

8. COMMISSION DE L'ASTRONOMIE MÉRIDIENNE

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A circular letter was sent out to all members of the Commission in December 1937, to which the majority have replied. While work is going on steadily in the Observatories where meridian observations are carried out, comparatively few catalogues have been published since 1935. In view of the very full report made three years ago it is only necessary to draw attention to the progress which has been made in the interval.

The improvement of the positions and motions of fundamental stars must always be recognized as the most important task of meridian astronomy, so that a sound basis for all other determinations of position may be available. It was agreed in 1935 to adopt the second revision of Auwers Fundamental Catalogue carried out at Berlin, and known as FK3, for ephemeris purposes. Following the provisional publication of FK3 in the *Berliner Jahrbuch* for 1936 the final results for the Auwers-Stars have been published as No. 54 of *Veröffentlichungen des Astronomischen Rechen-Instituts zu Berlin-Dahlem*. The data for the additional fundamental stars (*Zusatz-Sterne*) will be published later. The catalogue contains 905 stars besides 10 stars near each of the poles, and gives the results for the epochs and equinoxes of both 1925 and 1950. The data given are position, annual variation, secular variation, proper motion and its secular change—the unit of time is 100 years. The accuracy of the data at any date can be judged from the mean errors at epoch and mean errors of the proper motion, the mean epochs of observation being given. There are four appendices dealing with the FK3 system and of the reduction of catalogues, including N.F.K. and P.G.C., to the system. By means of these tables and of tables given by Auwers, Boss, Roy, etc., reducing various catalogues to the N.F.K. or P.G.C. systems, it is possible to reduce nearly all catalogues of importance to the FK3 system. The use of FK3 for the calculation of apparent places for all ephemerides from 1940 should lead to greater uniformity in observational catalogues in the future. Work on the 633 *Zusatz-Sterne* is in progress at Berlin. The positions and proper motions for 1900 are completed and published in *A.N.* 264, 201 and the trigonometric transformation to 1950 is finished. *A.N.* 265, 65 gives the results for the polar stars. This work should soon be completed.

There has been some delay in the publication of the *Albany General Catalogue*,* which will contain the positions and motions of about 32,000 stars including all the best observed stars, down to magnitude 7.5 or fainter. The catalogue should be of great use in general investigations into stellar motions, and it is hoped that it may be useful for the reduction of photographic plates (possibly taken with a diffraction grating). It is to be published in five volumes, four of which will be devoted to 6 hours of R.A. each, while the fifth will give a general introduction and discussion. A comparison of the catalogue with FK3 is given for 1950 in *A.J.* 1063 by H. Jenkins. The difference in the equinox is largely due to the fact that a cor-

* Now published. There are 33342 stars in all.

rection of $-0^s.040$ to Newcomb's R.A.'s was used at Albany and $-0^s.050$ at Berlin. There is a periodic difference in R.A. as the P.G.C. system was retained at Albany. There is very little difference in magnitude equation. The difference in declination is largely due to proper motion and the two systems agreed closely about 1900. Near the equator there is a difference of about $0''.2$ for 1950.

Reference may here be made to the George Darwin Lecture (*M.N.* 96, 714) by Prof. Kopff on "Star Catalogues, especially those of fundamental character", where a general synopsis of the present position of meridian astronomy is given. There is a strong feeling amongst some astronomers that while the bright stars are at present the most suitable for a fundamental system on account of the long series of observations of them in the past and the possibility of observing them in the daytime they are not ideal as fundamental stars. They have their own peculiar motions and are too bright for measurement on photographic plates. To get over the difficulty of brightness it has been proposed at various times to select fainter stars. No progress has been made in this direction since the 1935 meeting.

To remove difficulties connected with the use of bright stars M. Subbotin has suggested the use of late type stars which are fainter photographically than visually (*Astr. Jour. of Soviet Union*, 14, 242). The use of the spiral nebulae as a system of reference free from peculiar motions has also been suggested, and it will be remembered that many years ago Hertzsprung pointed out how suitable stars with sharp lines in the spectrum were for a determination of the constant of precession. No attempt has been made so far to connect the positions of spiral nebulae with fundamental stars. Recently, however, at the Leander McCormick Observatory a great deal of work has been done in using proper motions of bright stars on the Boss system to make relative photographic proper motions of neighbouring faint stars absolute on the same system (*Publications of Leander McCormick Observatory*, 7). The results have been rediscussed by Oort in *B.A.N.* No. 298. This method provides a solution of the problem of determining precession and galactic rotation free from errors arising from the large proper motions of the bright stars but still containing the systematic errors of the fundamental system.

For the determination of the latter, especially a constant error in the declination system, extensive use has been made in the past of the sun and the interior planets, and the principal observatories are still carrying on this fundamental work. Observations of the sun are still essential in this respect and, as Courvoisier points out, the errors in Newcomb's tables of the sun are large enough to have an important bearing on observations of minor planets which make a near approach to the earth. For the determination of corrections to the equinox and equator point, the planet Vesta was introduced many years ago, and recently the other three large minor planets have been included in the observing programme at several observatories. Unfortunately the corrections to Leveau's tables of Vesta given in *A.N.* 6092-3 appear to be unreliable and the latest observations show large residuals. The heavy and difficult work of computing the very accurate ephemerides for all these planets over an interval of several years seems therefore still to be undertaken. The scheme for the photographic observation of fourteen minor planets relative to fundamental stars proposed from Yale Observatory is being actively pursued and many plates have been taken. Investigations have been made into the methods to be employed in deriving corrections to ephemerides calculated by mechanical integration, by W. J. Eckert and D. Brouwer in *A.J.* 1069, and their methods have been applied by them to (287) Nephthys, and to (532) Herculina by F. H. Hollander in *A.J.* 1070. But much work will still have to be done before we can determine

how far the corrections to the orbital elements and the corrections to the adopted system of star-places can be separated.

In *Publications of Pulkova Observatory*, Series II, 44, Part 2, F. Renz gives a Fundamental Catalogue for the right ascensions of 1642 principal and 127 additional stars. This is based on observations of Backlund Hough stars at seven different observatories. The epoch is 1925.0 and the catalogue extends from -10° to the north pole. The corresponding catalogue for declinations was published earlier by Dneprovsky. In vol. 49 of the same series are given the results of observations with the Freiberg Transit at Nikolajew in the years 1914-24. The definitive results of the observations made at a station near the equator with an azimuth instrument by Leiden observers are now available (*Annalen Sterrewacht te Leiden*, 18, 1). They show the following corrections to the declinations of the P.G.C. and FK3:

Decl.	Lei-P.G.C.	Lei-FK3	Residual
-50° to -40°	$+0^{\circ}.55 \pm 0^{\circ}.11$	$-0^{\circ}.11$	$+0^{\circ}.10$
-40 „ -30	+ .41 .11	- .14	+ .07
-30 „ -20	+ .14 .09	- .24	- .03
-20 „ -10	+ .10 .09	- .16	+ .05
-10 „ 0	- .02 .08	- .30	- .09
0 „ $+10$	- .05 .09	- .44	- .23
$+10$ „ $+20$	+ .17 .09	- .35	- .14
$+20$ „ $+30$	+ .39 .09	- .14	+ .07
$+30$ „ $+40$	+ .34 .09	- .14	+ .07
$+40$ „ $+50$	+ .36 .10	- .09	+ .12
		Mean $-0^{\circ}.21$	

The numbers of the column Lei-P.G.C. are the direct result of the comparison of 473 star positions. The values of Lei-FK3 have been derived from the adopted difference between FK3 and P.G.C. The final column shows residuals from a constant difference of $-0^{\circ}.21$.

The observations of fundamental and other important stars are being carried out as in former years at the leading national observatories and detailed reference to them need not be given. At Besançon special observations are being made of Boss stars north of declination $+75^\circ$ and at the Cape a series of observations of southern circumpolar stars has been made at both culminations in the winter months of 1936.

Galactic Stars. In connection with the rotation of the galaxy a scheme proposed by Mineur for the observation of faint stars in the galaxy was approved by the I.A.U. in 1932. Observations are being made at Paris, Uccle, Besançon, Bordeaux and Strasbourg. Each observatory has selected 100 stars in common with those being observed at Paris. There are 4799 stars in all for the northern part of the galaxy. These observations are being made differentially relative to positions of stars in Eichelberger's catalogue.

Photographic Zone Observations. The determination of the accurate positions of the stars from photographs each covering an area of 25 square degrees or more has made steady progress. The northern sky is being observed by German observatories together with Pulkova under the auspices of the Astronomische Gesellschaft. The observational programme was carried out in about four years (1928-32). There are 13,755 reference stars, each observed twice at three different observatories. All the observations have been combined into a single catalogue, compiled under the direction of Prof. Peters at the Astronomisches Rechen-Institut at Berlin-Dahlem. The catalogues of the participating observatories will not be issued separately. The

photographic plates have all been measured. It was originally intended for the Rechen-Institut to take over the reduction of the measures from the observatories at Bonn, Bergedorf and Pulkovo. But although the use of a Hollerith machine for this purpose was found the most economical in time and strain, this method has been abandoned on account of the cost, and the three observatories have individually undertaken the labour. At Bergedorf the magnitudes of the stars have been determined on the international scale from the pole to $+57^\circ$ by means of the stars in the Kapteyn Areas as given in the first volume of the *Bergedorfer Spektral-Durchmusterung*.

For the southern hemisphere Yale Observatory is taking the regions to -30° and the work is progressing rapidly. For this part of the work a Hollerith machine is being used to facilitate the computations. The measures and reductions for the zone -30° to -35° have been completed at the Cape, the zone -35° to -40° is one quarter measured, and as the zone -40° to -52° is well covered by the *Cape Astrographic Catalogues* the zone -52° to -56° is now being observed. Experiments are being made at the Cape for the determination of magnitudes.

Other catalogues published since 1935 include:

Algiers Catalogue of 872 Fundamental Stars.

Greenwich Second Catalogue of Stars for 1925.0 containing stars in the Zone $+32^\circ$ to $+64^\circ$, together with fundamental stars.

La Plata: 2123 Boss Stars between declination -15° and -80° ,
4513 stars between declination -66° and -72° .

Catalogue of secondary reference stars for the opposition of Eros 1931 together with corrections to the places of the primary reference stars, by H. Spencer Jones and P. J. Melotte (*Memoirs of the R.A.S.* 65, Part IV).

Geschichte des Fixsternhimmels (G.F.H.) giving the positions of stars observed up till 1900 reduced to the equinox of 1875 has been completed for the northern sky. The volume dealing with the first hour of R.A. for the southern sky has already been published, and contains 130 pages as compared with 208 for the northern. This may not give a fair comparison of the data available in the two hemispheres as the Milky Way is in a north declination for the first hour of R.A., but it is probable that the observations of southern stars will be found to be considerably less numerous than for northern ones.

Precession and Secular Variation. Since the 1935 meeting correspondence has taken place between the members of Commissions 4 and 8 on the data which should be published in star catalogues. Prof. Kopff and Peters suggested that the century should be used as the unit of time and that the coefficient of T^2 instead of $\frac{1}{2}T^2$ (secular variation) should be used. The majority of the Commission approved the suggested change but a few, including the writer, do not see sufficient advantage in the proposal to justify it. Various suggestions have been put forward as to notation, e.g.

$$\alpha = \alpha_0 + \frac{d\alpha}{dT} T + \frac{1}{2} \frac{d^2\alpha}{dT^2} T^2 + \frac{1}{6} \frac{d^3\alpha}{dT^3} T^3 + \dots,$$

$$\alpha = \alpha_0 + \alpha_1 T + \alpha_2 T^2 + \alpha_3 T^3 + \dots,$$

$$\alpha = \alpha_0 + \rho_1 T + \rho_2 T^2 + \rho_3 T^3 + \dots$$

Morgan, who is not very enthusiastic about the change, suggests that we might use p_1, p_2 , etc. for the coefficients when proper motion is not included and $P_1 = p_1 + \text{p.m.}$, $P_2 = p_2 + f$ (p.m.) when it is included.

It may be noted that FK3 gives $\frac{d\alpha}{dT}$, and $\frac{d^2\alpha}{dT^2}$ (not $\frac{1}{2} \frac{d^2\alpha}{dT^2}$).

The *Precession Tables for 1950* published as No. 50 in the series of publications from the Astronomisches Rechen-Institut give the values of $\frac{1}{2} \frac{d^2\alpha}{dT^2}$ and $\frac{1}{2} \frac{d^2\delta}{dT^2}$. The

expression $\frac{d\alpha}{dT}$ in these tables naturally does not include the effect of proper motion, but the same expression is used in FK3 to include it. Mention might here be made of *Precession Tables* published by the Paris Observatory for a change in the equinox of 25 or 50 years. The tables are essentially constructed for declination $+21^\circ$, the mean declination of the Paris Zones, but additional tables are given to reduce them to any declination from -31° to $+55^\circ$, and for different time intervals.

Instruments and Methods of Observation. During the course of erection and bringing into use of the new Transit Circle at Greenwich several points of importance have been discovered. Dr Spencer Jones writes:

“From the experience already gained, care must be taken to detect errors that persist and appear real but ultimately prove to be spurious.

“Two examples may be quoted:

“1. Results given by the pivot telescope.

“2. A $\Delta\alpha_3$ term in the transit observations shown by a comparison with the R.A.'s of FK3.

“1. Any results given by the pivot telescope with a pronounced 2α term may be spurious, being produced by a tilt of the collimating lens in one of the pivots.

“A useful addition in this work is a Krupp's Mikrotast Gauge.

“2. A term $\Delta\alpha_3$ in the observed transits with the impersonal micrometer is of instrumental origin. Investigation showed that such a term will be produced by one or both of the following defects:

“(a) Following error or lag of moving wire behind its recorded micrometer reading.

“(b) Instability of the frame carrying the moving wire.

“Both can be determined by making use of the fixed wires of the instrument; that is, provided the fixed wire frame is entirely independent of both the R.A. and Z.D. wire frames respectively.

“For lag—by “hand-tapping” the moving wire at coincidence with a fixed wire successively backwards and forwards at speeds differing greatly.

“An alternative method by using stars near the pole, and comparing the two transits on the same night—the back and fro method with the ordinary drive at the star's speed.

“*Instability of frame.* Detected by coincidences of the moving wire with a fixed wire at different positions of the telescope, say, at intervals of 30° circle reading apart.

“*Note.* This test should also be made by the Z.D. wire on a speck of dust on one of the fixed wires.”

These investigations might help to throw light on some of the systematic differences found in meridian astronomy. The existence of pivot errors is a possible explanation of discordances of the form $\Delta\alpha_3$ in star catalogues. In *M.N.* **98**, 53 W. M. H. Greaves has found differences between the R.A.'s of the last Greenwich Catalogue and those of FK3 varying with the declination. This is attributed to the new method of determining azimuth from stars at a considerable distance from the pole, and may be connected with pivot errors. The tables given in Gill's *History of the Cape Observatory* (p. 75) show a pronounced 2α term for the horizontal displacement due to pivot errors, but such a term is not shown to any extent in the vertical direction. The fact that similar errors have been found in several determinations of pivot errors indicate that they are real. Terms in 2α , although they may be spurious as stated above, may arise from elliptical pivots and are the simplest kind of pivot errors.

Prof. Danjon writes:

“Je fais construire un instrument des passages à réflexion, du type que j'ai décrit en 1935 dans le *Bulletin Astronomique*, mais de plus grande dimension (ouverture de l'objectif et des collimateurs, 12 cm.). J'y ajoute un second collimateur, en face du premier, pour pouvoir effectuer, par retournement, la vérification des constantes.

M. A. Lallemand a établi un dispositif à lampes, permettant la synchronisation et la commande d'un chronographe imprimant Prin, sans aucun relais mécanique. Le système de M. Lallemand présente, sur celui de l'Observatoire d'Uccle, l'avantage de se désarmer spontanément.”

In the *Russian Astronomical Journal*, **13**, 3, S. Blazhko describes a method he has introduced with success at Moscow for the elimination of magnitude equation. The usual method of screens over the objective has the disadvantages that it is clumsy, affects the form of the images and upsets the balance of the instrument especially on windy nights. The new method is to cut down the light of bright stars in the eyepiece with one or other of several dark glasses carried on a disk which can be rotated in the eyepiece. After this the field illumination is brought up to the standard by use of a rheostat.

Subjects which may be discussed at Stockholm are:

- (1) Precession data.
- (2) Sources of instrumental errors.
- (3) Distribution of the observation of fundamental and other primary stars (e.g. stars of the *Albany General Catalogue*) amongst the various observatories.

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