4. COMMISSION DES EPHEMERIDES

PRÉSIDENT: Professor Dr W. Fricke, Direktor des Astronomischen Rechen-Instituts, Mönchhofstrasse 12-14, Heidelberg, Germany.

VICE-PRÉSIDENT: Dr G. M. Clemence, Yale University Observatory, Box 2023 Yale Station, New Haven, Connecticut, U.S.A.

COMITÉ D'ORGANISATION: A. Danjon, F. Fernandez de la Puente, J. Kovalevsky, D. K. Kulikov, D. H. Sadler.

MEMBRES: Cunningham, Duncombe, Fayet, Gondolatsch, Gossner, Kahrstedt, Lahiri, Lederle, Lévy, Planelles, Sadler (F. M. McBain), Sinzi, Tsukamoto, Wilkins, Woolard.

SURVEY OF PROGRESS

Introduction

The main purpose of this report is to indicate the directions in which progress has been made, and where in future the greatest effort should lie. The co-operation among the National Ephemeris Offices has shown itself to be a good basis for effective improvements of the ephemerides, and the importance of the conformity of published data has been generally recognized. The improvement of the ephemerides presents, however, a lasting problem, if one wishes to insure that the ephemerides fully meet the requirements of observations of highest precision. There is no doubt that at the present time ephemerides do not fully meet all requirements. Inadequacies in the basic theories are one of the most important causes. The steady increase of the accuracy of observations has revealed discrepancies which ought to be removed as soon as practicable. In this connection it seems to be necessary to suggest that sufficiently energetic action be taken by the Commission to meet the requirements with regard to basic theory, precision of calculation, and form of presentation. D. H. Sadler has written a note on the functions of the Commission which may be a guide for future action. This note is incorporated without modification as a paragraph in this survey.

The Reports of the Directors of the National Ephemerides given as usual in an Appendix to this report indicate the activities of the various Offices during the last years. They show in detail how agreed-upon improvements have been introduced into the production of the National Ephemerides.

Functions of the Commission
(*Contributed by D. H. Sadler*)

The functions of Commission 4 are twofold: firstly, to ensure that the published ephemerides fully meet the requirements of astronomers and other users; and secondly, to co-ordinate the work of the offices of the national ephemerides to ensure consistency, economy of effort, and efficiency.

Commission 4 adequately provides for the second of these functions, though modern methods of computation have reduced the necessity for sharing the burden of calculation. There still remains the question of economy of publication, but even in this field the ephemeris offices have probably done as much as is reasonably practicable.

However, it is far less certain that Commission 4 (and the offices of the national ephemerides) adequately provides for the first of these functions. To a low precision, suitable for navigation, topographical surveying, and for observational astronomy, the existing ephemerides are generally adequate, though not necessarily in the optimum form; but for comparison of theory with observation, for some aspects of radar astronomy, for space research and particularly for

the exploration of the solar system, the ephemerides are inadequate in respect of basic theory, precision of calculation, and form of presentation.

There are two main causes for this change. Firstly, the increasing speed, capacity, and availability of electronic computing machines enhance the value of machine-oriented ephemerides in machine-readable form; the printed values, to full precision in conventional form, are rarely used and then only for isolated comparisons usually to facilitate more precise predictions of particular phenomena. In some respects the position now is similar to that arising through the replacement of logarithms, as the main means of calculation, by calculating machines; then the change took 20 to 30 years to accomplish.

Secondly, radar astronomy and space exploration have introduced requirements not only for greater precisions of the theories, but also of the form of presentation; previously the astronomer has been concerned (observationally at least) with direction, but now distance is required also.

Decisions as to the form of the individual ephemerides will doubtless be made by the corresponding offices; ephemerides of the Sun, Moon, and planets, for space research, will probably be produced, at least in machine-readable form, by particular agencies which may, or may not, be the offices of the national ephemerides. However, Commission 4 can, and certainly should, continue to co-ordinate the work on ephemerides, particularly:

(*a*) by consolidating the opinions of conventional astronomers on the contents, and form of presentation of the national ephemerides;
(*b*) by re-considering the possibility of a single international volume containing the fundamental ephemerides in conventional form;
(*c*) by co-ordinating the calculation of ephemerides designed for space research, in respect of adopted constants and the avoidance of unnecessary duplication;
(*d*) by serving as a centre for the analysis of requirements for ephemerides, and by encouraging the development of more comprehensive theories.

IAU System of Astronomical Constants

The computations of ephemerides are based on astronomical constants, the most important of which have been in use for more than 60 years. There has been general agreement that changes in the conventional values of the constants should not be lightly made, and that frequent changes should be avoided. At IAU Symposium no. 21, held in Paris in May 1963, the question of the desirability of a change in the conventional system was rediscussed. The discussion led to the conclusion that a change cannot longer be avoided. There are the inconsistencies and inadequacies of the present system of astronomical constants, better values of some constants provided by recent determinations, and the difficulties the deficiencies produce in the discussion of observations of high quality. These have led to the afore-mentioned conclusion.

At the Symposium full accord was reached on a recommendation that the national and international ephemerides should be based on an improved system of astronomical constants, and that this system should be put into use as soon as it is practicable for the Ephemeris Offices. Resolutions were passed stating which constants shall be treated as fundamental constants and recommending that the general precession in longitude and the constant of nutation not be changed at this time. On recommendation of the participants of the Symposium, the Executive Committee of the IAU in July 1963 appointed a working group to prepare the revised system for consideration at the XIIth General Assembly. The working group after having requested the views of persons and organizations that are assumed to be affected by the introduction of a new system has set up a system of primary and derived constants. This system (see communication of the General Secretary of the IAU, page xlix of the *Agenda and Draft Reports*, to be reprinted in the volume **XII B** of the *Transactions* of the IAU) is being proposed by the working group for adoption by the IAU at the XIIth General Assembly.

A discussion of the proposal will take place at the scheduled 'Joint Discussion on the System of Astronomical Constants', while Commission 4, at its meeting in Hamburg, will have to discuss questions concerning the practicability of its introduction into the international and national ephemerides.

Definition of the Second of Time

The 'Comité Consultatif pour la Définition de la Seconde' set up by the 'Comité International des Poids et Mesures' met at Paris in December 1963. In consideration of the generally agreed desire to have an atomic definition of the unit of time, the consultative committee has drawn up several recommendations. According to these, the second as a basic unit of the International System of Units shall be defined as the duration of a specified number of periods of a radiation corresponding to a specified transition between two energy levels of an atom or of a molecule. Furthermore, it was recommended that the Ephemeris Second adopted in 1956 by the Conférence Générale des Poids et Mesures shall continue to be used in celestial mechanics.

The change in the definition of the unit of time will not affect the use of Ephemeris Time in astronomical problems.

National Ephemerides and Exchange of Data

The present situation as to the production and publication of national ephemerides can be seen from the Reports of the Directors. The disadvantages of independent computations, if these do not fulfil the requirements of highest accuracy, have been clearly recognized. It is gratifying to observe the goodwill and confidence existing among all the national ephemeris offices, which has increased the exchange of data and has led to satisfactory conformity of the data presented in the national ephemerides.

The *Explanatory Supplement* (to *The Astronomical Ephemeris* and to *The American Ephemeris*) prepared jointly by the Nautical Almanac Offices of Great Britain and the U.S.A. was issued by H.M. Nautical Almanac Office in 1961. This volume is of greatest value, as it presents a comprehensive explanation and derivation of the tabulated quantities in *The Astronomical Ephemeris*. Future changes in the methods of computation and in the values of constants will not diminish the importance of this publication.

While no attempt shall be made here to list minor modifications in the almanacs, it should, however, be mentioned that the *Connaissance des Temps* is publishing, from 1963 onwards, complete lists of mean places of the FK4 stars and of the FK4 Sup stars together with the parallaxes to be used in the computation of apparent places.

Introduction of FK4 into the APFS and National Ephemerides

The apparent places of fundamental stars (APFS) have been based on the *Fourth Fundamental Catalogue* (FK4) beginning with the year 1962. In practice, this has been achieved by the publication of corrections FK4–FK3 for all fundamental stars for the years 1962 and 1963 as supplements to the volumes APFS 1962 and 1963, in which the printed data are still based on FK3. The volume APFS 1964 is the first one in which the printed data are based on FK4. In the Astronomical Almanac of the U.S.S.R. for 1965, an appendix gives corrections which permit the transition from the system of FK3 to that of FK4 for all stars of the Russian Almanacs of the years 1962–1965. Other National Ephemerides which give positions of stars have also made satisfactory provision for the transition from FK3 to FK4.

The Astronomisches Rechen-Institut will advance the date of publication of *Apparent Places of Fundamental Stars*, so that the data will be more readily available to other Offices for the

purpose of reproduction. It is suggested that apparent places in National Ephemerides be printed by immediate photographic reproduction of the data in APFS, as has already been done in the *Suplemento al Almanaque Nautico y Aeronautico* (Buenos Aires).

Ephemerides for Space Research

No action has so far been taken by the Commission to meet the requirements of space research. COSPAR and other organizations have shown their great interest in ephemerides at various occasions, and computations have been carried out at several institutions. D. H. Sadler has suggested that Commission 4 should encourage all projects for the calculation of ephemerides for space research, and should provide opportunities for co-operation and collaboration with other organizations. How this can be achieved should be a matter of discussion at the XIIth General Assembly. The appointment of a working group on 'Ephemerides for Space Research' by the Commission may turn out to be advisable.

Miscellaneous

Concerning the research projects on the motions of the principal planets reference is made to R. L. Duncombe's report in the Appendix. On the new general theories of the Earth and Mars, see the Report of Commission 7.

J. Kovalevsky communicates that he is working at a comparison of Le Verrier's and Newcomb's theories of the Sun in order to relate Le Verrier's argument with Ephemeris time.

Y. Kozai calls attention to deficiencies in the orbital elements of the Saturnian satellites adopted in the almanacs. He found that (O-C) for the mean longitude of Mimas was as large as three degrees in 1950, if G. Struve's orbital elements are used. Y. Kozai improved orbital elements of six inner satellites of Saturn by using new series of observations during 1927–1947 in addition to those used by G. Struve for the determination of orbital elements in 1930. The most important improvement was made in Mimas' mean longitude. Observations of Mimas during the next years would be desirable to decide upon the improved expression for the mean longitude of the satellite.

B. Guinot reports: 'M. Duchesne et B. Guinot ont entrepris la mesure de l'unité astronomique en mètres, par une méthode purement optique, en étudiant la vitesse radiale de Mercure. Le système dispersif est un étalon interférentiel de Fabry-Pérot associé à un spectrographe de dispersion 4 Å/mm. Cet appareil a été monté au foyer coudé du télescope de 1·93 m de l'Observatoire de Haute-Provence. Le récepteur est une caméra électronique de Lallemand et Duchesne. 12 spectres exploitables ont été obtenus en octobre 1963. La comparaison des spectres obtenus aux élongations occidentales et orientales donnera, après 4 ans, une précision relative de l'ordre de 5×10^{-5} sur la valeur de l'unité astronomique en mètres, soit 0″001 sur la valeur de la constante de l'aberration'.

W. FRICKE
President of the Commission

APPENDIX: REPORTS OF THE DIRECTORS OF THE NATIONAL EPHEMERIDES

Instituto y Observatorio de Marina, San Fernando (Cádiz), Spain

The *Efemérides Astronómicas*, *Almanaque Nautico*, and *Almanaque Aeronautico* have been published regularly with only minor modifications. The *Almanaque Nautico para Uso de los Navegantes* is titled at present *Almanaque Nautico*.

Francisco Fernandez de la Puente

Astronomisches Rechen-Institut, Heidelberg, Germany

Fundamental Catalogue. The Fourth Fundamental Catalogue (*FK*4) containing the positions and proper motions of 1535 fundamental stars for equinox and epoch 1950·0 and 1975·0 has been published (*Veröffentlichungen Astronomisches Rechen-Institut*, Nr. 10, 1963). In the *Preliminary Supplement to the Fourth Fundamental Catalogue* (*FK*4 *Sup*) (*Veröffentlichungen Astronomisches Rechen-Institut*, Nr. 11, 1963) positions and proper motions of 1987 supplementary stars are given for equinox and epoch 1950·0 (See also Report of Commission 8).

The catalogue differences FK4-FK3 were published for equinox and epoch 1950·0 (See FK4 pages 131–134). The publication of the differences FK4-GC and FK4-N30 is in preparation.

For the observations within the AGK3R (reference star program) and for purposes of the IGY *Individual Corrections FK3R minus FK3* were published for the years 1956–61 (*Veröffentlichungen Astronomisches Rechen-Institut*, Nr. 6–8).

Preparatory work for the revision of the Albany General Catalogue (GC) has been started.

APFS and exchange of ephemerides. The annual publication of the international volume *Apparent Places of Fundamental Stars* has been continued. The volume 1964 is the first one in which the printed data are based on FK4, while the volumes 1962 and 1963 were supplemented by lists of *Definite Corrections FK4 minus FK3*. These supplements also appeared as separate publications (*Mitteilungen Astronomisches Rechen-Institut*, Serie B, no. 5 and 6). From volume 1964 onwards the computations of apparent places have been carried out on the Siemens 2002 Electronic Digital Computer.

A separate list of mean places of the fundamental stars for equinox and epoch 1965·0 is being prepared, and will be attached to the 1965 volume of APFS.

The FK4 and FK4 Sup on punched cards have been sent to institutions and observers on request.

We have communicated apparent and mean places to the following Offices for use in their almanacs:

Indian Meteorological Department (Alipore), Servicio de Hidrografía Naval (Buenos Aires), Deutsches Hydrographisches Institut (Hamburg), H.M. Nautical Almanac Office (Herstmonceux), Institut für Theoretische Astronomie (Leningrad), Direccion General de Faros e Hidrografia (México), Observatorio Astronomico Nacional (México), Bureau des Longitudes (Paris), Observatorio Nacional (Rio de Janeiro), Instituto y Observatorio de Marina (San Fernando), Observatorio Astronomico (Santiago de Chile), Instituto Astronômico e Geofísico (Sao Paulo), Japanese Hydrographic Office (Tokyo), Nautical Almanac Office (Washington).

W. Fricke

Nautical Almanac Office, U.S. Naval Observatory, Washington, D.C., U.S.A.

The Nautical Almanac Office is responsible for the publication of four annual ephemerides, the *American Ephemeris*—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.* Since the unification of the American Ephemeris and Nautical Almanac with the *Astronomical Ephemeris* issued by H.M. Nautical Almanac Office, Greenwich Royal Observatory, commencing with the volume for 1960, only slight modifications have been introduced in these volumes. An *Explanatory Supplement* to the *Astronomical Ephemeris* and the *American Ephemeris* and *Nautical Almanac*, prepared co-operatively by the Nautical Almanac Offices of the United Kingdom and the United States, was published in 1961.

The navigational almanacs have continued to be published with minor changes. Commencing in 1962, Rising, Setting and Depression graphs were added to the Air Almanac. A supplement to the Air Almanac for 1963 contains day and night sky diagrams, visual magnitudes, S4

magnitudes and spectral types of the navigational stars. Commencing with the issue for 1964, these data will be incorporated in the Air Almanac.

The preparation of advance predictions of solar eclipses, in accordance with the recommendation of the International Astronomical Union, has been continued; see the Report of Commission 12, Working Group on Solar Eclipses.

Progress of a co-operative project with Yale University Observatory to put star catalogs in machine readable form is indicated in the Report of Commission 8.

The special Ephemeris of the Radio Longitude of the Central Meridian of Jupiter is being continued for the years 1964–1967; see the Report of Commission 40.

A systematic Physical Ephemeris of Mars for each opposition from 1877 to 1965 based on Clemence's Theory of the Motion of Mars, and a revised position of the pole of Mars, has been completed; see the Report of Commission 16.

The research project on the motions of the principal planets conducted jointly by Yale University Observatory, the Watson Scientific Computing Laboratory and the U.S. Naval Observatory has been continued. The Theory of Mars—Completion appeared in *Astronomical Papers of the American Ephemeris*, (*A.P.*), volume **16**, part II. The Rectangular Co-ordinates of Ceres, Pallas, Juno and Vesta 1960–1980 appeared in *A.P.*, volume **16**, part III. The Marginal Zone of the Moon, by C. B. Watts comprises *A.P.*, volume **17**. Expansions in Elliptic Motion, an extension of Cayley's tables prepared by the Naval Weapons Laboratory, will appear in *A.P.*, volume **18**. On the new general theories of the Earth and Mars, see the Report of Commission 7.

R. L. Duncombe

H.M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux, England

The routine work of the Office has been continued. The Office is now responsible for the publication of four ephemerides:

The Astronomical Ephemeris—for astronomers,
The Nautical Almanac—for surface navigation,
The Air Almanac—for air navigation,
The Star Almanac—for land surveyors.

The first three 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 other country that desires to publish similar ephemerides in this form.

The advance proofs of the first part of *The Astronomical Ephemeris* have been circulated to the offices of the national ephemerides and to other agencies concerned with the preparation of navigational and other almanacs; no substantial changes have been made. Machine-readable copies of these data can be made available to suitable applicants. Special ephemerides (for the interpretation of radar observations and for ancient eclipses) have been prepared on request.

The *Explanatory Supplement* (to *The Astronomical Ephemeris* and to *The American Ephemeris*), briefly described in the Report presented to Commission 4 in 1961, was published in the United Kingdom during 1961; it has been received favourably as a comprehensive explanation and derivation of the tabulated quantities in *The Astronomical Ephemeris*. However, many of the methods of computation there described are already out-of-date and have been superseded by those made possible by electronic computers.

The occultation programme has been continued without substantial modification, but the predictions for the occultations of radio sources have been greatly extended.

D. H. Sadler

Bureau des Longitudes, Paris, France

La *Connaissance des Temps* continue à publier les éphémérides du Soleil et des planètes principales, calculées à partir des Tables de Le Verrier, modifiées par Gaillot pour les quatre grosses planètes conformément aux voeux du Congrès international des Ephémérides astronomiques. L'argument ainsi utilisé est légèrement différent du Temps des Ephémérides.

Aucun changement n'a été introduit pour les éphémérides de la Lune, qui sont en accord avec celles qui sont publiées par l'*Astronomical Ephemeris* d'où nous tirons aussi les éphémérides de Pluton. A partir de 1965, nous publierons aussi, pour tous les jours de l'année, les éphémérides de Cérès, Pallas, Junon et Vesta, calculées à partir des résultats d'une intégration numérique (voir *Astr. Papers of Am. Ephem.*, Vol. **16**, part III, 1962) et en utilisant les coordonnées du Soleil de Newcomb.

Depuis 1963, nous calculons et publions les positions moyennes des 1535 étoiles du FK4 et des 1987 étoiles du FK4 Sup dans le système FK4.

Les constantes pour la réduction des étoiles sont publiées, depuis 1962, avec une ou deux décimales de plus que précédemment; on a supprimé la publication de leurs logarithmes. On utilise, pour leur calcul, le temps sidéral de Le Verrier et les formules de nutation et d'aberration données par E. W. Woolard.

Nous ne publions plus, depuis 1963, les positions apparentes des étoiles—à l'exception de celles de la Polaire qui complètent désormais les autres tables relatives à cette étoile. Nous continuons toutefois à les calculer pour les 52 étoiles circumpolaires du FK4 (à l'aide des constantes de Bessel fournies par H.M. Nautical Almanac Office). Les résultats de ces calculs sont publiés dans les *Apparent Places of Fundamental Stars*. Ce calcul est fait à l'aide des formules améliorées tenant compte de tous les termes du second ordre (voir *Bull. Astr.* **24**, 75, 1963).

A partir de 1965, nous ne publierons plus les éléments pour le calcul des occultations des étoiles par la Lune.

Les calculs suivants: coordonnées rectangulaires du Soleil, éphémérides des quatre petites planètes, constantes pour la réduction des étoiles, positions moyennes des étoiles, positions apparentes des étoiles, phénomènes des satellites de Jupiter, sont désormais calculés sur la machine électronique IBM 650. Les résultats de ces calculs peuvent être envoyés sous forme de cartes perforées. Les autres calculs relatifs aux éphémérides publiées par la *Connaissance des Temps* seront automatisés lorsque le *Bureau des Longitudes* sera en possession de ses propres moyens de calcul.

Aucun changement n'est intervenu dans le calcul et la publication des *Ephémérides Nautiques* et des *Ephémérides Aéronautiques*.

pour A. Danjon, J. Kovalevsky

Ephemeris Department of the Institute for Theoretical Astronomy, Leningrad, U.S.S.R.

For the period under review four issues of the *Astronomical Almanac of the U.S.S.R.* for the years 1963, 1964, 1965, 1966 have been published.

In accordance with the decision reached by the Commission 4 (Ephemerides) at the XIth Meeting in Berkeley in 1961, the positions and proper motions of stars in the Astronomical Almanac of the U.S.S.R. for 1966 are given in the system of the FK4. The positions of 65 stars (out of 109), formerly taken from the GC, now are based on the more modern catalogues FK4 Sup and N30. As the above mentioned resolution of the IAU envisaged the introduction of the FK4 system beginning with 1962, corrections have been listed in an appendix to the Almanac for 1965 to permit a transition from the system of the FK3 to FK4 for all the stars of the Almanacs of 1962–1965.

In accordance with the decision of IAU Commission 4, an ephemeris of the lunar crater Mösting A has been regularly published in these issues of the Almanac.

Ephemerides of the Sun, Moon and major planets have been produced in full conformity with the first part of the *Astronomical Ephemeris* supplied in advance by the British Nautical Almanac Office.

The Nautical and Air Almanacs have been regularly published as before. For the period under review the *Nautical Almanac* has been issued for the years 1963, 1964, 1965 and the *Air Almanac* for 1962, 1963, 1964.

Computations of right ascensions of 664 stars for the Soviet Time-Service programme have been in progress. Annual ephemerides, including short period terms of nutation, have been computed for the years 1962, 1963, 1964.

An analysis of equations of condition determining corrections to the Earth's orbital elements from observations of the Sun has been made with a corresponding discussion of observations of the Sun during 1925–1953 (**1**). The obtained corrections to the elements of the Earth's orbit and to the inclination of the ecliptic to the equator are in fair accord with the results of Morgan, Clemence and Duncombe.

A preliminary evaluation has been made of the accuracy of the inner planets' co-ordinates published in astronomical almanacs (**2**).

Some investigations connected with the determination of astronomical constants have been carried out (**3–7**).

A new set of orbital elements of Jupiter's X Satellite from observations during 1938–1942 has been obtained. Tables containing jovocentric perturbations of the Satellite's co-ordinates have been drawn up, using the literal theory of the motion of the Moon by Delaunay (**8**).

Investigations should also be mentioned, connected with the elaboration of methods of integrating equations of celestial mechanics (**9–11**), and methods of evaluating errors in numerical integration (**12**), which may have wide application in the computation of different ephemerides of natural and artificial selectial bodies.

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D. K. Kulikov

Hydrographic Office, Tokyo, Japan

The Japanese Ephemeris has continued to be published for the years 1963 to 1965. The ephemerides of the Sun, Moon, and planets have been reproduced from the advanced proofs of the *Astronomical Ephemeris* provided by H.M. Nautical Almanac Office, while the remaining parts have been computed in the Hydrographic Office.

The value of ΔT for use in predictions of eclipses has been settled by arrangement with the Tokyo Astronomical Observatory each year.

From the 1963 volume onwards, the mean places of the stars have been substituted for the apparent places. Day Numbers have been presented in the computation system of so-called 'A, B-first', and τ has been counted backwards and forwards from the middle of the year.

The Nautical Almanac and *The Abridged Nautical Almanac* for the years 1962 to 1964 have continued to be published without substantial change.

The Polaris Almanac has been published annually for the purpose of surveying. In this almanac, the use of sidereal time is completely avoided and all quantities are given for the argument of Japanese Standard Time.

As a result of omission of apparent places of stars from the Japanese Ephemeris, a small ephemeris, provisionally named *Abstract from the Japanese Ephemeris*, which includes apparent places of bright stars and some quantities of the Sun, has been compiled for the years from 1963 onwards, at the request of the National Defence Agency. This ephemeris is expected to be refined into a more practical form in the near future.

In March 1963, a medium-size computer, HIPAC 103, was installed in the Astronomical Section of the Office. The output data from the computer for the computations of most parts of the almanacs and some parts of the Japanese Ephemeris are directly reproduced lithographically for printing.

For the purpose of the determination of ephemeris time, photo-electric observations of lunar occultation have been carried out as a routine. The resulting values of ΔT, with accuracy of $\pm$ 0·2 sec, seem satisfactory (**1**, **2**).

A committee on navigational satellites established by the Agency for Science and Technology has given the Office charge of research on satellite ephemerides.

The following ephemeris computations have been made at the Tokyo Astronomical Observatory:

Local predictions of the total eclipses of the Sun, 1962, February 4–5, and 1963, July 20.
Prediction of the total eclipse of the Moon, 1963, December 30.
Prediction of the partial eclipse of the Sun, 1964, December 4, and of the annular eclipse of the Sun, 1965, September 23.

At the International Latitude Observatory, Mizusawa, Hurukawa (**3**) has developed a set of formulae to compute apparent places of stars rigorously with rectangular co-ordinates.

At the Central Bureau of the International Polar Motion Service, Mizusawa, apparent declinations of the star pairs have been computed for latitude observations at five International Latitude Observatories.

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A. M. SINZI

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Since the presentation of the last report in 1961 three more volumes of the *Indian Ephemeris and Nautical Almanac*, viz. for 1962, 1963 and 1964, have each been published almost a year in advance. The edition for 1965 has been published in January 1964.

No substantial change has been made in the contents of the above publication except that the *Fourth Fundamental Catalogue* (FK4) has been adopted for mean places and annual proper motions of stars with effect from the 1964 issue. A new table has been added from the 1963 issue on incorporating precessional elements for reduction of mean places of stars to some back epochs.

The usual computations of the additional items for inclusion in the above publication have been continued. Among the new items of work undertaken in the intervening period mention may be made of an analysis carried out for re-fixation of the arcs of visibility for the calculation of heliacal rising and setting of the five principal planets on the basis of observations recorded at the Nizamiah Observatory, Hyderabad and the Kodaikanal Astrophysical Observatory. From the 1964 issue dates for the above phenomena have been computed on the basis of the revised values.

The work relating to the publication of a booklet *Tables of Sunrise, Sunset and Moonrise, Moonset*, being a reprint from the Indian Ephemeris and Nautical Almanac, is done annually.

In addition to the main publication, *Rashtriya Panchangs* giving all details of the Indian Calendar are published in English, Sanskrit, Hindi and nine regional languages, viz., Urdu, Bengali, Oriya, Telugu, Tamil, Malayalam, Kannada, Marathi and Gujarati. The issues for 1885 Saka era (1963–64) have been published in 1963.

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