various microwave solid state devices, superconductivity (briefly), lasers, image devices, integrated-circuit technology, and magnetic materials (again briefly). For each topic the pattern is to describe the background phenomena and physical principles, the kinds of devices that result, the present state of the art in device performance, and some of the practical applications and possible future trends for these devices, concluding with brief but carefully selected lists of references.

Microwave semiconductor devices, using bulk negative-resistance effects (the Gunn effect, LSA mode) and avalanche negative-resistance effects (Impatt, Trapatt), can now generate kilowatts of pulsed power at a few Ghz, watts of continuous power at tens of Ghz, and useful oscillations up to a few hundreds of Ghz. Two separate and authoritative sections cover these devices, whose impact on microwave and millimeter-wave device technology will be truly revolutionary. Another strong section describes the varied device possibilities of microwave elastic or acoustic waves (bulk and surface) at frequencies from 100 Mhz to 100 Ghz. These waves can now be generated, guided, modulated, amplified, convolved, diffracted, and detected, all inside (or on) tiny chunks of crystal.

A brief chapter reviews superconductive electronic devices, mostly still rather exotic, based on Josephson phenomena. The two following lectures review the present status of solid state and semiconductor lasers, and the physics and device applications of nonlinear optical polarization in optical parametric oscillators and harmonic generators. The following chapter on laser systems falls rather outside the device-and-phenomena-oriented pattern of the rest of the book, being concerned primarily with optical communications system calculations, rather than with the numerous laser applications in science and technology that might better have been included.

The remaining lectures give a useful survey of image pickup and display devices, vacuum and solid state; an authoritative survey of the battery of competing, still evolving technologies that produce integrated circuits with thousands of transistors per chip and millions of circuits per week; a similarly well done survey of microwave circuit elements, passive and active, fabricated in miniaturized integrated-circuit and microstrip form: and a brief but carefully selected review of some new advances in magnetic materials.

By its nature this book will have a limited useful lifetime. But for the next several years this collection of fairly up-to-date, generally well illustrated, conscientiously prepared survey articles can serve as a good starting point for exploring most of the topics covered.

A. E. SIEGMAN
Microwave Laboratory, Stanford University, Stanford, California

Motion Calculation

Astrodynamics. SAMUEL HERRICK. In two volumes. Vol. 1, Orbit Determination, Space Navigation, Celestial Mechanics. xxvi, 540 pp., illus. $34.50. Vol. 2, Orbit Correction, Perturbation Theory, Integration. xiv, 348 pp., illus. $24.50. Van Nostrand Reinhold, New York, 1971–72.

Herrick has won respect as educator, researcher, and consultant. Sets of his notes on orbital computations have been used almost since the start of the "space age," and rumors of a textbook have circulated for almost as long. The two volumes under review constitute that textbook; they reflect the author's skills, interests, and enthusiasms, and his opinions.

The first volume is principally concerned with the problem of two bodies: computations and applications. There are chapters on the preliminary determination of orbits (from three observations) and on orbit design, and thorough discussions of units and coordinate systems. There is also a chapter on perturbed equations of motion and their treatment. Finally, there are appendices dealing with reference formulas and terminology. In the second volume heavy emphasis is laid on the application of numerical methods for integrating second-order perturbed equations of motion (essentially as devised by Gauss) and on perturbation procedures in which the author's "perturbed variation" ideas and notation are used. The volumes contain throughout detailed listings of formulas and worked numerical examples.

The volumes represent a monumental amount of meticulous work, and form a monument to the author. But I fear that the greatest need for them has passed. Within limits they are valuable and stimulating references on the rich variety of methods available for treating some problems; but these volumes cannot stand alone. Important topics—statistical methods for data processing, for example, or analytical theories that are used to calculate orbits of artificial satellites—are omitted. In spite of his emphasis on computation, the author seems to be wedded to the usage (under his heading "QUICK-WIT") of the desk calculator and seems to be not at ease in referring to high-speed computers (FORTRAN and the like are referred to as "machine languages" and put into the category "NITWIT"!).

The author is, of course, under no obligation to be encyclopedic, and is entitled to a little nostalgia. But these are expensive volumes; the reader whose pocket has been touched may grudge, for instance, the devotion of four pages to a special method for solving Kepler's equation with a desk calculator; to learn how to solve this equation efficiently on a high-speed computer he will have to look elsewhere. I gained little from the sections on analytical methods. In the chapter entitled "Hamiltonian mechanics," I was baffled, for instance, by the sentence: "The implied osculating reference orbit is sometimes described by one or more of the following terms (in ascending order of mathematical generalization): separable, scleronomic, holonomic, and non-esophageal." The author seems not to be at home here.

The title reflects the author's wish to define a distinct discipline, and also his enthusiasm for some newly coined words. A lot of space is taken up by discussion of vocabulary, and the author has a lot of fun. To me, much of the spirit of the work is exemplified in the following definition, which I quote in full: "Algorithm: Algorism, misspelled because of mistakenly assumed association with the root of *arithmetic*; correctly applied to arithmetic using concept of zero; incorrectly substituted for *collection of formulae* by programmers who have been buffaloed into believing existence theorems were important, good programming not, contrary to fact; has gained considerable currency among persons too kindly to recognize arrant pedantry." Characteristic and amusing: but behind the times.

J. M. A. DANBY
Department of Mathematics, North Carolina State University, Raleigh