COMMISSION No. 31

TIME (L'HEURE)

Report of Meetings: 5, 9, and 10 August 1988

PRESIDENT: D. D. McCarthy SECRETARY: H. F. Fliegel

5 August 1988

REPORTS AND ADMINISTRATIVE MATTERS:

The Report of the Commission President was presented by D. McCarthy. For lack of space, a list of references to journal articles such as published in previous Reports was omitted, but reports were included by B. Guinot on the work of the Bureau International de l'Heure and Bureau International des Poids et Mesures (BIH/ BIPM), by Y. R. Miao concerning six institutes in China, by G. Hemmleb on the Zentral Institut fuer Physik der Erde (ZIPE), by S. Starker on the Deutsche Forshungs- und Versuchsanstalt fuer Luft- und Raumfahrt (DFVLR), by H. Enslin on the Deutsches Hydrographisches Institut (DHI), by E. Proverbio on the Time Service of the Cagliari Observatory, by P. Galliano on the Istituto Elletrotecnico Nazionale (IEN), by C. Kakuta on the International Latitude Service (ILS) Observatory at Mizusawa, by Yo Kubo on the Hydrographic Department of Japan, by S. Aoki on the Tokyo Astronomical Observatory, by J. Dickey on the Jet Propulsion Laboratory (JPL), and by W. Klepczynski on the US Naval Observatory. D. McCarthy noted that a questionnaire had been mailed concerning members' activities in the field of time, and perceived needs. On the basis of this questionnaire, the list of Commission members has been revised, and two working groups have been formed: "The Use of Millisecond Pulsars and Timing of Pulsars" (chair: D. Allan); and "Time Transfer with Modern Techniques" (chair: H. Fliegel).

Draft Resolutions I thru V were discussed and amended.

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SCIENTIFIC PRESENTATIONS:

A session on "The Use of Millisecond Pulsars and Timing of Pulsars" was chaired by D. Allan.

D. Backer (University of California at Berkeley) reviewed the contributions of pulsar studies to the determination of time. There are direct applications to astrometry, solar system dynamics, tests of general relativity, and also to knowledge of the interstellar medium, of matter at high energy, and of the collapse of massive stars. All these disciplines assist in the use of pulsars to form a stable time standard valid over months and years. There are 8 pulsars known with periods 11 milliseconds or less, and five radio observatories with active programs to study them: at Arecibo, Green Bank, Jodrell Bank, Nancay, and Parkes. J. Taylor (Princeton University) discussed the observability of effects of general relativity on pulsars. Three effects should in principle be observable: the Shapiro time delay due to ray bending within the solar system, advance of perihelion and change of period in binary pulsars, and gravity wave events. B. Guinot (BIPM) presented the status of International Atomic Time (TAI), against which pulsars are measured. Errors in TAI frequency affect determinations of pulsar periods, frequency drift affects determination of period rate of change, and annual effects produce an incorrect Earth reference orbit. The annual variation in laboratory time is about 3 parts in 10 E14, and is at least partly an effect of varying humidity. In the formation of TAI from about 170 participating clocks, such systematic effects are largely removed by use of an averaging algorithm, forming TAI by applying steering to the free atomic time scale EAL. E. M. Standish (JPL) analyzed the errors in the determination of the Earth ephemeris, and showed that they cannot account for the reported annual variations in determinations of pulsar periods. The session was summarized by D. Allan, who noted that the limit to the accuracy of reductions of pulsar data is clearly set by the international time scale; and he suggested that stored Hg- ion devices may extend this limit for time scales of 10 E6 seconds and greater.

9 August 1988

SCIENTIFIC PRESENTATIONS:

A session on "The Relativistic Aspects of Time" was chaired by P. Paquet.

K. Seidelmann summarized the activity of the working group on reference systems, which was tasked to define Barycentric Dynamical Time (TDB) and Terrestrial Dynamical Time (TDT) and their relationship to TAI. Specific problems were identified: the specification of the units of TDB and TDT; the use of the word "dynamical"; and the question whether TAI is "coordinate" or "proper" time. Seidelmann presented the following recommendations. Let the word "dynamical" be dropped, and replace the existing terms by TT, Terrestrial Time, defined in terms of the SI second on the rotating geoid, and TB, [Solar] Barycentric Time, defined as TT plus periodic terms only. A different proposal was made by V. Brumberg, who recommended adopting three distinct reference systems: BRS, GRS, and TRS -- Barycentric, Geocentric, and Topocentric Reference Systems -- related to one another by rigorous relativistic transformations between

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JOINT MEETING: COMMISSIONS 19 AND 31:

A joint meeting for scientific presentations was shared between Commissions 19 and 31. V. Zharov presented the design of an experiment to use a laser gyroscope to determine Earth rotation. Z. Shi reviewed the first use of GPS common view time transfer and synchronization in China. G. Winkler showed the design of the prototype Hg- ion frequency standard built by Hewlett- Packard and in initial operation at the US Naval Observatory. B. Xu discussed the concepts underlying the definitions of UT1, reviewing the proposals of Aoki et al. (1982), Aoki and Kinoshita (1983), and Aoki (1987). A paper by F. Silva on timekeeping in Brazil was read by D. McCarthy.

10 August 1988

SCIENTIFIC PRESENTATIONS:

A session on "Modern Techniques of Time Transfer" was chaired by H. Fliegel.

B. Guinot detailed the use of the GPS to form TAI, and the elimination of systematic errors from the procedure. The common view schedules developed by Allan at the US National Bureau of Standards (NBS) -- renamed the National Institute of Standards and Technology (NIST) -- are employed, in which the same sequence of Navstar observations are maintained for six months or more. The BIPM takes data for 10 days, and forms normal points centered on MJD's ending in the digit 9. Errors in station coordinates are eliminated using long spans of data, including observations not in the common view schedules. The outstanding error sources still remaining are due to multipath and the ionosphere. J. McK. Luck reported on the use of TV from the Australian National Communications Satellite System (AUSSAT), taking quasi- simultaneous GPS and AUSSAT measurements at several stations to correct the AUSSAT orbit differentially. W. Klepczynski presented a report on the Laser Ranging from Stationary Orbit experiment (LASSO), which is managed thru the LASSO Operations Coordinating Group (LOCG). Since the METEOSAT - P2 satellite on which the experiment is hosted rotates at about 90 rpm, initial efforts have been focussed on scheduling ranges when the event timers are in Earth station view, and on data reduction. The system is reported to be almost operational. D. Allan described the Civil GPS User Steering Committee currently chaired by the US Department of Transportation (DOT). H. Fliegel concluded the session by leading an informal discussion on work yet to be done to make GPS more useful. It was reported that the BIPM will lead an international program to produce accurate, uniform values for antenna geographic coordinates and receiver delays.

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the systems, including non- periodic changes of scale. N. Ashby (University of Colorado) showed what such transformations would entail. B. Yu recommended adopting a conventional nonrotating geocentric coordinate system as the basis for TAI. Turning to the subject of basic theory, H. F. K. Yilmaz sketched his alternative formulation of the Einstein field equations, recommending it as more responsive to the problems of celestial mechanics than the standard formulation. C. Alley reviewed the status of the University of Maryland experiment to measure the one- way speed of light, using endpoints at the Goddard Optical Research Facility and at the US Naval Observatory. M. K. Fujimoto and S. Aoki recommended adopting for the astronomical constant a value such that the speed of light will be 173.1446333 AU / day.

REPORTS:

B. Guinot presented the Report from the BIPM. He noted progress in the algorithms used to form TAI, and in time comparisons, especially by use of the Global Positioning System (GPS). G. Winkler announced the forthcoming meeting of the Comite Consultatif pour la Definition de la Seconde (CCDS), scheduled for 17- 18 April 1989 in Paris. The meeting will have three objectives: "to identify the problems arising in the daily operation of international coordination for time; to exchange ideas for possible improvements; [and] to reach a consensus on matters which require better coordination". J. Kovalevsky presented Resolutions 3 thru 5 which were adopted at the 18th assembly of the General Conference on Weights and Measures (CGPM).

The members approved the following nominations for 1988 - 1991:

President: P. Paquet Vice President: E. Proverbio

It was voted to include the chairs of the two working groups (Pulsars, Time Transfer) as members of the Organizing Committee:

Organizing Committee: D. Allan, N. Blinov, H. Fliegel, M. Fujimoto, M.Granveaud, B. Guinot, W. Klepczynski, J. Kovalevsky, Y. Miao, I. Mueller, J. Pilkington, Y. Shu Hua.

Representatives: to CCDS and BIPM: G. Winkler;
to the Federation of Astronomical and Geophysical data analysis Services (FAGS): J. Kovalevsky;
to Study Group 7 of the International Radio Consultative Committee (CCIR), S. Leschiutta.

The members approved unanimously the proposed list of new members and consultants to the Commission.

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