Cours d'Astronomie. By H. Andoyer. Paris, Hermann.
Première partie: *Astronomie théorique*, Third edition, 1923. 455 pp.
Seconde partie: *Astronomie pratique*, Second edition, 1924. 316 pp.

The third edition of the first part of Andoyer's comprehensive text on spherical astronomy (*Astronomie théorique*) has undergone considerable changes when compared with the two previous editions. The changes affect the theory of precession and that of the eclipses of the Sun and the Moon. There is besides in the new edition an additional chapter which deals with the determination of a Keplerian orbit, when three approximate observations are given. The material of the text is subdivided into four larger sections (livres); each section contains a number of chapters. There are altogether twenty chapters. The author's acknowledged mastership has given to science a text which ranks well with the four volumes of Tisserand's *Mécanique Céleste.* Very few and rather insignificant misprints have been noticed. It is observed that very few references are given, and an index would have added considerably to the usefulness of the text. The reader familiar with the English or German notations in spherical astronomy will probably wish that terms like *hour angle* (τ) and *sidereal time* (θ) had undergone no changes in notation. Likewise it would seem that to represent a star by letter M is not very fitting, particularly when the parallactic angle is represented by S. We notice on page 120 the notation t for sidereal, τ for mean solar, and H for apparent solar time, which seems not very good usage.

In the introductory section one chapter is devoted to spherical trigonometry. No restrictions are based on the magnitude of sides and angles of the "general" spherical triangle. The formula $\cos V = \cos\alpha\cdot\cos\alpha' + \cos\beta\cdot\cos\beta' + \cos\gamma\cdot\cos\gamma'$ is made the basis of the general study and by purely algebraic transformations all of the systems of formulas used in spherical trigonometry are derived. The consideration of adjoined spherical triangles and polar triangles employed for elementary spherical trigonometry are here replaced by transformations "S" and "T". The invariants

$$D = 1 - \cos^2 a - \cos^2 b - \cos^2 c + 2\cos a \cos b \cos c$$
$$= 4 \sin s \sin (s-a) \sin (s-b) \sin (s-c)$$

and

$$D' = 1 - \cos^2 A - \cos^2 B - \cos^2 C + 2 \cos A \cos B \cos C$$
$$= 4 \sin\sigma \sin\left(A - \tfrac{\sigma}{2}\right) \sin\left(B - \tfrac{\sigma}{2}\right) \sin\left(C - \tfrac{\sigma}{2}\right)$$

where $2s = a + b + c$, $2\sigma = A + B + C - \pi$, play in this theory an important role.

In the second and third sections the theory of the corrections is given which are to be applied to given observations. The reader will find among these the theory of refraction very attractive since very short and quite original. Designating the refraction on the path C

by R, the radius vector by r, the index of refraction by n, the zenith distance of observed ray of light by z_0, the author employs for R a power series development in tan z_0 as follows:

$$R = \int_C \frac{\frac{r_0}{r} d\left(\frac{n_0}{n}\right)}{\sqrt{\operatorname{ctn}^2 z_0 + 1 - \left(\frac{n_0}{n}\right)^2 \cdot \left(\frac{r_0}{r}\right)^2}}$$

$$= A \tan z_0 - B \tan^3 z_0 + C \tan^5 z_0 - D \tan^7 z_0 \pm \cdots.$$

He shows that the coefficients A, B, C, D can be determined approximately for $z_0 < 75°$ with an error not exceeding $0''.1$ without establishing first the connections between the variables r and n by means of introducing three new functions in the customary way. These functions involve the density of the air, the atmospheric pressure and the temperature. The horizontal refraction cannot be dealt with so easily. Here an assumption of a relation between the temperature and density of the air is of course necessary. The auxiliary function

$$\varphi(u) - \frac{r_0}{r} d\left(\frac{n_0}{n}\right) = \varphi(u)\, du$$

is put in the form $\varphi(u) = a \cdot e^{-ku}$ and Andoyer shows that the computation of R will then be in such a form that Radau's tables for $\Psi(x)$ where $\Psi(x) = e^{x^2}\int_x^\infty e^{-x^2} dx$ become readily available. A comparison of Andoyer's value of R with that of Radau for a mean condition of the atmosphere shows that his value differs only by $20''$ from that of Radau, obtained in a much more laborious manner. Such an agreement for horizontal refraction is all one may ask for.

For the presentation of the theory of precession and nutation the author has written an introductory chapter (X) on Keplerian motion and a general outline of planetary perturbations. It would have been highly desirable to extend the scope of this chapter so as to include the fundamentals in the theory of a rotating body. Chapter XI requires a facile knowledge of both and presents probably more difficulties to the reader than any other chapter.

Of the second part written in collaboration with A. Lambert it will suffice to say that W. W. Campbells *Practical Astronomy* is probably the nearest approach in the English language to the presentation of the subject matter in this book. While, in the study of the equatorial, reference is given to the photographic instrument by which the "carte du ciel" is obtained, there is no chapter devoted to the reflecting telescope. The text contains nine photographic cuts some of which illustrate new instruments or instrumental accessories. Since only French makes are selected, it can hardly be said that the great advance in instrumental equipment which the last quarter of century has witnessed in this country and elsewhere is given sufficient recognition.

KURT LAVES