go into action. But as the editor so properly puts it: "A mastery of earth-bound techniques and their application to observational astronomical research is imperative for fruitful exploration with both old and new, unpredictable, developments." This country is committed to space research to the tune of tens of billions of dollars, with the result that we have an appalling shortage of trained astronomers, men thoroughly familiar with spectroscopic and photometric techniques, who know what needs observing and with what. It is truly an emergency situation that seems to be little appreciated by either the National Aeronautics and Space Administration or the National Science Foundation. The best way to train observational astronomers is well known—with modern telescopes of moderate size, located in good climates. Of the dozen or more top graduate schools of astronomy in this country, only the University of California at Berkeley and California Institute of Technology have such telescopes, so located. The American Astronomical Society has nine times awarded the Helen Warner Prize to the best young astronomer. Graduates of Berkeley have won it five times and those of Cal Tech twice. It seems abundantly clear that what is needed—and as quickly as possible—is a goodly number of moderate-size, modern telescopes, located in good climates, for *all* of our top graduate schools, with the responsibility for the telescopes and the instrumental development and operation definitely allotted to specific schools. These schools already have an abundance of students, but a large majority of such students lose heart and turn to other fields, when they discover what they have to cope with in the way of obsolete and inadequate instruments and nearly impossible weather conditions. It is quite possible to run a mile race in

ankle-deep mud, but it can be done much better and much more enthusiastically on a good cinder track. This suggested program of new equipment would run into tens of millions of dollars, but the stakes involved are three orders of magnitude higher.

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Measurement Technology

Instrumentation for Engineering Measurement. R. H. Cerni and L. E. Foster. Wiley, New York, 1962. xii + 456 pp. Illus. $12.50.

The dramatic advances in measurement technology during the last decade would justify a series of books for a variety of readers. Cerni and Foster have provided a valuable reference for nonspecialists who need practical information on how to obtain and process data in the field or laboratory. The emphasis is on the measurement aspects of instrumentation, with only incidental reference to control aspects.

Perhaps the most valuable contribution is the comprehensive review of modern measuring components and systems. The treatment of sensors and transducers is encylopedic; explanations are easily followed, and carefully selected line drawings clarify the descriptions. The typical treatment consists of a statement of basic principle of operation, a description of practical devices, a specific discussion of performance characteristics, and a summary of the advantages and disadvantages of the device in comparison with alternative devices.

A similar treatment of data indication and recording methods provides useful information on the characteristics of electrical, optical, magnetic, analog, and digital devices. This material, like that in the section on sensors and transducers, is descriptive rather than analytical, and it can be understood and used with benefit by engineers or scientists with limited backgrounds in instrumentation.

In contrast, much of the material on telemetry, data transmission, and data processing requires some specialized knowledge of communication theory for ready understanding of the brief mathematical analyses presented. Apparently telemetry is a field of special interest to one of the authors, and as a result, this topic is treated on an entirely different level from that of the material in the earlier part of the book.

Perhaps the major weakness of the book is the lack of homogeneity in the technical level. Instrumentation engineers who wish to extend their knowledge of telemetry will have no use for the elementary discussion of systematic and random errors or for the description of the D'Arsonval movement. On the other hand, mechanical engineers will have great difficulty following the brief discussion of feedback and stability or the analysis of pulse-position modulation and pulse-code modulation systems.

For the experimenter with a difficult measurement problem, this book provides a good review of a great variety of modern methods. It may not solve his problem, but by clearly pointing out capabilities and limitations of practical devices and systems, it should help him along the road to a solution.

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Investigative Tool

Introduction to Molecular Spectroscopy. Gordon M. Barrow. McGraw-Hill, New York, 1962. xiii + 318 pp. Illus. $10.75.

Elementary Introduction to Molecular Spectra. Børge Bak. North-Holland, Amsterdam; Interscience (Wiley), New York, ed. 2, 1962. xi + 144 pp. Illus. $6.

The theory, experimental techniques, and results of molecular spectroscopy have been discussed in numerous books and summary papers, both brief and lengthy, at a wide range of levels. Any addition to this literature should be evaluated in terms of how successfully the author achieves a selected objective. Barrow and Bak indicate in the prefaces to the books reviewed here, which they undertook to prepare for beginners (that is, for students and workers in biology, organic chemistry, and so forth), concise, simple, and easily absorbed summaries of the concepts of molecular spectroscopy. Barrow was considerably more successful than Bak in attaining this goal. Neither author devoted more than a few general remarks to experimental techniques, and both found it necessary to incorporate rudimentary discussions of wave mechanics.

Barrow takes the slightly willing student by the hand and gently nudges him through 11 chapters that are graduated in mathematical sophistication and in complexity of subject material. With the aid of simplified examples and graphic illustrations he manages to bridge the gap between advanced treatises on molecular spectroscopy and the cursory treatments that may be found in unconnected chapters of the currently popular melange of "Physical Methods for . . . ." This introductory volume, which is set up in textbook form, requires no prior knowledge of quantum mechanics or of group theory. Those who follow the text seriously and correctly complete all the problems will find their efforts rewarded with a fairly good understanding of molecular spectroscopy (but not of quantum mechanics or of group theory). The chapters on the physics of absorption and emission of radiation and those on molecular symmetry, group theory, and normal mode analysis are well written. The treatment of electronic spectra is necessarily highly abbreviated, but the crucial roles played by the quantization of angular momentum and by the symmetry of the molecular wave functions are properly stressed.

The author and publishers should be commended for the format of this book. The paper, printing, and binding are very good, and there are enough carefully prepared diagrams to be of considerable help, particularly to those students who find it difficult to visualize the shapes of functions of several variables. The "order of magnitude" estimates are also instructive; quotations of values for real molecules are a bit sparse, perhaps inadequate to indicate the range in magnitudes that one encounters.

In my opinion there are two serious omissions. Raman spectroscopy is mentioned once (on page 2) and nothing is said about selection rules for Raman transitions or about how these facilitate the establishment of molecular symmetries, even though these topics were discussed at some length for infrared absorptions. The use of molecular parameters, as derived from spectroscopy, to compute thermodynamic functions is