scientific research, the improvement of science education, the development of human resources (including the training of more scientists and engineers) are all social problems. These and other social aspects of the use of science and technology are illuminated in many papers, especially in volumes 9 to 11.

James R. Killian, Jr., in a discussion entitled "Science and public policy," says that "This new domain of political science—the relating of science and scientists to government policy—has gained new importance from the unfolding opportunities to put science to work for the less developed nations." Charles V. Kidd's essay, "The loss of scientists from less to more developed countries" is a thoughtful analysis of that problem. Jerome B. Wiesner writes on policies for scientific and technological education, Wilbur Schramm and Gerald F. Winfield on new uses of mass communication, Hollis W. Peter on guidelines in the process of change, and F. M. Tiller on cooperative programs for strengthening engineering education. These and many other contributions are well worth reading.

These volumes are recommended for enjoyable browsing, for use in courses or seminars that deal with social implications of science and technology, and for convenient reference to obtain a short summary of applicable knowledge on the topics covered. It would also be a good idea to suggest that professional colleagues and institutions in newly developing countries request a set through the local United States A.I.D. mission.

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Solar Research

Solar Flares. Henry J. Smith and Elske v. P. Smith. Macmillan, New York; Collier-Macmillan, London, 1963. xii + 322 pp. Illus. $12.95.

A great many of us find that writing is the most difficult task of the day. I, for one, must enlist the aid of friends to review the end result, an imposition on their time. But even after I have forced the manuscript upon my friends, it often proves difficult to get honest criticism—to have them really chop up my work and say what they think. Certainly the friends and coworkers of the Smiths have failed them, if they saw the manuscript of *Solar Flares*. And one wonders about "the expert and painstaking assistance" of the editorial adviser.

In this book the Smiths attempt to provide a critical survey of recent research, both theoretical and observational, on the subject of solar flares in all their varied aspects. The project is ambitious, and it was undertaken conscientiously. But the book should begin with chapter 6, "The nature of flares and stellar activity," for it is in this chapter that a flare is defined. Chapters 2 through 5 then follow in order. Chapter 1, "Solar phenomena," should be reorganized and rewritten. It is too confusing, abounds in incorrect statements, and fails to supply the reader with adequate background.

Chapter 2 begins with a discussion of the instrumentation for observing the optical phases of flares. Figure 3 is wrong. Section 1.2 covers the analysis of photographs for flare positions, area, and brightness. In section 1.3 we learn that the classification of flares by "importance" is based primarily on corrected areas, but area corrections to flare observations are not discussed until section 3.1. The sections that follow cover the published sources of flare data; the statistical interpretation of the relation of flares to sunspots; and the characteristics of flares—durations, brightness, areas, shapes, behavior, and effect on prominences.

The physical processes related to flares, as they are obtained by the analysis of spectroscopic observations, are the subject of chapter 3. Here the Smiths have collected and summarized a large body of data, some of it from European sources, including a great deal from the Crimean Astrophysical Observatory. The expert well understands the shaky ground and the inconsistencies in the interpretation of the Balmer line profiles discussed in section 4; indeed, the expert himself has contributed to the inconsistencies—let others beware. This discussion is followed by a good account of other elements that can be detected by their emission lines. Section 11 covers ultraviolet radiation and x-rays.

I am not competent to review chapter 4 (31 pages) which deals with radio emission from flares. Chapter 5, "Solar corpuscular emission and geophysical phenomena," is excellent. The solar-modulated phenomena, 1 year, 27 days, and the sudden Forbush decreases are described and interpreted on the basis of the many proposed mechanisms that have been set forth. High- and low-energy cosmic ray emission is treated in detail and well. The geomagnetic field with its variations and finally the physics of the ionosphere are briefly touched upon.

This book is a survey, but it is not suitable for use as a textbook. It is well indexed and well referenced; apparently there are no serious omissions of relevant research. The authors are to be congratulated on their excellent coverage of the research contributions from Eastern Europe.

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Astronomical Data

Stars and Stellar Systems. Gerard P. Kuiper and Barbara M. Middlehurst, General Eds. vol. 3, *Basic Astronomical Data*. K. Aa. Strand, Ed. University of Chicago Press, Chicago, 1963. xviii + 495 pp. Illus. $12.50.

This book, the fourth published volume of an announced nine-volume series, is of the same high quality, interest, and usefulness as its predecessors. It is especially valuable inasmuch as no book like it has previously been published, yet it deals in a detailed and authoritative way with the classification of astronomical data that is at the very heart of progress in this observational science. Little attempt has been made to discuss instrumentation, observational techniques, or reduction methods, for these topics were covered in volumes 1 and 2.

The 22 chapters and the two appendixes were written by 28 authors, each an active worker and an authority in his field. The first seven chapters deal with positions and proper motions and associated star catalogs. The next four chapters deal with stellar classification through spectra or by photometric observation. Chapters 12 and 13 discuss interstellar absorption; chapters 14 and 15 give empirical physical data on stars, and chapter 16 is concerned with interstellar polarization. The next three chapters describe surveys of, and

data on, double and variable stars, and luminosity calibrations are discussed in the last three chapters. The first appendix is a brief but most useful account of star catalogs and charts; the second describes the Palomar Sky Atlas which has been the kernel of so many modern researches and which, with respect to the southern hemisphere, urgently needs completion. Chapters of particular interest and importance are F. P. Scott's "Fundamental proper motions"; P. C. Keenan's "Spectral classification"; B. Strömgren's "Quantitative classification methods" (this includes a useful discussion of narrow-band photoelectric photometry); H. L. Johnson's "Photometric systems"; two chapters by the late D. L. Harris III: "Stellar temperature scale, bolometric corrections" and "Stellar masses, luminosities and radii"; and A. Blaauw's "Calibration of luminosity criteria."

This book should be studied by graduate students, and it is a "must" for professional astronomers and for the writers of astronomical textbooks. It will also be useful to the rapidly increasing number of scientists who are associated with the space effort and thus require astronomical information. In my own case I expect to refer to it again and again during the coming semester in teaching a graduate course on galactic structure. The price is so low that it will be purchased by many graduate students; this circumstance contrasts sharply with the high cost of the somewhat similar volumes of the *Handbuch der Physik*.

A useful addition to the list of charts given in the first appendix would be the Union Observatory Charts which cover the southern sky south of declination −19 degrees to about the 13th photographic magnitude. These charts have a reference coordinate system drawn in on them and are extremely useful to the increasing numbers of southern hemisphere observers. The production of the charts (by E. L. Johnson, observer at the Union Observatory in Johannesburg) was a "labor of love" that required many long years of work.

The text bears continued testimony not only to the observations of the past but also to the needs of the immediate future. For example, we know of nearly 3000 eclipsing binaries and some 65,000 visual binaries, but in the final discussion of the empirical mass-luminosity relation only 13 "reliable" eclipsing binaries and 41 visual binaries could be used. We still know very little about the masses of white dwarfs, long-period variables, cepheids, or population II red giants. We need more telescopes located in superior climates. The membership of the American Astronomical Society has increased by 61 percent in the last six and one third years, and this explosive growth is only in its beginnings. In that same period the number of research telescopes has been increased by less than 20 percent, and many older telescopes have become markedly less effective as a result of obsolescence, the encroachments of city lights and smog, and the newer techniques that require the best atmospheric conditions. This is an especially serious situation when one remembers that almost all of the great astronomical discoveries of the past have been the result of *telescopic observation*. We enter the expensive Space Age caught in a strait jacket. Suddenly astronomy has become much too important for its instrumentation to continue to be supported only by the occasional generosity of a millionaire.

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Metallurgy

Nickel. An historical review. F. B. Howard-White. Van Nostrand, New York, 1963. xiv + 350 pp. Illus. $6.95.

This book is a remarkable production. It is written in a manner that captivates the reader, yet it is a highly authoritative documentary story of the occurrence of nickel and of the uses that men have made of it. Only one who has spent his life in "the world of nickel" could have written this account. Howard-White's association with the nickel industry provided him with a unique store of information about the history and uses of nickel, and he combines a wealth of scientific and economic facts with the highlights of human history in an informative and imaginative manner.

The book begins with an interesting, quantitative description of the occurrence of nickel in nature and continues with a discussion of the early appearance, more than 5000 years ago, of nickel in copper alloys. Although nickel has been utilized in the form of copper alloys (as a result of the natural occurrence of nickel in copper ores) and iron alloys (of meteoric origin) for thousands of years, it was not until the 19th century that it was identified as an element. The author's description of its isolation and subsequent uses as an alloying element and as a pure metal is replete with references and documentary evidence. Most metallurgists and engineers, who take for granted the ready availability of high-purity nickel, will be surprised to learn that this seemingly well-behaved metal was in reality a recalcitrant element that, for many decades, defied the best efforts of metallurgists and chemists to refine it.

Many of the mineral deposits in Europe and Asia (the first to be mined for nickel) contained large amounts of arsenic. This impurity made the reduced metal brittle and often poisoned those who worked in the refineries. In subsequently discovered Canadian deposits, nickel was associated with copper, which also made the extraction of high-purity nickel difficult and expensive. It was not until the latter part of the 19th century that economically satisfactory refining processes were developed. Even then nickel did not find a ready market, but intelligently directed research on possible uses of this element and the development of more efficient methods of refining increased the production from 25 million pounds in 1900 to a peak of 100 million pounds at the end of World War I. The use of nickel in armaments accounted for the major part of this rise. When this need no longer existed, production dropped precipitously until, by 1922, world use had returned to the 1900 level. Then, during the 1920's, the dividends of research really became evident, for by the end of that decade the total usage reached a high of over 120 million pounds. Since then there have been numerous hills and valleys in the production curve, but the overall trend has been upward. By 1961, the annual consumption had reached 600 million pounds.

In the closing chapter interesting and important uses of nickel are described in an authoritative and accurate manner. The reader is left with the optimistic feeling that this extremely useful element will assume a position of ever increasing importance in our highly sophisticated technological world.

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