

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. Strömberg'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.

JOHN B. IRWIN

*Goethe Link Observatory,
Indiana University*

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.

EARL R. PARKER

*Department of Mineral Technology,
University of California, Berkeley*