

31. COMMISSION DE L'HEURE

Report of Meetings

PRESIDENT: W. Markowitz.

SECRETARIES: N. Stoyko, M. Thomson.

First meeting, 17 August 1961

The session was opened by the President, who asked for comments on the *Draft Report*. There being none, the *Report* was approved.

Nominations were made for the Organizing Committee of Commission 31. The Director of the BIH was proposed as a member, but he considered that he was not eligible to be on this Committee. The following were then nominated: L. Essen, W. Markowitz, H. M. Smith, M. M. Thomson, and a member from the U.S.S.R., to be designated later (N. N. Pavlov).

APPARENT PLACES OF FUNDAMENTAL STARS

Dr Fricke reported that corrections to star positions in *Apparent Places of Fundamental Stars* (APFS) to change from FK 3 to FK 4 will be available by January 1962. The FK 4 catalogue will appear first in the APFS for 1964, since the volume for 1963 has already reached the manuscript stage. It was agreed, in keeping with Resolution No. 59 adopted in 1958 at Moscow, that the determination of Universal Time will be based on the FK 4 as of 1 January 1962. Danjon remarked that the change from FK 3 to FK 4 would be straightforward for transit instruments, but would create a problem for PZTs. The President suggested that this question be referred to the Organizing Committee. This was approved.

A proposal concerning the notation of Ephemeris Time had been sent to the Presidents of Commissions 17 and 31 by the President of Commission 4. The President (of Commission 31) remarked that the proposed notation does not change definitions previously adopted by the IAU which define Ephemeris Time. These are contained in *Trans. IAU* 9, pages 451 and 458 to 462, and 10 page 72. Comments on the proposed Resolution were made by G. Wilkins for Commission 4. The Resolution was discussed, and then approved by Commission 31.

Proposals had been received by the President concerning the method of denoting the epoch of observation. H. M. Smith had proposed that the fraction of the Julian Day be given, and B. Guinot had proposed that the fraction of the Besselian year be used. Members of Commission 31 had been invited to distribute their comments, and other proposals, to members of the Commission in advance of the Berkeley meeting. These proposals were discussed, but no agreement was reached.

The question of adopting a fixed origin for the pole, which is used to compute corrections for variations in longitude, was next discussed. The President pointed out that harmful discontinuities in time-keeping were introduced by shifting the origin. E. Fedorov thought that a fixed origin could not be adopted. Further discussions were postponed, as the meeting ended.

Second meeting, 19 August 1961

The session was devoted to a discussion of changes in speed of rotation of the Earth, in particular, during the year 1959. This is discussed in the *Draft Report*.

The President stated that in reply to his request he had received reports from eight observatories. Summaries of these reports are given in the mimeographed Report to COSPAR by

Wm. Markowitz, of 4 April 1961. The President reviewed additional studies that had been made.

He noted that two different methods were used to correct for polar motion and seasonal variation. In the method adopted by the IAU, U.T. 0 is transformed into U.T. 2 by correcting for observed polar motion and for extrapolated seasonal variation.

Danjon, in his method, uses a mathematical formula to remove the effect of the 14-month term in the polar motion, obtaining T.U. $_{1/2}$. He analyzes several years of observation to determine the seasonal variation for each observatory. This combines corrections for the 12-month term in the polar motion, for the annual variation in speed of rotation, and for systematic corrections to star places. T.C. 1 is obtained when T.U. $_{1/2}$ is corrected for the seasonal variation.

The President stated that U.T. 2 and T.C. 1 are essentially equivalent in that both give the speed of rotation of the Earth, freed of certain periodic effects. He and R. G. Hall had determined, for Washington, U.T. 2, using the corrections of the BIH, and T.C. 1, using the corrections of Danjon; the graphs of U.T. 2 and T.C. 1 for Washington are essentially the same.

The President asked *D. Brouwer* to give an account of his analysis of the fluctuation curve which was published in *A.J.*, 57, 132, 1952. Brouwer stated that he was led to the attempt to represent the fluctuation curve on the assumption that the second differences of the annual means are random quantities with mean value zero.

If the derivative of the fluctuation curve can be approximated by straight-line segments, then the fluctuation curve itself should be representable by a series of parabolic segments. At a point of the curve where two parabolic segments join, the two arcs have a common tangent. However, the interpretation of the fluctuation phenomenon might require a more complicated hypothesis than that advanced by Brouwer or by B. L. van der Waerden (*A.J.*, 66, 138, 1961), who introduced a term for friction.

A. Mikhailov reported that at Pulkovo, N. Pavlov had found no sudden change in speed in July 1959, but had found a change in phase of 30° in the seasonal variation of 1959.

J. Bonanomi commented on the formula of B. Guinot and S. Débarbat for the 14-month Chandler motion. For the interval 1956.5 to 1960.1 the Neuchâtel observations and the formula were in close accord. Hence, no error was introduced by Danjon through use of T.U. $_{1/2}$. The Neuchâtel observations were treated according to the method of Danjon, but the annual variation found is different from that found by Danjon for Neuchâtel. T.C. 1 derived at Neuchâtel, Bonanomi stated, shows no irregularity in speed of rotation near 1959.5.

A. Danjon gave a report of his recent work on the study of speed of rotation, described in *C.R.*, 252, pages 2039, 2343, and 2779, 1961. Danjon exhibited plots of T.C. 1 for the Paris, Greenwich, Washington, and Neuchâtel observatories. The President hoped that Professor Danjon would distribute the numerical details of his studies. Danjon said he planned to do so.

Third meeting, 22 August 1961

This session was concerned chiefly with action on recommendations and resolutions.

Discussions of specifying the mean epoch of observation were continued. No agreement was reached and the President suggested that the Calendar date, Julian date, and Besselian date might all be given on a trial basis. This will be done by the U.S. Naval Observatory, starting 1 January 1962.

Discussion of the proposal for adopting a fixed origin for use in determining corrections to time for polar motion was resumed. The President pointed out that the effect of the discontinuity when a change was made was uncertain. He listed three different sets of values which had

been issued by the BIH for the change in co-ordinates made in the last quarter of 1958. He pointed out that this impeded, in particular, studies in changes in speed of rotation of the Earth. Objections to adopting a fixed origin were made by A. Danjon, N. Stoyko, and B. Guinot. Since agreement could not be reached at this time, the President suggested withdrawing the resolution for adopting a fixed origin, which was done.

A proposal for creating a joint commission of the IAU and IAG to derive new conventional longitudes for time-service stations was discussed. The President remarked that the time-transmissions of several countries were co-ordinated and it was essential that discordances in conventional longitudes should be removed. Empirical corrections were being applied, for example, by the U.S. Naval Observatory to the Washington and Richmond, Florida, observations for time, because of errors in the conventional longitudes, to bring them in accord with those of the Royal Greenwich Observatory. A revision of the longitudes would eliminate the necessity for empirical corrections. According to proposal B.2 of the *Draft Report*, the revised longitudes would be available in 1963.

Professor Danjon stated that the BIH was prepared to issue a revised list shortly, which could be adopted for use on 1 January 1962. Use of the BIH list would save time. The President was in accord with the change proposed by Danjon because it would shortly eliminate the need for empirical corrections. He noted, however, that, while the new longitudes would serve to co-ordinate time transmissions, the various star lists had not been referred to FK 4 and that there were uncertainties due to the change in the origin of the pole in 1958. Hence, a further revision might have to be made at some time in the future.

It was agreed to modify proposal B.2 so that the BIH would derive new longitudes in consultation with the observatories concerned.

A resolution was adopted, recommending that high-altitude artificial satellites be launched which would be useful in the study of time.

It was agreed that each year, in consultation with observatories which determine time, the BIH should recommend a fractional offset from nominal frequency which is to be used in the succeeding year by stations which transmit constant frequency during the year.

Danjon suggested that the use of rhythmic signals should be discontinued. This was agreed.

The question of combining Commissions 19 and 31 was discussed. It was agreed that the two should not be combined at this time, but that the question could be studied again in the future.

Dr J. Bonanomi continued his report, begun at the second meeting. J. De Prins had analyzed the frequency spectrum of T.U. $\frac{1}{4}$ at Neuchâtel. For the interval 1957.5 to 1960.8 there are maxima at frequencies 1 year and $\frac{1}{2}$ year. However, for the 5-year interval, 1956.3 to 1961.6, there is only a pronounced maximum at 1 year. These results are of interest since the existence of a semi-annual term appeared, previously, to have been well established. This question should be studied further, it was agreed.

The President thanked the Secretaries for their services. He expressed his appreciation, upon the conclusion of his term of office, to the Director of the BIH for the co-operation of the Bureau. He thanked the Chef du Bureau for his work in providing promptly the corrections $\Delta\lambda$ for the large number of time-service stations.

RESOLUTIONS ADOPTED BY COMMISSION 3 I

1. The provisional value of Ephemeris Time that is obtained by comparing the Moon's mean longitude, given by observations, referred to the equinox of FK 4, with the positions tabulated in the Improved Lunar Ephemeris is denoted by E.T. 0. The difference E.T. 0 - U.T. 2 is denoted by ΔT_0 .

2. A list of new conventional longitudes of time-determining stations shall be prepared by the BIH in consultation with the observatories concerned. Time-keeping will be based on these new longitudes as of 1 January 1962.

3. It is recommended that high-altitude satellites be launched which can be used for experiments concerning the fundamental nature of time.

4. Each year, after consultation with observatories concerned in the transmission of time pulses and constant frequency, the BIH shall recommend a value of the fractional offset from nominal frequency to be used during the next year in order that the time pulses shall be nearly on the system U.T. 2. The offset is based on an assumed frequency of 9 192 631 770 c/s for caesium.

5. The use of rhythmic time signals should be discontinued.

RÉSOLUTIONS ADOPTÉES PAR COMMISSION 3 I

1. La valeur provisoire du temps des éphémérides, obtenue en comparant la longitude moyenne de la Lune résultant d'observations rapportées à l'équinoxe du FK 4, avec les positions données par l'Improved Lunar Ephemeris est appelée T.E. 0. La différence T.E. 0 - T.U. 2 est appelée ΔT_0 .

2. Une liste des nouvelles longitudes conventionnelles des stations horaires sera préparée par le BIH en consultation avec les observatoires intéressés. La conservation de l'heure sera basée sur ces nouvelles longitudes dès le 1er janvier 1962.

3. On recommande le lancement de satellites artificiels de haute altitude qui puissent être utilisés pour des expériences sur le caractère fondamental du temps.

4. Chaque année, après avoir consulté les observatoires intéressés par la transmission des signaux horaires et des fréquences constantes, le BIH recommandera une valeur du décalage de la fréquence nominale qui doit être utilisée durant l'année suivante, de sorte que ces signaux horaires restent approximativement dans le système T.U. 2. Le décalage est basé sur la fréquence adoptée de 9 192 631 770 Hz pour le césium.

5. Les signaux horaires rythmiques devront cesser.