8. COMMISSION DE L'ASTRONOMIE DE POSITION

Report of Meetings, 23, 24 and 25 August 1967

PRESIDENT: R. H. Stoy.
SECRETARIES: W. Gliese,
C. A. Murray,
G. van Herk.

The greater part of the meetings of Commission 8 at Prague was devoted to scientific matters. Formal business was limited to the selection of a new organizing committee, the adoption of the Draft Report and the consideration of a number of resolutions.

The new organizing committee as accepted by the Executive of the Union is as follows:

President: A. A. Nemiro

Vice-President: W. Fricke

Organizing Committee: A. N. Adams, J. E. B. von der Heide, P. Lacroute, R. H. Stoy, R. H. Tucker, H. Yasuda, M. S. Zverev.

The Draft Report was adopted without amendment. Relevant additions to it have been incorporated at appropriate places in the present report. The four resolutions which were passed are:

(1) Commission 8 strongly recommends that, for the time being, all meridian observations continue to be reduced to the equator and equinox of 1950·0.

(2) Commission 8 reaffirms its recommendation that observers include time and latitude stars in their observing programmes.

(3) Commission 8 stresses the great importance of photographing the southern heavens in their entirety with good astrometric cameras during the period of the S.R.S. programme.

(4) Commission 8 notes with great appreciation the progress already made with the S.R.S. programme and renews its encouragement to other southern observatories to take part in this work.

The scientific reports fell into three groups: those relating to work in hand, those reviewing the accuracy of the fundamental system, and those surveying new instrumental methods and techniques. An attempt was made to avoid unnecessary duplication of material both with the Joint Discussion on Modern Problems of Fundamental Astrometry and with meetings of cognate commissions.

WORK IN PROGRESS

Scott reported on the work of the committees of which he was Chairman. There was nothing to add to the Draft Report of the Double Star Committee. Very satisfactory progress had been made in the various Reference Star programmes. A catalogue of final positions of 21 499 AGK3R stars, reduced to the FK4 system, had been formed. In summarizing the accuracy of the Catalogue positions, *Scott* pointed out that while the stars which were common to the USNO list and Zverev's list had each received the full 10 observations, most of those which were in Zverev's list alone had received only 8 observations; this resulted in a somewhat larger mean error for the latter. The average mean errors for all stars were $\pm 0^{s}.0050 \sec \delta$ and $\pm 0''.116$ in R.A. and Dec. respectively; 95% of all stars had mean errors less than $\pm 0^{s}.0095 \sec \delta$ and ± 0.214 in the two co-ordinates. So far, there had only been time to compare AGK3R with a catalogue of northern PZT stars observed with the USNO 7-inch transit circle by Dr. J. A. Hughes. The actual mean errors of the differences were in satisfactory agreement with those expected from the known accidental errors of the two catalogues. Further comparisons with the Yale Zone Catalogues, the G.C. and the S.A.O. Catalogue would be carried out.

Good progress had been made with the observations of the SRS programme. The Bergedorf meridian circle arrived in Perth in July 1967 and was expected to be operational later in the year.

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The USNO 7-inch transit circle arrived at El Leoncito during January 1967, and observations were begun in July.

The President remarked that the successful completion of the AGK3R programme, and the excellent progress with the SRS programme owed much to the hard work and enthusiasm of Scott and his colleagues at the Washington Naval Observatory. We were all most grateful to them and to the astronomers throughout the world who have cooperated so wholeheartedly in these projects.

Dieckvoss gave an account of the progress of the AGK3 photographic programme. Now that the final AGK3R had been received from Scott, it was hoped that the first of the five volumes of AGK3 ($+ 90°$ to $+ 55°$) would be ready for the printer by the end of 1967. The AGK3 data, including proper motions and spectral types, would be available in machine readable form to interested institutions. Proper motions of individual stars, specified by AGK2 number, could be supplied on request. The mean square error of the new epoch appears to be not larger than $\pm 0''.18$ in both coordinates while the mean errors of the proper motion components is $\pm 0''.008$ in both coordinates.

In the discussion on these reports, *van Herk* asked whether the 11 observational catalogues, which together formed AGK3R, showed any systematic differences depending on magnitude, to which *Scott* replied that it was difficult to separate errors depending on magnitude from those arising from different combinations of observatories, since the fainter Zverev stars had received fewer observations than the majority of stars in the catalogue.

In reply to a further question by *van Herk*, *Dieckvoss* said that AGK3 results could be supplied for stars of a specified spectral type.

Hoffleit then described the current state of the Yale Zone Catalogue work. She displayed a preliminary copy of the catalogue for $-30°$ to $-35°$. The positions were rather less accurate than those in most of the Yale Catalogues, but they had been of great value in indicating large errors in the early Cordoba catalogues, (many entries in which depend on one meridian observation only), with consequential corrections to proper motions in CPC. All high proper motion stars had been especially checked and no new ones, which were not already in the Luyten Surveys, were found. A feature of the catalogue was the series of charts showing the magnitude and direction of proper motion of all stars whose motions were appreciable. This would be of value in searching for common proper motion stars, and members of moving clusters. The catalogue for $-35°$ to $-40°$ would probably be published in 1968. The zones between $-40°$ and $-50°$ and between $-60°$ and $-70°$ had been measured but not yet reduced. The plates south of $-70°$ overlap appreciably in both right ascension and declination. A large number of faint Melbourne stars selected by Eichhorn are being measured on these South Polar Cap plates in addition to the CPC stars which constitute the programme stars measured in the other zones.

Stoy said that it was most desirable that the southern hemisphere should be re-photographed, preferably by three or more separate cameras, during the SRS programme. The Cape had undertaken to provide one such series of plates with generous overlaps between them. Commission 8 should consider a resolution on this matter.

Eichhorn requested that one or two stars per square degree, reaching the magnitude limit of the Astrographic Catalogue, should be included in the observing lists for the photographic zone catalogues. These would provide material for determination of the magnitude equation in the Astrographic Catalogue when their proper motions became available.

Vasilevskis reported on the second-epoch work of the Lick Proper Motion Programme which has been started. The first phase will be a pilot programme which will not exceed two years; proper motions of approximately 20,000 stars are expected to be obtained. The second phase will cover completely the sky photographed during the first epoch. It will be possible to obtain proper motions in step with taking the second epoch photographs due to automatic measurements of plates and to high speed reduction of measurements. The Automatic Measuring Engine has been completed and installed at Lick Observatory by the Gaertner Scientific Corporation.

Wesselink spoke on the Yale-Columbia Proper Motion Programme which is the southern counterpart to the Lick Programme. He described buildings, telescopes, and the plates used in El Leoncito. The programme has 600 centres covering the sky between $-25°$ and $-90°$ declination. The

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plate centres are 5° apart in declination. So far first epoch plates have been obtained for 180 centres; the completion of the observing programme for the first epoch plates is expected within 3 more years. The taking of the second epoch plates will begin 20 years from now. It is expected that the resulting proper motions will have an accuracy of $\pm$ 0.″005 per year.

Vasilevskis suggested an overlap of 3 zones of the two programmes.

THE ACCURACY OF THE FUNDAMENTAL SYSTEM

Fricke asked that any observations relevant to the improvement of the FK4 should be sent to the Astronomisches Rechen-Institut at Heidelberg where investigations of possible improvements are carried out continuously. He drew attention to the paper "Desiderata for FK5" to be presented at the Joint Discussion.

Adams discussed the progress being made by F.S. Danse at USNO toward the construction of an instrumental catalogue of positions and proper motions of fundamental stars. Six absolute catalogues of positions, observed with the six-inch transit circle between 1910 and 1962, were now available.

Afanasjeva described work by Pavlov, Staritsyn and herself on the Reference Catalogue (RC) of right ascensions formed from the latest three photo-electric catalogues of the Pulkovo time service. Comparison with FK4 showed small systematic variations with declination which were confirmed by N30 and several recent astrolabe catalogues. There was also a systematic difference between RC and FK4 depending on magnitude which was confirmed by observations made at Moscow and Paris.

Guinot reviewed briefly the progress of the various astrolabe observing programmes, which were designed to improve the fundamental system. Five catalogues had already appeared, two were in press, while observations were continuing at seven observatories between latitudes + 49° and − 34°.

Vassiliev gave an account of astrolabe observations made at Pulkova and *Anguita* described the results of observations made with the astrolabe at Santiago, which is operated jointly by the Universidad de Chile and the E.S.O. The differences of the form $\Delta\alpha_\delta$ between the astrolabe observations and FK4 agreed well with those obtained from the meridian observations presented at the Joint Discussion. The difference appeared to increase numerically with increasing southern declination, reaching about 0.^{s}03 at $\delta = -60°$. This result was confirmed in a later paper by Thomas, presented by *Murray*, on results derived from observations of FK4 stars and also GC stars reduced to the FK4 system, made with the Cape astrolabe.

van Herk drew attention to the systematic differences in μ_α of the FK4 stars as given in the FK4 and in N30. The differences show a marked dependence on magnitude amounting to − 0.″160 $\pm$ 0.″026 per 100 years per magnitude in the region $-28° > \delta > -80°$.

A smaller, but nevertheless significant, magnitude dependence was found in the region round the Hyades. van Herk's investigation was restricted to stars brighter than the seventh magnitude as the FK4 contains no fainter stars. It would appear dangerous, therefore, to reduce any catalogue of faint star proper motions to the system of either the FK4 or N30 as one might apply corrections which are erroneous to the extent of the average values of proper motions for stars of the ninth magnitude.

Fricke remarked that the differences between the systems of FK3, N30 and FK4 are smaller in μ_δ than in μ_α and that there was a high probability that the μ_δ systems are much more reliable than the μ_α systems because of the controlling effect of the Sun and planet observations. The μ_δ systems of N30 and FK4 are free of noticeable errors due to the neglect of latitude variations prior to 1900.

The next two papers dealt with the improvement of the fundamental co-ordinate system by observations of minor planets. *Aoki* gave an account of Yasuda's work on the four bright minor planets, which is published in *Publ. astr. Soc. Japan*, **18**, 297, 1966. *Polojentsev* read a paper by Orelskaya, reviewing the present state of the programme for using ten minor planets, which had been elaborated by Samoilova-Yakhontova of the Leningrad Institute of Theoretical Astronomy. Sixteen observatories had so far contributed over 7000 photographic observations, but further progress

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could not be made until the systematic errors in the Yale catalogues could be determined from comparison with the results from the current reference star programmes.

DEVELOPMENTS IN INSTRUMENTATION AND TECHNIQUES

Lacroute discussed the possibilities of making angular measures from satellites. Such measures being made from outside the atmosphere would be completely free from the complications and systematic errors introduced by refraction. Lacroute described equipment weighing about 150 kilograms which could be used on a satellite that was stabilized to about one minute of arc. A system of mirrors superimposes on the same objective two fields at a predetermined angle of the order of 90° apart. The focal plane of the objective is scanned by two photon counters. Angles between stars brighter than magnitude 7 could be measured within one second of time to an accuracy of $0''.01$. This apparatus would have immediate and important applications. It is clear that the moment has come when astrometrists must take an interest in measures made in space.

Teleki discussed the influence of refraction in fundamental astrometry. (See also *Trudy* 17 *Astrometric Conference SSSR*, 1966). He pointed out that it was unjustifiable to use a conventional refraction table at all observatories since anomalous refraction of a systematic character, and even normal refraction, was known to depend on the local topography. Refraction tables in current use were based on theories devised in the nineteenth century and ignored much new information on the structure of the atmosphere that was now available. He urged that the whole refraction problem should be studied intensively and that as much care should be given to the siting of astrometric instruments as is now given to the location of large reflectors.

Høg described the Bergedorf 19-cm Repsold meridian instrument which has been equipped with photoelectric micrometers employing fast data logging for observing the star and reading the declination circle. Results obtained during test measurements in Bergedorf gave internal mean errors for a photoelectric observation of $\pm 0^{s}.012$ and $\pm 0''.25$ as compared with $\pm 0^{s}.016$ and $\pm 0''.43$ for a visual observation made during the AGK3R programme. The 7200 corrections of the 3′ divisions of the two gold circles were determined with a mean error of $\pm 0''.14$ by the general symmetrical method in a very short time.

Requième reported on the first results obtained with the photoelectric micrometer of the Bordeaux transit circle which was described to Commission 8 at Hamburg in 1964. Observations of FK4 stars between $-20°$ and $+75°$ gave a mean square error for a single observation of $\pm 0^{s}.010$ sec δ. SRS stars in the equatorial zone as faint as magnitude 9.0 gave a mean error of $\pm 0^{s}.0126$ as compared with $\pm 0^{s}.0183$ for visual observations made with the same instrument before 1964. The size of this mean error seems to be practically independent of magnitude and spectral type. There is, however, a systematic difference between photoelectric and visual observations of the same stars which seems to depend not on magnitude but on spectral type. It is practically zero for K stars but reaches 8.5 millisecond for A stars and may be caused by the chromatic properties of the transit circle objective.

Laustsen outlined instrumental developments and results obtained with the Copenhagen transit circle at Brorfelde of which a full account has been published in Nr. 190 of the *Publikationer og mindre Meddelelser fra Københavns Observatorium.* The chief points of interest are the photographic micrometer and the photoelectric recording of the circle. The observed internal mean errors of a single observation of a star brighter than magnitude 11 are $\pm 0^{s}.015$ sec δ and $\pm 0''.22$. With the method of photoelectric scanning, which has been in use since December 1965, a circle position can be determined with the six photoelectric micrometers in 16 seconds with a mean error of less than $\pm 0''.03$. Division errors have been determined for all 2160 diameters with a mean error for the correction to a single diameter of $\pm 0''.026$. The measures for this investigation took only 15 hours and the reductions 20 hours. *Laustsen* remarked that systematic errors of the order of $0''.1$ to $0''.2$ and extending over several degrees might well exist in division error corrections determined by the older methods and that these might give rise to catalogue errors of the type $\Delta\delta_{\delta}$.

Høg remarked that the accuracy of the reading of the declination circle claimed by Laustsen was

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unbelievably high. He wanted to stress, however, that he did in fact believe it. Such high accuracy is produced by using a glass circle illuminated from behind, by the scanning data logging technique proposed by himself in 1960, and by the accurate alignment of the microscopes perpendicular to the circle. They had had trouble at Hamburg because a gold circle reflects like a mirror.

Plans for a new transit circle under consideration for the USNO were discussed by *Klock*. It is intended that the instrument should incorporate the most advanced optical and mechanical techniques available. Readings from the photoelectric micrometers and digitized circle will be fed straight to a computer. The conventional long refracting telescope, which is particularly susceptible to thermal and flexural errors, will be replaced by a compact folded reflector system.

Høg said that the use of an on line computer with a meridian instrument as planned by Klock is a solution for the very near future. The rapid development of cheap process computers like the PDP-8 should make the simple data logging systems a short intermezzo in meridian instrumentation techniques.

De Barros reported that the new axis for the Porto mirror transit circle which was brought into use in April 1967 showed no appreciable flexure and that the various micrometers are now digitized.

Woolsey made a brief report on the progress that has been made with bringing the Ottawa mirror transit into service. An examination of the instrumental constants has revealed an instability in the central section which produces a large change in azimuth during a night's work. There is also a scatter in the registration of both co-ordinates which is attributable to thermal effects between the two collimators.

Harin gave some results of the application of his modified Courvoisier method for measuring the flexure of a tube (*Trudy* 17 *Astrometric Conference SSSR*, 1966.) Preliminary observations with the Wanschaff vertical circle showed that the ends of the tube are not directed exactly along a vertical line when the tube is pointed at zero zenith distance. The ends deviated to north or south according to the direction of the rotation of the tube when setting it to the zenith. The mean deformation for one end was about 4 microns as compared with the horizontal deformation of 170 microns. It seems that this '*Biegungsrückstand*' (residue of flexure) is due to peculiarities in the construction of the tube.

Levy spoke briefly on the search for a suitable site for the French National Astrometric Observatory. The 19 cm meridian instrument of the Liège Observatory has been installed on an isolated plateau about 1700 m above sea level near Font-Romeu in the Eastern Pyrenees and has been working there since April, 1967. If the site proves satisfactory, two meridian instruments with photoelectric registration, one for right ascension and the other for declination, will be installed and also a large astrograph.

Some considerations on the optimum design and location for transit instruments were discussed by Pavlov in a paper read by *Afanasjeva*.

Debarbat showed the results of observations of Mars (1963), Vesta (1963), Uranus (1964), and Jupiter (1964 and 1965/66) which were made with the Danjon astrolabe. Only observations made in two passages (east and west) were used to compute the deviations $\Delta\alpha$ and $\Delta\delta$ from the elements published in the American Ephemeris. In most cases comparisons with meridian observations made at the same epoch are very satisfactory. The discussion of the observations of Mars manifested that the accuracy was of the same order as that reached in the observations of stars.

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