4. EPHEMERIDES (ÉPHÉMÉRIDES)

PRESIDENT: V. K. Abalakin.
VICE-PRESIDENT: A. M. Sinzi.
ORGANIZING COMMITTEE: R. L. Duncombe, T. Lederle, J. H. Lieske, B. Morando, A. Orte, P. K. Seidelmann, G. A. Wilkins.

INTRODUCTION

This Report is compiled by using the reports of the Directors of the national ephemeris offices reviewing the programs for the preparation and publication of astronomical ephemerides of variuos purposes, i.e. for astronomers and space scientists, marine and air navigators, and surveyors. Some proposals of Commission members are also included. The Report may be of interest also to other I.A.U. Commissions, and mainly to Commissions 7, 8 and 31. Principal topics belonging to the Commission competence and some items to be presented to the XVIIth General Assembly of the I.A.U. in Montreal will be reviewed in following comments.

Before proceeding it is fitting to pay tribute to the memory of Dr Edgar W. Woolard who passed away 17 June 1978. His scientific activities were fruitfully associated for many years with Commissions 4 and 41.

COMMISSION 4 WORKING GROUP ON NUTATION

In accordance with resolutions adopted at the I.A.U. Symposium No. 78 (Kiev, May 1977) the Working Group on Nutation was established to give a proper consideration to the subject. The Chairman of the Working Group is Dr P. K. Seidelmann. The results of the exchange of opinions and ideas among the members of the W. G. and several advisers were incorporated by Dr Seidelmann in the Draft Report of the W. G.

The final recommendations of the Working Group on Nutation will be made available to all I.A.U. members prior to the XVIIth General Assembly and will be discussed at a joint meeting of Commissions 4, 7, 8 and 31. Moreover, the I.A.U. Joint Working Group on Cartographic Coordinates and Rotational Elements of Planets and Satellites has been established by Commissions 4 and 16. The Chairman of the Joint Working Group is Dr Merton E. Davies.

INTERNATIONAL MEETINGS OF INTEREST TO THE COMMISSION

The following international scientific meetings have taken place between the XVIth and XVIIth I.A.U. General Assemblies:

(i) The I.A.U. Colloquium No. 41 "Dynamics of Planets and Satellites and Theories of their Motion" (Cambridge, U. K., August 1976);
(ii) The I.A.U. Symposium No. 81 "Dynamics of the Solar System: Theory and Application" in honour of Prof. Dr Yusuke Hagihara (Tokyo, May, 1978);
(iii) The I.A.U. Symposium No. 82 "Time and the Earth's Rotation" (Cadiz, May 1978);
(iv) The U. S. Naval Observatory Symposium "Star Catalogues, Positional Astronomy and Celestial Mechanics" in honour of Professor Paul Herget (Washington, D. C., November 1978).

MATTERS FOR DISCUSSION IN MONTREAL

Following items are proposed to be included into the Agenda of the Commission 4 meetings (either alone or with other Commissions) during the XVIIth I.A.U. General Assembly:

(i) On the status of work on the FK5 (Dr W. Fricke);
(ii) Dr D. H. Sadler's proposal to re-consider the Resolution No. 1 (Nomenclature for Time-scales) adopted at the joint meeting of Commissions 4 and 31 in Grenoble on 30 August 1976;
(iii) Dr A. Orte's statement concerning the inadequacy of the present definition of Universal Time and the necessity of its clarification in the future (to be discussed jointly with Commission 31).

PUBLICATION OF INTERNATIONAL AND NATIONAL EPHEMERIDES

The Nautical Almanac Offices of the Royal Greenwich Observatory and the U. S. Naval Observatory have continued to produce jointly the three unified publications: The American Ephemeris and Nautical Almanac/The Astronomical Ephemeris, The Nautical Almanac, and The Air Almanac.

The 1981 edition of the American Ephemeris/The Astronomical Epheris will be revised in both content and arrangement, the Astronomical Phenomena and Planetary and Lunar Coordinates also will be joint publications satisfying the requirements for advanced data. Dr Wilkins informs: "It is unlikely that the volume of the Astronomical Ephemeris for 1981 will be published by the beginning of 1980, as had hoped; it will be printed only by the U. S. Government Printing Office, but it will also be published by H.M.N.A.O. under the new common title : The Astronomical Almanac". Copies of Planetary and Lunar Coordinates 1980 - 1984 have been distributed by H.M.N.A.O. quite widely to organisations preparing local almanacs.

During the period under review three volumes of The Astronomičeskij Ežegodnik SSSR (the Astronomical Year-Book of the U.S.S.R.) for the years 1979-1981 have been produced in the Institute for Theoretical Astronomy, Leningrad, U.S.S.R., on the generally adopted theoretical basis, the volume for 1982 being in press. The Appendices to these volumes contain the ephemerides of the four ancient (Galilean) satellites of Jupiter for 1978-1980 as prepared in, and received from, the Bureau des Longitudes, Paris, France. The regular publication of the ephemeride of the lunar crater Mösting A has been continued.

Dr Morando writes: "Le Bureau des Longitudes a publié en 1976, 1977 et 1978 la Connaissance des Temps pour 1977, 1978, 1979 respectivement sous sa forme habituelle... En 1977 le Bureau des Longitudes a édité par ses propres moyens un ouvrage d'un type nouveau appelé Connaissance des Temps, nouvelle série, éphémérides astronomiques pour l'an 1978. Cet ouvrage contient les coefficients des développments en polynômes de Tchebychov des coordonnées du Soleil, de la Lune, des planètes et des satellites galiléens de Jupiter".

The Japanese Ephemeris, the Nautical Almanac, the Abridged Nautical Almanac and the Polaris Almanac for Azimuth Surveying have continued to be published by the Hydrographic Department of Japan, Tokyo, for the years 1977, 1978 and 1979, respectively. Dr. Sinzi informs: "It is scheduled that (i) the Japanese Ephemeris from the volumes of 1980 onwards contains the fundamental ephemerides of the Sun, Moon and planets

computed at the Department, being rigorously based on the respective basic data on which the Astronomical Ephemeris is based, and (ii) the Japanese Ephemeris for the year 1980 also contains the predictions of the solar eclipses in 1981-1985 as a supplement. The volumes for 1981, 1982 and 1983 will contain similar data for 1986-1990, 1991-1995 and 1996-2000, successively.

A new publication, the Almanac for Computers has been introduced by the U.S.N.A.O. on an experimental basis, starting with the issue for 1977. This volume contains polynomial coefficients which provide the means for computing the positions of the Sun, Moon and planets for any time during the year to the accuracy desired and includes star positions and coefficients in order to provide mean or apparent places to different levels of accuracy.

Dr Orte communicates from the Instituto y Observatorio de Marina at San Fernando (Cadiz), Spain,: "The Efemérides Astronomicas and the Almanaque Nautico continue to regularly be published... After a public survey amon actual and potential users of the Almanaque Aeronautico it was decided to discontinue this publication after the 1976 issue, supplementary tables to the Almanaque Nautico permitting its use also to air navigators".

According to information from Dr A. Bandyopadhyay, the Nautical Almanac Unit of Regional Meteorological Centre, Calcutta, India, has published three volumes of the Indian Astronomical Ephemeris for the years 1977, 1978 and 1979. They contain basic astronomical data as required for India as well as the ending moments of tithis, nakshastras, yogas, etc.

In addition, two other publications have been issued annually to meet public requirements for certain astronomical information: (i) Tables of Sunrise, Sunset and Moonrise, Moonset, (ii) Rashtriya Panchang (in English and eleven Indian languages) giving data required for the Indian Calendar.

As Dr Fricke reports the computation and publication of Apparent Places of Fundamental Stars (APFS, in annual volumes) has been continued at the Astronomisches Rechen-Institut at Heidelberg, F.R. Germany. The edition for the year 1980 (now in print) will be the last of 25 volumes (4 produced at Herstmonceux and 21 at Heidelberg) which have been prepared on a card-controlled typewriter. As from the 1981 edition onwards the data will be transcribed on a magnetic tape from which the volume will be printed automatically by a photo-composing method.

Progress has been made in the work on the FK5. Most of the observations which have become available after the completion of the FK4 have been taken on magnetic tape and are ready for the determination of systematic differences against the FK4. The U.S. Naval Observatory, Washington, D.C., and the Center de Données Stellaires at Strasbourg have contributed efficiently to this task.

The work on the determination of equinox and equator of the FK5 has resulted in new findings on the origin of the non-precessional motion of the equinox of the FK4; reference is made to a report given by Dr Fricke (in press: Proc. I.A.U. Symp. No. 81).

Attention is drawn to published work related to the I.A.U. (1976) System of Astronomical Constants and to the FK5. Lieske, Lederle,

https://doi.org/10.1017/S0251107X00010567 Published online by Cambridge University Press

Fricke and Morando (19.043.006) have developed the expressions for the precessional quantities based upon the I.A.U. (1978) System, and Fricke (19.043.007) has presented the basic material on which the new value of the luni-solar precession is based and has outlined the arguments in favour of the change of the constant of precession (19.043.002). Lederle (Bull. CDS, No. 14) has computed tables giving information on the accuracy of the FK4 data at different epochs.

OTHER PUBLICATIONS

The fourth impression of the Explanatory Supplement to the A. E. was published by the Nautical Almanac Offices of the R.G.O. and the U.S.N.O. in 1977 with some amendments and additions.

The H.M. Nautical Almanac Office has continued to publish The Star Almanac for Land Surveyors and has included in it new tabulations of polynomial coefficients for the calculation of sidereal time and the solar ephemeris.

The preparation of the Bureau of Land Management Ephemeris for land surveyors has been continued by the U.S.N.A.O.

The epoch 1980 edition of Publication No. 249, volume 1, Sight Reduction Tables for Air Navigation, was calculated and prepared by the Defense Mapping Agency Hydrographic Center, U.S.A.

The navigational almanacs have been produced as before by the I.T.A., Leningrad, the Marine Almanac being published for 1978-1980, and the Air Almanac for 1977-1979.

Circumstances of solar eclipses in 1976, 1977 and 1979 with arguments in UT have been prepared in the U.S.N.A.O. and published in the U.S.N.O. Circulars.

The Altitude and Azimuth Almanac for the Antarctic Observation and the Abstract from the Japanese Ephemeris have been compiled annually at the request of the Defence Agency of Japan by the Hydrographic Department, Tokyo.

Le Bureau des Longitudes a publié les Éphémérides Nautiques pour 1977, 1978 et 1979 et l'Annuaire du Bureau des Longitudes pour ces mêmes années. Il contrôle également la publication des Éphémérides Aéronautiques.

The Air Almanac for 1977 was published for the first time in India in October 1976 on the basis of the data supplied by the H.M.N.A.O., the volumes for 1978 and 1979 having been published.

PLANETARY, LUNAR, AND SATELLITE RESEARCH

At the U.S. Nautical Almanac Office derivation of trigonometric expressions for the geocentric and heliocentric positions of the Sun, Moon and planets to one minute of arc precision and valid for hundreds of years has been completed.

Planetary observations are being collected and reduced to the FK4 system for comparison with new planetary ephemerides.

The Chebyshov polynomials are applied to the preparation of planetary ephemerides as well as to construction of very accurate plane-

tary theories at the U.S!N.A.O., Bureau des Longitudes, I.T.A.

As a joint work of the Tokyo Astronomical Observatory and the Hydrographic Department of Japan Newcomb's Tables of the Sun and those of inner planets have been reconstructed rigorously to investigate character of figures tabulated in these Tables as well as the actual ephemeris data printed in the Astronomical Ephemeris.

A first-order theory of the motion of Mars has been constructed at the Tokyo Astronomical Observatory and is found to be in a good agreement with the theory of Mars by G. M. Clemence. Calculations of second-order perturbations are being undertaken. The plan to construct theories for other inner planets is under way.

A new analytical theory of motion of the four inner planets designated as AT-1 has been constructed at I.T.A., Leningrad, being fitted to radar measurments of Venus made in 1962-1975 and to positional observations.

The regular distribution of the predictions of occultations of stars by the Moon has been continued by the Nautical Almanac Offices of R.G.O. and U.S.N.O. The H.M.N.A.O. has received and processed about 9000 timings of occultations of stars each year during the review period. Magnetic tapes containing 108 000 observations made in 1943-1978 are available, the data for 1943-1971 being published on microfiche in R. Greenwich Obs. Bull. No. 183.

Lunar occultation data from 1920-1943, prepared at the U.S.N.A.O., have been combined with data from 1860-1920 and 1943-1977, prepared at the R.G.O., and 1627-1860, prepared at the U.S. Defense Mapping Agency. The reduction of the data is completed at the U.S.N.A.O. and analysis is in progress.

Observations of occultations of stars made in 1861-1942 have been collected at the H.M.N.A.O. in a joint project with U.S.N.O. and analysed for variations in the rotation of the Earth.

Based on about 40 observational catalogues north of -4° declination a new Zodiacal catalog which is in the FK4 system has been prepared at the U.S.N.A.O. for reduction and analysis of lunar occultation timings. Preliminary results have yielded solutions with greatly improved accuracy for the equinox, obliquity, and equator, and an improved table of ΔT values.

Dr D. W. Dunham, President, International Occultation Timing Association, writes: "I have modified computer programs and machine-readable planetary data supplied by the U.S.N.O. to compute accurate astrometric and apparent ephemerides for over 160 minor planets at daily intervals from 1978 to 2000... The astrometric (equinox 1950.0) ephemerides have been supplied on magnetic tapes to Royal Greenwich and Lowell observatories which have used them mainly for work with occultations of stars by minor planets... A system of computer programs nas been developed by Dr T. C. Van Flandern and myself to use the apparent ephemerides to find and compute all possible observable Lunar occultations of minor planets. Accurate osculating elements of orbits for my work have been supplied by the I.T.A., Leningrad, and Cincinnati Observatory".

The search for, and detailed prediction of, occultations of stars

by major and minor planets and by satellites has continued at H.M.N.A.O.

Dr Sinzi reports: "For the purpose of estabioshing the relation between ET and TAI observations of occultations of stars by the Moon are made at the Hydrographic Department of Japan as routine. About 1000 timing data including 600 photoelectric data have been obtained every year. The value of ΔT in the future is thus estimated taking the tendency of UT1 - TAI as announced by the B.I.H. into account".

Dr Morando writes: "Le Bureau des Longitudes a programmé, à partir des théories existantes, les éphémérides des satellites naturels des planètes dans le but d'une collaboration internationale éventuelle. Il effectue également de nombreuses recherches en Mécanique Céleste pour améliorer les théories des planètes et de la Lune dans le but d'augmenter la précision des éphémérides. Enfin les perfectionnements qu'il a apporté à la théorie de Sampson lui permettent de publier les coordonnées différentielles des satellites galiléens de Jupiter sous forme de polynômes de Tchebychov avec une erreur maximum de 0".01 ".

The 100th anniversary of the discovery of the satellites of Mars was commemorated by a scientific symposium at the U.S.N.O. in 1977. The relevant papers on satellites will appear in Vistas in Astronomy.

Photographic plates of the Martian moons, Galilean satellites, Jupiter V, and the seven brightest satellites of Saturn were obtained by Dr D. Pascu at U.S.N.O. The observations of the Galilean satellites have been used by Dr J.H. Lieske for improving the ephemerides of these satellites for the Voyager mission.

The work on the improvement of the orbits of the satellites of Saturn and Mars has been done at the H.M.N.A.O. and I.T.A., Leningrad.

Dr Bandyopadhyay informs that a project on "Determination of some astronomical constants by ancient Indian astronomers" based on old Indian scripts in Sanskrit has already been completed.

Special predictions have been issued by the H.M.N.A.O. for lunar occultations of radio, X-ray, γ-ray and infrared sources. An accurate position for GX9+1 has been derived from lunar occultations in collaboration with Mullard Space Science Laboratory, U.K.

A number of institutions are engaged in the laser lunar ranging experiments with the goal of scientific applications of results.

CONCLUSIONS

We still are deeply involved in the problem of changes in the foundations of the ephemeris work that comprise planetary theories, the system of astronomical constants, time and the Earth's rotation dynamics, and even practical aspects of future ephemeris publication. The progress that is made since the XVIth General Assembly gives us the hope on successful completion of this task well before the end of the twentieth century.

V. K. ABALAKIN
President of the Commission

https://doi.org/10.1017/S0251107X00010567 Published online by Cambridge University Press