Preface

THIS volume is intended to provide a comprehensive treatment, including recent developments, of the principles of fundamental positional astronomy. The classical treatises on spherical astronomy by Brünnow, Chauvenet, de Ball, Oppolzer, and Newcomb have become deficient because of later developments, but no later treatises of comparable completeness and rigor have appeared, and the more recent material has been widely scattered through the literature.

The longer intervals of time over which observations have now been accumulated, the continually increasing precision of the observations, and the higher orders of accuracy in astronomical data needed for new scientific problems and technological applications have resulted in many former methods and concepts becoming inadequate. In particular, mathematical developments to the second and third order are often necessary where the first order of approximation was formerly sufficient, and it has become essential to take account of the nonuniformity of mean solar time.

The exigencies of our own duties at the U.S. Naval Observatory directed our attention to the need for a new authoritative treatment. We have restricted the contents to the principles of spherical astronomy and the theory of fundamental astronomical observations. The practical details of operating particular astronomical instruments are not included, and only brief references are made to the methods used in navigation, surveying, and engineering astronomy. Several topics which were the subjects of extensive sections in some of the classical treatises have been omitted, as they are more properly subjects for separate volumes and are now adequately treated in easily accessible publications—in particular, the theories of special phenomena such as eclipses, transits, and occultations; the theory of least squares and other methods for the adjustment of observations; methods in numerical mathematics, and techniques of numerical calculation.

Special care has been taken to formulate definitions that are precise and meticulous, and to derive formulas applicable in both the Northern and the Southern Hemispheres of the Earth. In general, mathematical relations are explicitly derived in a completely rigorous form before approximations are made to obtain the formulas that are needed for practical purposes. In

applied mathematics it is essential to take advantage of approximations, but without sacrificing rigor of thought or neglecting to verify that the departure of the approximation from rigor is inconsequential for the immediate purpose. The order of accuracy necessary in practice often increases as technological advances take place and additional needs develop, but sometimes the approximations implicit in accepted standard methods are overlooked or forgotten. The formulas are left in their basic forms. The development of calculating machines has outmoded the logarithmic transformations given in the classical treatises; and the development of high speed electronic computing machinery has radically altered the practical methods of numerical calculation and the transformations needed in any given case.

At the 1964 General Assembly of the International Astronomical Union in Hamburg, revised values were adopted for several astronomical constants and will be introduced into the national and international ephemerides as soon as practicable. The revised constants will slightly alter the numerical coefficients in some of the formulas. The constants which will replace those from which these coefficients were derived are given on pages 112–113. The new values of the astronomical unit and the velocity of light give a light-time of $499^{s}.012$ for unit distance, to replace both the value $498^{s}.38$ derived from the former constant of aberration, and the value $498^{s}.58$ derived from the former velocity of light and solar parallax.

In discussing the inertial reference system (Chapter 19), we have purposely refrained from any mention of Mach's principle which, although the subject of much discussion, seems so far to have eluded any operational formulation.

The manuscript of the book was read in its entirety by Robert R. Rawlings, and in part by Raynor L. Duncombe, Armstrong Thomas, and Dan Pascu, of the Nautical Almanac Office, U.S. Naval Observatory. Their comments have enabled us to make a number of improvements in the text.

EDGAR W. WOOLARD
GERALD M. CLEMENCE

January, 1966