

APPENDIX: REPORTS OF THE DIRECTORS OF THE NATIONAL EPHEMERIDES

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During the period under review two issues of the *Astronomical Yearbook of the U.S.S.R.* for the years 1971, 1972 have been published, and that for 1973 is in preparation. The positions and proper motions of the stars are in the FK4 system as recommended by Commission 4 in 1961. Further, as recommended at the meeting in Hamburg in 1964 (*Trans. IAU*, 12 B (1964), 105, 1966) the IAU System of Astronomical Constants has been introduced into the tabulations of the day numbers, solar and lunar eclipses, ephemerides for physical observations of planets, and the factors *S* & *C*. The corresponding differential corrections to the Moon's ephemeris as well as re-calculated eclipse data for 1971 have been tabulated separately in the Appendix to the *Yearbook* for 1971. As from the edition of the *Yearbook* for 1972, the lunar ephemeris $j = 2$ will be published in accordance with the recommendations adopted in Prague in 1967.

The regular publication of the ephemeris of the lunar crater Mösting A has been continued in the editions of the *Yearbook* mentioned above.

Fundamental ephemerides of the Sun, Moon, and planets have been printed in full conformity with the first part of the *Astronomical Ephemeris* circulated in advance by H. M. Nautical Almanac Office, Royal Greenwich Observatory.

The navigational almanacs have regularly been produced as before. The *Nautical Almanac* has been issued for the years 1970, 1971, and the *Air Almanac* for 1969, 1970.

The predictions of lunar occultations for 1968, 1969, 1970, computed by and received from H. M. Nautical Almanac Office, Royal Greenwich Observatory, were distributed, as usual, to the Soviet observatories.

A new electronic computer BESM-4 was installed in January–March 1969 making practicable the systematic calculation of ephemerides.

A series of papers on different topics of celestial mechanics and computational procedures were published in the *Bulletin* of this Institute.

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Le travail de calcul et de rédaction des publications du Bureau des Longitudes a été poursuivi à un rythme accéléré au cours des trois dernières années sans toutefois qu'il ait encore été possible d'avancer les dates de parution des volumes.

Le contenu de la *Connaissance des Temps* n'a pas été modifié dans son ensemble. Le système UAI de constantes astronomiques a été introduit depuis le volume pour 1968. Toutefois, on n'a pas tenu compte du changement de constantes dans le calcul des coordonnées vraies du Soleil et des planètes. Pour la Lune, on a continué à publier les éphémérides avec les anciennes constantes mais on donne un tableau de corrections pour passer au nouveau système.

La totalité des tableaux variables de la *Connaissance des Temps* à l'exception de ceux relatifs aux satellites de Jupiter, les éclipses et quelques courtes tables sont composés de manière automatique grâce à un convertisseur de bandes 7 canaux en bandes Monotype.

Les recherches concernant le mouvement des satellites galiléens de Jupiter se poursuivent. A court terme, une amélioration dans la présentation des éphémérides permettant le calcul facile des coordonnées rectangulaires tout en introduisant les termes antérieurement négligés de la théorie de Sampson a été étudiée. Elle sera introduite dans la *Connaissance des Temps* pour 1972, en même temps qu'une méthode rigoureuse de calcul des phénomènes sera utilisée. A plus long terme, on a commencé à refaire les calculs de la théorie de Sampson avec les constantes d'intégration tirées des travaux de De Sitter. Enfin, en liaison avec l'Institut Tecnológico de Aeronáutica (São José dos Campos, Brésil) les études pour la construction d'une théorie nouvelle sont activement menées.

La totalité des Ephémérides Nautiques est calculée sur ordinateur et composée automatiquement.

Les Ephémérides aéronautiques, dont des épreuves reproductibles sont désormais envoyées directement par le U.S. Nautical Almanac Office et le H. M. Nautical Almanac Office, continuent à être publiées sous la même forme qu'auparavant.

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The Office has continued, without substantial change, the production of the four ephemerides: *The Astronomical Ephemeris* – for astronomers; *The Nautical Almanac* – for surface navigation; *The Air Almanac* – for air navigation; and *The Star Almanac* – for land surveyors. The first three of these ephemerides are completely unified with the corresponding U.S. editions, which are printed separately from identical reproducible material; this material can be made available, at a small charge, to the official almanac-producing agency in any country that desires to publish similar ephemerides in this form.

The fundamental ephemerides of the Sun, Moon and planets contained in the first part of *The Astronomical Ephemeris* for 1972 and 1973 have been circulated to ensure that the tabulated data are available to all agencies responsible for the preparation of navigational and other almanacs.

As from the year 1972 there will no longer be in *The Astronomical Ephemeris* an appendix containing the differential corrections, or the formulae from which they can be derived, necessary to convert the printed ephemerides to those based on the IAU System of Astronomical Constants. However, in strict accord with the recommendations of the Commission at the thirteenth General Assembly (*Trans. IAU*, 13 B, 47–49, 1968) the printed ephemerides of the Sun, Mercury, Venus and Mars do not incorporate these corrections, they are in fact strictly continuous with the ephemerides as printed up to the end of 1971. The corrections are generally small and are often negligible; formulae (similar to those previously given in the appendices) will be included in the Explanation for 1972 and future years. It should, however, be noted that the Sun's longitude is now tabulated to 0".01, so that the corrections to be applied are now significant in that unit, and may reach 0".04 in the apparent longitude.

The only substantial changes in the tabulations for 1972 are: the incorporation of the changes, necessary to convert to the IAU System, in the ephemerides of the Moon (which is now in accord with the specification for $j=2$), the outer planets (Jupiter to Pluto) and the four minor planets; the tabulation of an additional figure in the Moon's horizontal parallax for 0^h and 12^h on each day, and the inclusion of hourly values to 0".01; the introduction of a new ephemeris, for 0^h and 12^h on each day, of the distance of the Moon in units of the Earth's equatorial radius; and the extension of the ephemerides of the minor planets throughout the year.

The fundamental ephemerides for 1972 have been set by a photocomposing system controlled from the output of the ICL 1909 computer, on which all the calculations have been made. Due to limitations in the available equipment, the process has not been entirely satisfactory in practice, but it has served to demonstrate that the editing programs possess all the flexibility required to produce copy to a high standard – both of accuracy and presentation. Improved equipment will be used for future years.

A start has been made on the major project of recalculating, to a considerably higher precision than that aimed at by E. W. Brown, the effect of planetary perturbations on the motion of the Moon. Little real progress has been made with the theoretical work, other than to recognize the considerable difficulties that arise in using Brown's method to higher precision. However, a comprehensive program of numerical integration designed to provide a basis for the comparison of the theory with values obtained by direct numerical integration of the differential equations is now in operation.

Co-ordinates of the Earth with respect to the centre of gravity of the Sun and planets (S9) have been prepared, and made available, for the analysis of current observations of pulsars.

The availability of the ICL 1909 computer has made practicable the reduction of observations of lunar occultations almost as and when they are received, and observers can thus be informed of

the results of their observations within a short time. This has led to a considerable encouragement to observers, as well as to improvements in methods of observation.

The limb corrections given in *The Marginal Zone of the Moon* (A.P.A.E., Vol. XVII) by C. B. Watts have now been put into machine-readable form, so that in future these need no longer be laboriously taken out by hand. The systematic reduction of observed occultations, including limb corrections, is now complete from 1958 to 1968, and will be extended backwards in due course to 1943. The observations from 1960–1966 have been subjected to a detailed analysis (*Mon. Not. R. Astr. Soc.*, **144**, 129, 1969), the main result being that the duration of the second (the SI second, as now adopted internationally) differs very little from that of the ephemeris second as determined from the ephemeris of the Moon, $j = 1$.

The programme of predictions of occultations by the Moon, including those of radio sources, has been somewhat extended; a computer programme for the systematic prediction of grazing occultations, is almost complete. A comprehensive programme for the prediction of occultations of stars by the planets (including minor planets) has just been completed. The earlier programme, by inspection, brought to notice the occultation of a star by Neptune on 1968 April 7, the collected observations of which have made possible (*Mon. Not. R. Astr. Soc.*, in press) an extremely accurate relative position of the planet and star, and a new determination of the planet's diameter.

D. H. SADLER

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Astronomical Constants. When the IAU System of Astronomical Constants was adopted in 1964, the value of the astronomical unit in kilometers was based on radar measurements of interplanetary distances. The values known from determinations by the dynamical method deviated from the radar value. The discrepancy has been clarified and eliminated in the past three years. A determination of the mass of the Earth-Moon system has been carried out by Zech (Heidelberg, 1969) by numerical integration of the orbit of Eros. The result $1/m_{E+M} = 328894 \pm 30$ (m.e.) agrees very well with recent determinations by Rabe (Cincinnati, 1967) and Lieske (New Haven, 1968), and all three are in very satisfactory agreement with the mass resulting from the inter-planetary radar distance measurements.

The correction to Newcomb's value of lunisolar precession determined by Fricke (Heidelberg, 1967) has been the object of further investigations. A re-determination on the basis of Newcomb's data has cleared up the origin of Newcomb's error, and an uncertainty arising from an unexplained part in the variation of obliquity of the ecliptic has been explained and eliminated. The results of these latter investigations will soon be published.

Fundamental Catalogues. The systematic differences between 71 observational catalogues and FK3, which had been determined and applied in the construction of FK4, were published by Nowacki and Strobel (Heidelberg, 1968). Under the supervision of Lederle the documentation of star catalogues on punched cards has been continued; these data are made available, in accordance with the recommendations of the Working Group on Space Ephemerides. Investigations have been made with the aim of developing improved methods for the construction of fundamental and general catalogues of stars.

APFS and exchange of ephemerides. Within the period under review four volumes of *Apparent Places of Fundamental Stars* were published (1969–1972). Apart from the communication of apparent and mean places for the FK4 and FK4 Sup stars in listed or printed form, the material is also available in machine-readable form (punched cards or 5-channel paper tape) on request.

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The Japanese Ephemeris has continued to be published for the years 1969 to 1971. The ephemerides of the Sun, Moon and planets have been reproduced from the advanced proofs of the *Astronomical*

Ephemeris provided by the H.M. Nautical Almanac Office and the remaining parts have been computed in the Department. Corrections to the Moon's ephemerides for conversion to the IAU system are given for every half day.

The Nautical Almanac, *The Abridged Nautical Almanac*, and *The Polaris Almanac for Surveying* for the years 1968 to 1970 have continued to be published without substantial change. *The Altitude-Azimuth Almanac for the Antarctic Expedition* and *The Abstract from the Japanese Ephemeris* have been compiled annually at the request of National Defence Agency.

In consultation with the Nautical Society of Japan, the Department re-examined the contents of the *Astronomical Navigation Tables* (H.O. No. 601), which had been employed as standard for sight reduction in Japan, and the revised edition was published in 1969.

The value of ΔT for use in predictions of eclipses and compilations of almanacs and the national calendar, which is compiled at the Tokyo Astronomical Observatory, has been settled by arrangement with the Tokyo Astronomical Observatory from results of occultation observations made at the Department, taking the tendency of A.T. — U.T. into account.

A. M. SINZI

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During the period under review, the volumes of the *Indian Ephemeris and Nautical Almanac* for 1969 and 1970 were published. The issue for 1971 is expected to be published by February, 1970. No substantial change in respect of the contents of the publication has been introduced during these years. As regards the IAU System of Astronomical Constants, some of the revised values have already been introduced in the 1968-issue. From 1969 the revision of the horizontal parallax of the Moon has been indicated in the relevant tables, while those of the planets have been fully revised.

In addition to the above main publication, the following two other publications continue to be issued annually:

(i) *Tables of Sunrise, Sunset and Moonrise, Moonset* — a reprint from the *Indian Ephemeris and Nautical Almanac*.

(ii) *Rashtriya Panchang* in twelve languages, giving details of Indian calendar and festival dates. The issues for 1891 Saka Era (1969–70 A.D.) were published in 1969.

The publication of the English translation of the Marathi book on the history of Indian astronomy the *Bharatiya Jyotish Sastra* by late S. B. Dixit has been taken up. The first part of the book covering the Vedic and Vedanga periods was edited and published. The remaining parts covering the Siddhantic and modern periods will be published soon.

N. C. LAHIRI

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The work in this Ephemeris Office has been to continue the publication of the *Efemerides Astronomicas*, the *Almanaque Nautico*, and the *Almanaque Aeronautico*, with only minor modifications. During the period January 1967 to January 1969 we have carried out the mechanization of most of the calculations of this Office.

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The Nautical Almanac Office is responsible for the publication of four annual ephemerides: *The American Ephemeris and Nautical Almanac* — for astronomers; *The Nautical Almanac* — for surface navigation; *the Air Almanac* — for air navigation; and *The Ephemeris* — for land surveyors, as well as the pamphlet *Astronomical Phenomena*.

The *American Ephemeris*, unified with the *Astronomical Ephemeris* issued by H. M. Nautical

Almanac Office, Royal Greenwich Observatory commencing with the volume for 1960, has continued to be published. The volumes for 1968, 1969, 1970 and 1971 include appendices which contain corrections to convert the tabular data to the IAU System of Astronomical Constants (*Trans. IAU*, **12B**, 105, 1966). Beginning with the *American Ephemeris* for 1972, the IAU System of Astronomical Constants has been included in the tabular material.

A computer-controlled photo-composition method utilizing paper tape has been used to prepare the *Air Almanac* for 1969 and 1970. Starting with the *Air Almanac* for 1971 a faster photo-composition system using magnetic tape has been introduced.

Preparation of the circumstances of solar eclipses with argument in U.T. has been continued (see *U.S. Naval Observatory Circulars*, nos. 116, 122, 123 and 125). The cooperative project to put star catalogs in machine-readable form has also been continued (see *U.S.N.O. Circ.* no. 114). A special ephemeris of the radio longitude of the central meridian of Jupiter, System III, has been computed for the years 1968–71 (see *U.S.N.O. Circ.* no. 117). Additional astronomical information has been prepared and published in *U.S.N.O. Circulars* as follows: 'Phases of the Moon 1960–2003' in no. 119 and 'Sunlight, Moonlight and Twilight for Antarctica, 1969–1971' in no. 120.

The research program on the motions and masses of the planets has been continued (see report of Commission 7). Reprints of Volumes VI (Newcomb's Tables of the four inner planets) and X, Part II (Robertson's Zodiacal catalog) of the *Astronomical Papers of the American Ephemeris* have been issued.

R. L. DUNCOMBE

Brief reports and notes

J. Arias-de Greiff reports that the publication of the *Anuario de Observatorio Astronómico Nacional*, Bogotá, Colombia, has continued regularly since 1966 with only minor changes. Most of the material has been provided by H.M. Nautical Almanac Office, the U.S. Naval Observatory and the Astronomisches Rechen-Institut: the remainder has been computed in the Centro de Cálculo Electrónico at the University of Columbia.

The Jet Propulsion Laboratory, Pasadena, U.S.A., has undertaken an extensive programme of ephemeris computation in connection with space missions. Descriptions of much of this work are given in the *Technical Reports* of the Laboratory and copies of the ephemerides on magnetic tape can normally be made available on a reciprocal basis. A summary of the work on the lunar ephemeris has been given by J. D. Mulholland (*Nature*, **223**, 247–9, 1969).

I. I. Shapiro reports that at the Massachusetts Institute of Technology, Cambridge, U.S.A., over 150000 optical observations of the right ascension and declination of the Sun, Moon and planets for the period 1750 to 1968 have already been put into a machine-readable form. It is hoped that arrangements can be made to make these data available to others.

Several large-scale comparisons between collected observational data and planetary orbits obtained by numerical integration are in progress and preliminary results have been reported by Melbourne and O'Handley (Jet Propulsion Laboratory) and by Oesterwinter and Cohen (U.S. Naval Weapons Laboratory, Dahlgren, Va., U.S.A.). These will form a valuable supplement to the recent determinations of astronomical constants from analyses of the orbits of individual natural and artificial bodies.

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