J. Andersen (ed.), Reports on Astronomy, Vol. XXIVA, 1–20.

COMMISSION 4: EPHEMERIDES

(EPHEMERIDES)

PRESIDENT: E M Standish
VICE-PRESIDENT: J Chapront
ORGANIZING COMMITTEE: V K Abalakin, J-E Arlot, T Fukushima, M-F He, C Y Hohenkerk, G H Kaplan, H Kinoshita, G A Krasinsky, J H Lieske, H Schwan, P K Seidelmann

1. IAU COMMISSION 4 GENERAL REPORT

The Commission has established its own website (http://ssd.jpl.nasa.gov/iau-comm4/) containing the following main topics:

- Information
  - Where to Obtain Ephemerides
  - Recent Papers and Information Related to Ephemerides
- Observational Data
  - (Measurements to which the ephemerides are adjusted)
- Commission 4 Personnel
- Commission 4 Activity

The Commission presently has 88 full members and 3 consultants.

2. INSTITUTIONAL REPORTS

References for publications related to the ephemeris activities discussed in the following reports being made available on the Commission's Website.

2.1. Royal Greenwich Observatory / HMNAO

The Royal Greenwich Observatory was closed in October 1998, following a decision by the Particle Physics and Astronomy Research Council.

HMNAO was relocated to the Rutherford Appleton Laboratory, operated by the Council for the Central Laboratory of the Research Councils. The office continues to operate on a self-funding basis, relying entirely on sales of publications and services. HMNAO's complement is SA Bell, CY Hohenkerk and DB Taylor, managed by SA Bell reporting to PT Wallace. AT Sinclair (the previous head) retired and D Harper resigned due to the closure of the RGO.

Joint publications with the US Naval Observatory, The Nautical Almanac, The Astronomical Almanac and Astronomical Phenomena, have been produced on schedule.

New publications including The UK Air Almanac and the RGO Guide to the 1999 Total Eclipse of the Sun have been produced since 1997. Work is in progress on a new publication, provisionally entitled The Astronomers' Diary, and on new versions of Compact Data and Planetary and Lunar Coordinates. Our navigational software, NAVPAC, is being upgraded to exploit the MS-Windows environment. Changes to the Astronomical Almanac are in progress.

DB Taylor has published a series of papers on the dynamics of the major satellites of Saturn and Uranus.

HMNAO continues to provide web services to astronomers (http://www.nao.rl.ac.uk/). Some of our software has been made available to the UK National Maritime Museum via Websurf. Expansion of these services is planned.

2.2. U.S. Naval Observatory

P. Janiczek retired as Head of the Astronomical Applications Department; J. Bangert assumed the position. A. Fiala was appointed Chief of the Nautical Almanac Office following the death of L. Doggett. N. Oliversen was appointed Chief of the Product Development Division. The Dynamical Astronomy Division was created and is headed by G. Kaplan.

Publication of The Astronomical Almanac, The Nautical Almanac, The (U.S.) Air Almanac, and Astronomical Phenomena continued as a joint activity between Her Majesty's Nautical Almanac Office of the United Kingdom and the U.S. Nautical Almanac Office.

Version 1.5 of the Multiyear Interactive Computer Almanac (MICA) for both PCs and Macintosh computers, covering years 1990-2005, was released in 1998. Version 2.0 of the Naval Observatory Vector Astrometry Subroutines (NOVAS), in both Fortran and C, was released in June 1999.

USNO/AE98, a set of high precision ephemerides for 15 large asteroids, covering years 1800-2100, was released in June 1999. New masses were determined for 1 Ceres, 2 Pallas, and 4 Vesta.

Newcomb, a software system for generating high-accuracy, fundamental ephemerides of major solar system bodies is under development.

A major upgrade of the popular Astronomical Applications Department web site (http://aa.usno.navy.mil/AA/) was completed during 1996.

2.3. Paris Observatory Lunar Analysis Center

At DANOF, a department of Paris Observatory, a group titled "Paris Observatory Lunar Analysis Center" performs reduction and analysis of LLR observations, in connection with CERGA at Grasse.

A new set of lunar and solar orbital parameters and free libration parameters has been determined by direct fit to LLR observations. Besides, a determination of the orientation of the ecliptic inertial reference frame with respect to the IERS reference system and to the dynamical equatorial reference frames has been obtained. The introduction of these results into the ELP series (with a new series for tidal effects) provides new ephemerides of the orbital motion of the Moon.

For the lunar libration, analytical complements to Moon's lunar libration theory have been found. The introduction of fitted free libration parameters in the soon-to-be completed solution will provide an ephemeris of the lunar libration.

We plan next year to provide these solutions on our Website (DANOF).

2.4. Institut de mecanique celeste - Bureau des longitudes

During the past triennum, the Service des calculs et de mecanique celeste du Bureau des longitudes became the Institut de mecanique celeste et de calcul des ephemerides (by decree of June 2, 1998). It is now an institute of the Observatoire de Paris providing ephemerides to the astronomical community and in charge of the ephemerides of Bureau des longitudes.

- Printed publications: the "Connaissance des temps" (annual): the theories used in order to build the ephemerides have not been changed; "Supplements to Connaissance des Temps": configurations and phenomena of the major planetary satellites and positions of the faint satellites, JVI to JXIII and SIX; "Notes Scientifiques et Techniques" (continuous): asteroid and comet ephemerides; "Annuaire du Bureau des longitudes" (annual): now includes predictions of applulses and stellar occultations by asteroids; "Ephemerides Nautiques" (annual): navigational data. An explanatory supplement "Introduction aux ephemerides astronomiques" has been published in 1997 and contains all the theoretical information on the making of ephemerides.

- Electronic form via the ftp site (ftp.bdl.fr): software for ephemerides of Sun, Moon, planets and satellites; notes on comets containing osculating elements with their accuracy, dates of transits at perihelia together with (O-C); phenomena of the Moon and the planetary satellites (eclipses, occultations, mutual events); maps and tables of visibility for the Moon and Solar eclipses.

- On-line ephemerides (http://www.bdl.fr/): serving a large public, now through the french minitel network; most of the objects of the solar system, geocentric and topocentric positions, several reference frames; different theoretical models and ephemerides for physical observations; graphic representations; eclipse predictions for the Sun and the Moon.

- International distribution: predictions of Galilean satellite phenomena and configurations, sent yearly to several ephemeris offices and astronomical laboratories.

2.5. Institute of Theoretical Astronomy

In 1998 the Institute of Theoretical Astronomy was attached to the Institute of Applied Astronomy (St-Petersburg), while keeping its main directions of research (Astronomical Almanacs, ephemerides of minor planets and comets).

A dynamical model of the Moon and minor planets was developed, based upon simultaneous numerical integrations of the equations of motion of the major planets, of up to 300 minor planets, and of the lunar orbit and rotation. Preliminary values of constants were obtained by fitting to radar data 1961-1997, to ranging and doppler from the Viking and Pathfinder landers, and to LLR (1969-1998).

A PC version of Russian Astronomical Almanac which reproduces all parts of the almanac has been constructed. The software is available by request on a commercial basis.

The integrated program package ERA has been updated. It includes tools for processing various observations and for creating ephemerides of the Moon, major planets, minor planets, comets, space probes and satellites. The package is available free upon request.

In 1998 a 32 meter astrometric radiotelescope of the IAA began producing bistatic ranging to Mars and Venus with Eupatoria as the transmitter and with Svetloe and Shanghai as receivers. Simultaneous VLBI observations of these planets and reference quasars also were obtained.

In collaboration with Observatory El Teide (Canary Islands) a program of CCD observations of natural satellites on the background of Hipparcos stars was begun for the accurate fitting of the planetary ephemerides to Hipparcos.

2.6. National Astronomical Observatory of Japan

Annually the National Astronomical Observatory of Japan (NAOJ) publishes the "Calendar and Ephemeris", a basic almanac designed for astronomical observers, teachers, and citizens. This work has been conducted by the "Ephemeris Computation Office" (ECO).

In April 1998, it was put under a new organization, the "Public Relations Center" (PRC). Together with another office under PRC, the "New Object Information Office", the ECO is currently preparing to enhance the ephemeris/almanac computation service through the WWW by introducing the NASA/JPL's HORIZONS database and by creating a Japanese version of it.

2.7. Astronomisches Rechen-Institut

The annual volumes "Apparent Places of Fundamental Stars" were published for the years 1997, 1998 and 1999. For economical and scientific reasons the following changes will be introduced starting with the data for the year 2000:

- Replacement of the former extensive volumes by a small booklet, giving the introductory explanations and apparent places for a few stars as examples.
- The data for many more stars will be given via the internet (http://www.ari.uni-heidelberg.de/ariapfs/).
- The apparent places are tabulated day by day for all stars
- The basic data for the apparent places will be taken from the forthcoming FK6 catalogue and from the Hipparcos catalogue. Both versions will be offered via the internet.

2.8. Purple Mountain Observatory

We are in a transition period. Liu Bao-Lin, Li Neng-Yao, Xian Ding-Zhang and three other persons have retired. Tong Fu and Di Xiao-Hua have been transferred to other posts. There are two new persons, Fu Yan-Ning(male) and Cheng Zhuo (female).

Our main annual publications are the *Chinese Astronomical Ephemeris*, *Nautical Almanac*, *Surveying Almanac*, and *Popularized Astronomical Ephemeris*. We also have almanacs on various Chinese Calendars. All of the layouts, including graphs, are automatically typeset by computer.

An electronic ephemeris has been produced and distributed, and a major revision for Windows is being produced. A web page for ephemeris service is being constructed.

As a conventional service, we predict, for both public and astronomers, local circumstances of most astronomical phenomena. There are other works for aerospace and military departments.

2.9. Jet Propulsion Laboratory/Caltech

The Solar System Dynamics group continues under the supervision of D K Yeomans as part of JPL's Navigation Section. The group's interactive website (http://ssd.jpl.nasa.gov/) provides a wide variety of astronomical tools and constants that utilize JPL's latest high-accuracy ephemerides. Web or Telnet access is available for the "Horizons" system, an interactive provider of customized ephemerides for all the major planets and natural satellites, several spacecraft, and all comets and asteroids with well-determined orbits.

The group continues to support JPL's ongoing interplanetary missions with the most accurate, up-to-date ephemerides. The latest planetary and lunar ephemerides, DE405, and the 6000 year compressed equivalent, DE406, were created in 1997 and are available on CDs. For the natural satellites, element-type formulae have been fit for all of the minor satellites, while higher precision ephemerides have been integrated for the major ones, extending over the past few decades and extending into the future for a decade or two. For comets and asteroids, ephemerides are created as needed using integrations fit to all available observations.

The Navigation Ancillary Information Facility (NAIF), under the supervision of C H Acton, provides spacecraft and astronomical ephemerides along with complete software packages for the complete interpretation and analysis of the mission products from JPL spacecraft. The NAIF website is (http://naif.jpl.nasa.gov/naif.html).

E M Standish
President of the Commission