not the atom–atom recombination of neutrals important in chemical kinetics. Simple radiative recombination was dealt with in volume 2, so this chapter is devoted to more complicated processes such as three-body recombination and inverse autoionization, and it also includes multiple-collision and collisional-radiative processes that are important in the actual decay of the electron density in a recombining plasma. Except for this treatment, and the 15 pages devoted to the application of collisional information to the ionosphere, the book generally concentrates on the basic physics of single-collision processes and stops short of many-step (bulk) processes and of applications.

The rest of volume 4 is devoted to elastic and inelastic (excitation, charge-transfer and ionizing) collisions of fast ions or atoms with atomic or small molecular targets. Roughly speaking, volume 3 treated collisions in the thermal-energy range; this volume treats processes from a few eV upwards.

To make each volume of this work totally self-contained would have required undue duplication; instead, the authors freely refer to developments in earlier volumes. This is especially noticeable in connection with theoretical topics. (For instance, the often-used Landau–Zener formula, which appears nowhere in the subject index, is applied in volume 4 at pages 2597–99, but the central equation for it is given only in volume 3, pages 1915–17; for the basic material on the Born approximation, which is often referred to, one must go back all the way to volume 1.) Nonetheless, in view of the fact that any reader of this volume will have some other references on standard scattering theory available to him, these occasional stumbling points will cause no great difficulty in using this volume by itself, and its value as a compendium of information on its own is very great.

In such a rapidly growing field any book is bound to be outdated in some respects by the time it appears. In this one, unfortunately, the latest information is at least four years old. In compensation the reader is presented with a work that is remarkably well put together and free of editing and printing errors. The half-life of usefulness of a book like this must even now be of the order of 10 years or more. Nevertheless there have been some significant developments in this field even in the four years that have elapsed between the closing date and publication. These changes include a major growth in the effective application of electronic-structure calculations to the prediction and interpretation of inelastic scattering of ions and atoms, and an increased appreciation of the importance of various types of coupling in inelastic processes, including the rotational interaction that couples states of different angular-momentum symmetry. Presumably developments like these will be reflected in volume 5, and we can hope that the authors and Oxford University Press will see to it that the gap between the closing date and publication is considerably narrowed when it appears.

FELIX T. SMITH
Stanford Research Institute
Menlo Park, California

Currents in Hadron Physics

V. De Alfaro, S. Fubini, G. Furlan, C. Rossetti
874 pp. Elsevier, New York, 1973. $97.50

This is a good addition to the books on the theory of elementary particles. It contains a detailed coverage of current algebra and its application to understanding the weak and electromagnetic interactions of leptons and hadrons. There is a good deal of discussion of soft-pion theories, dispersion sum rules, the use of the infinite momentum frame, and phenomonological Lagrangians. This approach has been central to elementary-particle theory for some time, and the present work, written by a group of physicists who have made important contributions, gives an exhaustive, not to say, exhausting account. In addition to the detailed discussion of current algebra, the book also has long chapters on strong interaction S-matrix theory and duality, which do not obviously fit and could have been dispensed with. Most of the book is a description of work done in the late 1960's and, because of the inevitable delays in producing a book of this kind, does not cover the developments of the past few years. The final chapter deals with current commutators on the light cone. The excitement generated by the success of the gauge theories in unifying the weak and electromagnetic interactions, the quark structure of the nucleon as revealed by the deep inelastic neutrino scattering, and the discovery of neutral weak currents with all its ramifications is not to be found here. There are only occasional references to experimental data, and these to results that are several years old.

Judging the potential audience for such a work is difficult. It is far too long and detailed to be used as a graduate text, although it could be a useful reference work. The field is moving so rapidly that its utility as an introduction to a central area of particle theory will not last long, if indeed it still exists. In addition it is much too detailed to play such a role. I do not know the solution to this problem, but it seems clear that the production of hundred-

dollar books is not a good solution. It is an interesting comment on our society that a modest extrapolation of present trends will allow all of us to buy sophisticated electronic calculators, but no individuals and only the richest libraries will be able to afford books of this type.

M. DERRICK
Argonne National Laboratory
Argonne, Illinois

Astronomy: Fundamentals and Frontiers, 2nd edition

R. Jastrow, M. H. Thompson
518 pp. Wiley, New York, 1974. $14.50

Concepts of Contemporary Astronomy

P. W. Hodge
547 pp. McGraw-Hill, New York, 1974. $9.95

Principles of Astronomy: A Short Version

S. P. Wyatt, J. B. Kaler
487 pp. Allyn and Bacon, Boston, 1974. $10.95

The Science of Astronomy

H. Crull, W. Kaufmann
466 pp. Harper & Row, New York, 1974. $8.50

In recent years astronomy has become possibly the most mind-boggling adventure of the human mind. The nation's professional astronomers, consisting of fewer than 2000 persons, now oversee an annual budget of several hundred million dollars, making the field virtually the *per capita* giant of modern big science. Yet this flow of dollars scarcely keeps pace with the flood of knowledge. If every discipline has its epoch, this surely must be the Age of Astronomy.

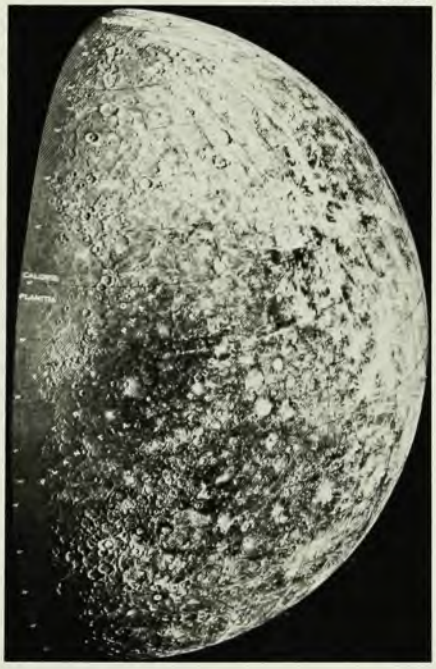
The electronics and space eras have opened the entire electromagnetic spectrum to observation and have facilitated *in situ* studies of the greater terrestrial environment; detectors vary from a neutrino counter in a mine shaft (studying processes in the Sun's core) to Pioneer 10 (soon to depart the solar system). The phenomena investigated range from the cataclysmic birth of the cosmos to the frenetic death of stars, largely in tranquil near-emptiness.

While observational astronomy has moved apace, theoretical astrophysics has likewise matured from its recent infancy into possibly science's most profoundly productive field: The enigmatic quasars, pulsars, black holes, and the like may soon lead to breakthroughs not only in astronomy but also in basic physics. And astronomy increasingly offers to all sciences the ultimate lab: the universe. From curvature of space to structure of nucleons, from intergalactic void to stellar core, from gamma ray to lunar rock—modern astronomy weds the sciences into an inextricably multidisciplinary endeavor.

Along with the flux of astronomical findings and conjectures has come an inpouring of new astronomers; since the late 1950's the annual growth rate of their population has been about 18 percent compared with 7 percent in other fields. Similarly, enrollments by college nonscience students in general education courses in astronomy have risen at comparable exponential rates. The books under review, along with scores of other competitors, are responses to this market.

A decade ago, astronomy courses for nonscience majors often were two terms long, but with the liberalization of requirements and with the growth of junior colleges, the two-term market shrank while the one-term rose. Most of the recent texts consequently aim at the latter market. Regrettably, the similarity among them is even greater than among their counterparts in physics. Certain features today are virtually *de rigueur:* photos from NASA and the Hale, Lick and Yerkes Observatories; a qualitative narrative, involving no math beyond rudimentary algebra; and usually a single column format with

US GEOLOGICAL SURVEY



The surface of Mercury is revealed in detail for the first time by Mariner 10 photographs taken during March 1974. The surface looks much like the Moon, but long, linear cliffs or scarps, some which are over 300 miles long, point to an interior much like the Earth's.