

hasty interpretations. These warnings are especially valuable for the novice in the field.

Two appendices give some valuable information on the methodology and a glossary of synonymous morphological terms and phrases. An extensive bibliography concludes the volume.

The book is written in a lucid style and therefore should also be placed on the shelves of high school libraries, where it could serve as a healthy antidote to the textbooks that describe *Paramecium* as a "simple" organism.

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Astronomical Charts

Star Atlas of Reference Stars and Non-stellar Objects. Prepared by the staff of the Smithsonian Astrophysical Observatory. M.I.T. Press, Cambridge, Mass., 1969. 152 loose charts + 24-page booklet, boxed. \$18.50.

The primary source for the preparation of this Atlas was the *Smithsonian Astrophysical Observatory [SAO] Star Catalog* (1966), which lists 258,997 stars and includes virtually all stars brighter than the visual magnitude 9 with positions and proper motions for the epoch and the equinox 1950.0 on the FK 4 fundamental system. The SAO Catalog was assembled primarily for the purpose of locating reference stars useful in reducing satellite positions on the Baker-Nunn satellite tracking camera plates. However, it has become of increasing importance for other purposes both to professional and to amateur astronomers.

Other objects that have been added to the Atlas are 2000 stars near the south celestial pole for which the proper motions are not known, and all *New General Catalogue* (NGC) and *Index Catalogue* (IC) objects, with those brighter than about magnitude 13 designated with special symbols.

In general format the SAO Atlas resembles the *Bonner Durchmusterung* (BD) and *Cordoba Durchmusterung* (CD) charts. These charts are still extensively used although they are considerably out of date with their coordinate grid for the equinox of 1855.0 and star positions for approximately the same epoch. The SAO Atlas in many cases will undoubtedly replace these old sources of information.

In the SAO Atlas the sky is divided into eleven bands of equal width of declination, and projections most appropriate for each band have been selected—stereographic projection for the celestial poles, Mercator for the equatorial regions, and Lambert conformal conic for the mid-declinations.

The declination grid is in one-degree intervals, and an overlay reseau allows the eye, with the use of magnification, to interpolate positions to approximately one minute of arc.

The scale of the SAO Atlas is 6.95 minutes of arc per millimeter, which is equal to that of a camera with a focal length of 494 millimeters. This is slightly less than half the scale of the *Durchmusterung* charts. The reduced scale and the increase in the number of sheets of the SAO Atlas make the format more convenient than the *Durchmusterung* charts, but will require the use of a reading glass—at least where there is low illumination such as dim light in the dome.

The quality of the charts is generally excellent, and since each original chart was plotted on an enlarged scale (1 arc min/mm) on an analog computer, with star and object positions and magnitudes inked in by hand, a minimum of errors should be expected.

Since the stars in the SAO Atlas have precise positions (the average standard deviation of a position in the SAO Catalog is ± 0.5 arc sec) this set of charts makes it extremely convenient for the professional as well as the amateur astronomer to identify and select suitable reference stars for measurement of photographs—whether he is determining the positions of an asteroid, comet, or artificial satellite. Even the professional astronomer, using the SAO Catalog on tape and an on-line plotter, might find the Atlas useful for quick verification of his plot.

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The Physics of Sound

Theoretical Acoustics. PHILIP M. MORSE and K. UNO INGARD. McGraw-Hill, New York, 1968. xxii, 938 pp., illus. \$23. International Series in Pure and Applied Physics.

This book is unique. It is a graduate-level textbook covering many aspects of theoretical acoustics with a thoroughness not encountered elsewhere. It in-

cludes much of the material contained in Morse's earlier book, *Vibration and Sound*, but is about twice as long. Added to the earlier book are chapters covering the relatively new areas of nonlinear acoustics, acousto-optical effects, plasma acoustics, the acoustics of moving media, and coupled acoustic systems. In addition, there are many new sections illustrating the use of modern theoretical techniques in practical problems.

The first chapter is a nice, gentle introduction, written from a physicist's point of view, to some of the mathematics to be used throughout the rest of the book. The reader is then led in successive steps from an understanding of the simplest vibrating systems to methods of solving intricate acoustical problems. By the time he comes to study sound waves in fluids, he has been introduced to random and transient phenomena, normal modes, the use of Green's functions, the Born approximation, variational techniques, and second-order effects in connection with studies of coupled linear oscillators, flexible- (and stiff-) string waves, and a brief study of transverse waves on bars, membranes, and plates. These theoretical techniques are then used to discuss not only the simpler, standard acoustical problems but also more involved questions such as radiation from violent fluid motions, from random sources, from aircraft propellers, and from pistons set in locally reacting surfaces; scattering from surface irregularities and turbulence; and propagation in ducts with nonrigid walls, in ducts containing sources, scatterers, or discontinuities, in rooms, and in coupled acoustical systems. The last quarter of the book consists of somewhat more qualitative discussions of the acoustics of moving media (including sound generation by turbulence and by flow around rigid bodies, the effect of flow on transducer response, and effects at the interface between moving fluids); plasma acoustics; interactions between light and sound; and nonlinear acoustics.

Each chapter is followed by problems that complement the text material, but the solutions are not provided. The index is fairly complete, and there is a useful glossary of symbols. Also included in the back of the book are tables of special functions, impedance charts, and a short bibliography of books and review papers. A shortcoming of the book is the almost total lack of references to original papers.