

## 8. POSITIONAL ASTRONOMY (ASTRONOMIE DE POSITION)

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### 1. INTRODUCTION

We commemorate four members who have, each in their own position, helped much to advance or promote our work: B. Harris, V. Maitre, F. P. Scott, J. Verbaandert, who died in the past three years. W. Dieckvoss, H.-U. Sandig, and H. W. Wood retired from their positions in Hamburg-Bergedorf, Dresden, and Sydney, respectively. Our thanks are due to them for all what they have done in the field of astrometry.

These past three years are marked by a searching investigation of new ideas on the technical side of determining positions, and in some cases by a progressive development. In fact, if all these new ideas will bear fruit, the outlook and scope of astrometry will change, within the next decade, past all belief.

To comply with the demands of the General Secretary, this Report has been drafted as concise as possible. Literature will be quoted as much as possible by giving the indexing in the *Astronomy and Astrophysics Abstracts (AAA)* or *Astronomischer Jahresbericht (AJB)*.

Our Commission knows three Groups, each dealing with a special subject:

- (a) Study Group on Horizontal Meridian Circles, headed by E. Høg,
- (b) Study Group on Astronomical Refraction, headed by G. Teleki,
- (c) Working Group on Results of Astrolabes, headed by G. Billaud.

(Notice the subtle difference in denomination which has, once, been considered necessary.)

Various members have cooperated with activities sponsored by other Commissions, the outcome of which affect our sphere of activities as well. The proposals to change the astronomical constants are amongst the noteworthy.

### 2. PROGRAMS, TECHNIQUES, CATALOGUES

At many Observatories programs are in progress, have recently been finished, or are at the verge of beginning. The following details, apart from those programs which were set up to check the quality of an instrument, have been reported.

#### A. Australia

In *Sydney* the photography of the Southern sky with plates 5x5 deg with complete overlap in both coordinates, is continued. Zones from  $-38^{\circ}30'$  to  $-63^{\circ}30'$  are completed. At the moment the zones  $-71^{\circ}$ ,  $-73^{\circ}30'$ , and  $-76^{\circ}$  are in observation (W. H. Robertson).

#### B. Denmark

At *Brorfelde*, the program including 1500 NPZT and about 3000 other stars was finished. The measurements of the photographic plates from the photographic micrometer are expected to be finished at the end of 1976. The final reductions for 1000 stars (5000 observations) yield a final m.e. for one position of  $\pm 0^{\circ}012$  in RA and  $\pm 0''20$  in Dec. A program of reference stars

for radio sources is being carried out. A MC catalogue has been published in 1973 (09.041.001) (H. J. Fogh Olsen).

### C. Federal Republic of Germany

The *Hamburg-Bergedorf* Observatory published the AGK3 in 8 volumes in 1975. The data given allow to regain the revised AGK2 positions. The random errors depend strongly on magnitude and the tables in the introduction may be used when addition of more recently determined positions becomes possible. A machine-readable edition of the catalogue on magnetic tape in EBCDIC-code was produced for the Astronomisches Rechen-Institut by T. Lederle. Our congratulations go to our colleagues for completing this enterprise!

At the Computing Centre of the Hamburg University about 84000 cards were punched with all essential data of the BD from  $-2^\circ$  to the North Pole. Editing on magnetic tape has begun. It is a question whether there exists genuine demand for a machine-readable BD to decide whether continuation is vindicated (W. Dieckvoss).

In *Hamburg* the regular observing programs with the zone-astrograph started again in 1975. From reductions of about 50 plates the expected high quality of the optical system is well confirmed (11.041.057). For a single star position on one plate a m.e. of  $\pm 0''.13$  is obtained. Photographic positions of FK4 stars in selected fields have been obtained using a 6-mag. grating. From the first order images an accuracy of  $\pm 0''.12$  for a single position is obtained, and FK4 stars may, therefore, be included directly as high accuracy reference stars in block adjustment projects covering larger areas. An observing program for optical positions of radio sources in the FK4 system has been started. Second-order reference stars will be obtained with the zone-astrograph. An investigation concerning the project of a new photographic four-fold coverage of the northern hemisphere has been carried out (11.041.057). The final positions and p.m. are now expected to have a m.e. of  $\pm 0''.07$  and  $\pm 0.004''/a$ , respectively. The work on block adjustment techniques has been continued; a general computer program of arbitrary overlap patterns is being developed (11.041.009). Due to recently found discrepancies in the Strasbourg AGK2/3 solution (*AA*, in press) an independent block adjustment of the original catalogue data is being prepared (C. de Veigt).

At the *Munich* Observatory the observations of absolute declinations of FK4 stars, major planets, and the four bright minor planets are continued with the VC (F. Schmeidler).

### D. France

At *Bordeaux* the observations of the whole Northern PZT program was completed in May 1975, each star being observed on average six times with the photoelectric micrometer. The positions will be published next year in *AA Suppl.* In close cooperation with the 'Centre d'Études et de Recherches Géodynamiques et Astronomiques' the following goals for the improvement of the Bordeaux MC were fixed: (a) automatic setting of the instrument and full process control by means of a minicomputer, (b) extension to the 12.5 mag. in spite of the important sky background due to the proximity of Bordeaux and without loss of accuracy. Two automatic angular read-outs are now tested: a glass circle with incremental encoder track and four electrooptic reading heads, and a new metallic circle with special photoelectric microscopes. Further, a new objective adapted to the spectral sensitivity of the photomultiplier and colour filter is under construction. Present scheduling indicates that the full automation of the Bordeaux MC will be achieved by the end of 1977. These developments prepare the new automatic MC working to the 14th magnitude which is planned for the CERGA by 1980 (Y. Requième).

*Grasse*. The Centre d'Études et de Recherches Géodynamiques et Astronomiques (CERGA) was officially founded in Grasse in 1975. We hope to witness soon a thriving astronomical community at Grasse.

In *Paris* the MC catalogue Paris I 1950.0, containing positions in the zone  $+33^\circ$  to  $+36^\circ$  for 3997 stars and prepared for use as reference catalogue of the photographic catalogue, is now available as Astrometric Data No. 37 at the Centre de données stellaires de Strasbourg. The catalogue has not been published (J. Lévy).

A compilation of the work done on planets at various observatories with the Danjon impersonal astrolabe has been made at the Paris centre. The participating observatories are mentioned.

Jupiter is observed now at Santiago di Chile. Previous observations done from the northern hemisphere have been discussed and published (Débarbat and Grudler: 09.099.001; Débarbat and Pâquet: 09.099.015; Débarbat: 10.041.006). The theoretical aspects of the treatment of the observations of the Galilean satellites performed during 1964 and 1965 have been published (Chollet and Débarbat: 12.041.012; Davila, Débarbat, and Journet: *Coll. IAU*, 28).

Mars is observed at Alger, Richmond, San Fernando, and Washington (1973/74). Paris will soon resume the observations of this planet. The San Fernando observations have been published (12.044.032). Saturn has been observed at Alger (1969/70), Besançon (1971/72/73/74, the results from 71/72 have been published: Colin, Grudler, and Oblak: 12.041.011), Grasse (1972/73), Paris (1971/72/73, published 09.041.023 by Chollet *et al.* for 71/72, Débarbat *et al.* 13.041.007 and 14.041.001), Richmond (1974/75), San Fernando (1970/71/72/73, for the three seasons published in: 10.044.042, 11.044.011, 12.044.032), Washington (1974/75).

Vesta: after the trial observations in 1963 observations have now been performed at Alger (1969/70) and Richmond (1973/74).

The Sun has been observed at Grasse (Laclare, 13.041.010) and a campaign to observe the Sun regularly has started in the summer of 1975.

At Quito, favourably located through its low absolute latitude, planets and satellites are now again observed. The Besançon astrolabe went out of service in 1973 (S. Débarbat).

#### E. German Democratic Republic

In *Babelsberg* the PZT is now engaged in routine work for SIR and IPMS. The PZT observations from 1972 and 1973 served to improve the positions of the Potsdam PZT catalogue. New p.m. in Dec. for the PZT stars were calculated (M. Meinig, 1975, *Veröff. Zentr. Inst. Physik d. Erde*, in press) from the corrected declinations and from the data of five older catalogues observed since 1915. Though the examination of the *Potsdam-Babelsberg* MC showed a favourable result (J. Liebert, 11.032.061) there is at yet not a possibility to resume routine work.

At *Dresden* a photoelectric device was developed for the Potsdam TI (Pothoff, 12.031.180) which was tested in connection with thorough studies of the temperature field (Dittrich, 1975, *Veröff. Zentr. Inst. Physik d. Erde*, in press). It was possible to obtain equality between interior and exterior r.m.s.e. ( $\pm 0^s007$ ) for the means of 12 evenings with about 10 stars each. In cooperation with Moscow Sternberg Institute corrections to declinations of Dresden Horrebow pairs are derived in Moscow. The Horrebow program will be finished at the end of March 1976 after nearly 18.6 years continuous work in favour of the above mentioned and other programs.

From the *Potsdam* Danjon astrolabe observations (1961.75-1970.75) corrections to the FK4 were derived (Höpfner, 1975, *Veröff. Zentr. Inst. Physik d. Erde*, No. 32).

The *Tautenburg* Schmidt will be used to examine systematic errors of the  $\Delta\alpha$ -type of fundamental stars on overlapping plates in a closed zone of declinations. The astrometric quality of the  $3^{\circ}.1 \times 3^{\circ}.1$  plates was found to be very good ( $\pm 0''.10$  interior,  $\pm 0''.15$  exterior error (Sandig, 11.041.013, Kinner, 1976, *Jenaer Rundschau* in preparation). Theoretical considerations of error distribution in closed zones of declination showed – as expected – similar good results as for the closed sphere covered by overlapping plates (Ebner, 02.041.004).

*Tautenburg* and *Potsdam* (Zentralinstitut f. Astrophysik) will cooperate with *Dresden* (Lohrmann Observatory) in a pilot program, starting in the autumn of 1975, for the declination zone centred on Dec  $+52^{\circ}.5$ . A repetition some 20 years later will allow to derive absolute p.m. with respect to galaxies. Optical counterparts of some radio sources will be included in the positional work (H.-U. Sandig).

#### F. Great Britain and Cape

As the two Meridian Departments, at Herstmonceux and at Cape, have been working very closely together, a combined report follows. The programs undertaken at *Cape* were brought to

a close when the Gill Reversible TC was taken out of commission on 1974 April 26. The Head of Department, A. Shortland, returned then to Herstmonceux. All star observations obtained at Cape since March 1961 are now in computer-readable form at Herstmonceux. Preliminary O-C's for all these observations have been produced. Examination and analysis are now in hand. At Cape the  $-52^\circ$  to  $-64^\circ$  zone observations were completed; the last zone ( $-64^\circ$  to  $-90^\circ$ ) was abandoned. The minor planets and, occasionally, the major ones were observed. The Bright Stars associated with the SRS project were included in the Cape observing list until the withdrawal. We should remember the many important contributions in astrometry from the Cape!

At *Herstmonceux* regular observations of the Sun, major planets, the four bright minor planets and all FK4 stars north of  $-31^\circ$  Dec. have continued. In 1974 the Moon limbs and the crater Mösting A were added to the observing list. As at 1975 July the observing program containing 3087 lunar occultation stars of Robertson's catalogue (*APAE X*, pt. II), to be observed four times each, was 92% completed in each clamp position. The Northern PZT program, containing 1719 stars, was 87% completed. Observations of selected variable stars are continued. Special observations of Algol, reduced to the FK4 system, were used in conjunction with photographic observations to determine the zero point of the RA system of the Cambridge 5-km radio telescope. The re-reduction of the observations made with the Airy TC at Greenwich from 1942 to 1954, using the 'centroid' method to determine revised Azimuth and Clock Corrections after modifying the tabular places, is well advanced. Investigations are continuing for defining the fundamental instrumental system of the *Herstmonceux* observations. Good progress is being made in arranging for p.m. data to be processed by the computer, taking advantage of magnetic disc storage.

The Hilger and Watts contact-type digitisers and decoders fitted in 1957 to the circle-film-measuring machines were replaced in January 1975 by Teletrak optical digitisers and decoders. The original 12 cm divided heads are retained for use in setting-up procedures and for periodical checks on the read-out from the digitisers. Work at the National Engineering Laboratory, Kilbride, Scotland, on the development and construction of an automatic digital circle-reading system employing moiré-fringe principles is at an advanced stage: trials on the telescope are expected to commence towards the end of 1975. The unused movable circle of the Cooke TC has been removed and is undergoing modifications to carry the new fringe grating in a circle of approximately the same diameter, 61 cm, as the existing circle divisions. The problem of using read-out heads at up to 5 cm from the grating has been overcome. During the trials the digital read-out from the new fringe arrangement will be recorded simultaneously with the exposure of the films in the fixed cameras. A mounting has been designed for attaching a Helipot potentiometer digitiser to the ZD micrometer, so that the micrometer settings can be automatically recorded by means of a multi-channel data logger, which will be used also to record the meteorological data. The new RA drive utilising a stepping motor has been designed but cannot be installed until the new circle-reading system is operational. All these changes necessitate a complete reappraisal of the whole recording system for the TC.

Preliminary talks between the Meridian Departments at *Herstmonceux* and at the Copenhagen University Observatory, Brorfelde, are taking place with a view to cooperating in the programming, manning and running of the Carlsberg Automatic MC if it is moved to a new site. Publications: 'The Position of  $\beta$  Persei', R. H. Tucker *et al.*, 10.041.005; 'Provisional Positions of the Sun and Planets from 1957 to 1971 (FK4 system)', M. E. Buontempo *et al.*, 12.041.041 with an Appendix by R. H. Tucker on 'the Simultaneous Determination of Azimuth and Clock Correction for a TC', and an Appendix by B. Emerson on a 'Method of Calculating Apparent Places of Stars'; 'Second Greenwich Catalogue of Stars for 1950.0', by K. C. Blackwell *et al.*, 11.041.008, with an Appendix by K. C. Blackwell on 'Cooke TC Collimation Investigation; Provisional Positions of the Moon, 1958-1971', by K. C. Blackwell *et al.*, 14.041.028. In Press: 'Provisional Positions of the Sun, Moon and Planets, 1972-1973' by K. C. Blackwell *et al.* (K. C. Blackwell and A. Shortland).

### G. Japan

At *Mizusawa* the International Latitude Observatory will derive corrections to the FK4 and FK4 Sup star positions from the individual observations carried out with the Danjon astrolabe during the period 1966 to 1974.

At the *Tokyo* Astronomical Observatory regular observations of the Moon, planets and the four bright minor planets referred to the FK4 system have been continued. The results of the observations of solar system bodies from 1968 to 1973 were published by Yasuda *et al.* (13.041.041). Observations of Eros were made with the MC from 12 December 1974 to 28 March 1975. From observations within the SRS and the BS programs, corrections to the positions of FK4 stars north of  $-35^\circ$  and of FK4 Sup stars from  $-10^\circ$  to  $-30^\circ$ , together with the catalogue of 743 BS stars, were published by Yasuda *et al.* (13.041.034). The final results of 3651 SRS stars were sent to Washington. The residual magnitude effects in the observations of these stars were investigated by Yasuda *et al.* (13.041.035). The observations of O and B stars north of  $-30^\circ$  and brighter than visual magnitude 8.5 are being continued. Meridian observations of the Northern PZT stars are required for relating the positions of these stars to the FK4 and as an aide to determine p.m. Reversely, the PZT observations can contribute to the improvement of the fundamental system if the positions of the PZT stars are known in the system of the FK4. Meridian observations of 1717 PZT stars have been completed by the end of August 1975. Each star was observed six times. The catalogue of star positions and p.m. used in the Tokyo PZT observations were improved using the PZT observations themselves from the period 1956 to 1974 (13.044.026, Appendix). Improved positions of Mizusawa PZT stars were also derived using the PZT observations themselves from the period 1959 to 1973. They were reduced to the new Washington PZT star system. The group corrections to the positions used in the PZT observations amount to  $-0^s.040$  (22 h) in RA and to  $+0^m.43$  (01 h) in Dec. (H. Yasuda).

### H. The Netherlands

At *Leiden*, observations of minor planets, the Pleiades and of some variable stars are made with the 33 cm refractor. Some optical positions of radio sources have been provided. The automatic measuring machine for plates is still in the state of development (G. van Herk).

### I. Roumania

In *Bucarest* the observations of 952 NPZT- ( $+45^\circ$  to  $+59^\circ$ ), 199 Prague PZT- ( $+50^\circ$ ), 377 double stars ( $+40^\circ$  to  $+65^\circ$ , Scott's list), with four observations on each star, started in 1971, were finished in 1975. All O-C's in RA and in Dec were obtained for 1176 SRS- and 610 BS stars ( $-10^\circ$  to  $+5^\circ$ ) observed during 1962-1967. The last revisions of some greater O-C's are taken up at present. The results will be sent, this year, to the U.S. Naval Observatory. For about 750 FK4 stars ( $-18^\circ$  to  $+20^\circ$ ) O-C's are studied in RA and in Dec. in dependence of both coordinates. The results will be published in 1977 together with the SRS and BS catalogue (E. Marcus).

### J. Spain

In *San Fernando* the first two catalogues of astrolabe observations with FK4 and FK4 Sup stars have been completed. The catalogues, covering the periods 1969.01-1971.29 and 1971.22-1973.43 (CASF 1 and 2), contain 190 and 226 stars respectively. They will be published. A third campaign of observations for catalogue purposes started in June 1973. Systematic observations of planets with the astrolabe have continued. The three campaigns (1972-1975) with 47 double transits for Saturn and the campaign in 1974/75 with 26 double transits for Mars are included in the Paris report. From September 1973 the MC is engaged in the NPZT star program. By August 1975 41% of the observations had been completed. With

this instrument, 71 transits of planets have been observed. In conjunction with the astrolabe and meridian circle observations of planets, 31 plates have been taken on planets with the Carte du Ciel astrograph. New differential drives will be installed in both astrolabe and RA meridian circle micrometer (L. Quijano).

#### K. U.S.A.

At *Washington* the refurbished six-inch TC commenced a new observational program late in the summer of 1974. It consists primarily of Zodiacal stars, PZT stars and the high priority Blaauw stars, along with the fundamental stars, Sun, Moon and the planets. There are nine minor planets on the list. Major instrumental changes to the instrument were a new temperature-compensated objective, a new circle scanning system and an improved inductosyn system. A new glass circle is currently being constructed by the Heidenhain Corporation. Improved reduction methods permit preliminary observed minus computed positions to be produced the morning after the observational tour. After many delays in completion of the Automatic TC, the original manufacturer was dismissed and a new contractor, Boller and Chivens, Inc., has been contracted to complete the necessary work. A catalogue entitled 'Catalog of Proper Motions for the 5,965 Stars of the Six-Inch TC Program 1949–1956' was published (Rhynsburger, Gauss, 14.041.029). A new circle scanning system was constructed under a National Science Foundation grant for the Sao Paulo MC under supervision of Klock. This system was constructed as a provision for a cooperative observational program of Zodiacal stars between the two observatories (B. L. Klock).

The Southern TC Division of the USNO at Washington reports: Upon completion of the SRS program the seven-inch TC was shipped back to Washington for refurbishment. A new clamp mechanism and slow motion drive have been designed and tested. A new micrometer drive has also been developed. An automatic setting device, to be used with a new data acquisition system, is presently under construction. Final results of the SRS observations have been received from Abbadia, Bordeaux, Cape, Nicolaiev, San Fernando, Tokyo and Washington.

Reduction of the observations is well advanced at the other observatories. The USNO program at El Leoncito, Argentina, was completed in 1973. A total of over 150 000 observations of SRS, FK4 and FK4 Sup stars was made. For the 21 499 AGK3R stars the derivation of p.m. was continued. To date (September 1975) 40 catalogues have been reduced to the fundamental system, producing p.m. for approximately 15 000 stars (J. L. Schombert).

#### L. U.S.S.R.

As usual, our colleagues from the U.S.S.R. devote much energy to astrometry. In sequence of observatories they report:

##### 1. *Engelhardt*

The program of PZT stars is completed. The Repsold MC was used to make observations at large zenith distances to check the new refraction tables. Much work has been done in computing new tables for refraction for the Study Group on Refraction. The declinations of major planets are being observed. Simultaneous observations performed with the MC and the ZT have produced interesting results about the influence of the lower atmosphere; moreover, the declinations for the 66 stars have been determined according to the Sanders-Raimond method. This method yielded the best results from three methods to determine absolute declinations (use of nadir, of Polaris, being the others). The ZT gave declinations according to the differential method with a m.e. of  $\pm 0.3$ . Correlation analysis has been applied to the study of equator points. Changes in zero-points can now be followed on a strictly mathematical base.

## 2. *Golosseyevo*

Here the Wanschaff VC was modernized and installed in a new pavilion. The circles are read photographically and the films are measured photoelectrically. Absolute observations of bright (FK4) and faint (FKSZ) stars have been started with the VC. Observations of the Sun and major planets are continued, as is the case with investigations on astronomical refraction.

## 3. *Institute for Theoretical Astronomy*

A new, enlarged, program of observations of minor planets for the years 1974 to 1990 has been compiled. The following planets have been added to the former ten: nos 25, 148, 398, 532, 568, 582, 594, 704 and 1301 (14.041.020). So far 34 observatories have consented to participate.

## 4. *Kharkov*

Observations of the Sun, the major planets and lunar occultations are performed. The declinations of the FKSZ stars in the zone  $-10^{\circ}$  to  $+90^{\circ}$  in the FK4 system have been published (13.041.078). Two catalogues of bright stars have been published as well (abstracts given in 11.041.015 of RA of 1740 and 1335 stars).

## 5. *Kiev*

Here, the differential observations of FKSZ stars ( $-10^{\circ}$  to  $+90^{\circ}$ ) were completed for the second epoch; the reductions will be finished in 1975. The results of the observations on 3839 stars (1963–69) were published (12.041.046, Gregul, Drofa, Chernega). With the MC the observations on 2524 BS stars ( $+10^{\circ}$  to  $+90^{\circ}$ ) are continued. The compilation of a general catalogue of BS stars, observed at different observatories was started. In Kiev also a photoelectric machine for measuring the film recordings of the circle readings was constructed (12.034.064).

## 6. *Moscow Sternberg Institute*

This institute studied the influence of temperature and refraction anomalies in and near the pavilion (14.032.018/019/020). The absolute determinations of 187 circumpolar stars are near completion. The Sanders-Raimond method for determining fundamental declinations is used. Observations of the Sun and the major planets are continued. The catalogue of the KSZ stars ( $+40^{\circ}$  to  $+60^{\circ}$ , in RA and Dec.) has been published (13.041.031). The declinations of the latitude stars, based on micrometric observations with the wide-angle zenith telescope ZTL-180, were published (08.041.071; 13.041.070, abstracts only). The m.s.e. of one observation is  $\pm 0''.22$ . The declinations of 437 stars in the Moscow zenithzone ( $|z| \leq 45'$ ) are determined with the ZTL-180. Observations and reductions of 20 scale pairs compiled from the stars of the Washington PZT program were finished. Work on improving the method of meridian differential observations was continued.

## 7. *Nicolayev*

Nicolayev has organized a laboratory for plotting precise divisions on circular and linear scales. Refraction anomalies are studied like in Moscow. The absolute observations of 395 bright stars of the U.S.S.R. Time Services program (performed with the Freiberg-Kondratjev TC) have been finished. A continuation of this work (in RA) of 420 FK4 stars is made. During the Polar night 1974–75 an expedition of four observers, working in long series from 20 to 70 h, have finished, at Spitzbergen ( $\varphi \approx 80^{\circ}$ ) the first cycle of determining RA of bright stars. Instrument used: the small photoelectric TI. Marks in the meridian and the level were used. Here also, observations of the Sun and major planets are continued. The reduction of observa-

tions of SRS and BS stars (zone  $0^\circ$  to  $-20^\circ$ ) was finished. The catalogues have been sent to the Pulkovo and Washington Observatories. Differential observations of the FKSZ stars (Dec.  $> 0^\circ$ ) have been started with the MC. The reduction of RA for 9500 Zodiacal stars was finished; those of the declinations are continued. With the zone-astrograph, photographic observations of stars in the  $\pm 10^\circ$  zone up to the 12th magnitude have been started.

#### 8. *Odessa*

A printing chronograph for recording transits has been designed. A catalogue of 200 declinations observed with the MC for the Pulkovo ZTL-180 program was published (14.041.025).

#### 9. *Pulkovo*

The PVC (AJB 60.2283) completed the absolute determination of declinations of the FK4 and FKSZ stars in Chile (1965–66). A visual-photoelectric machine for measurement of the startrails obtained with the PVC was constructed (08.034.151). After reconstruction, the Sukharev HMC will be used for the determination of absolute declinations; the experimental series of observations of RA will first be finished (13.041.050). The reduction of six independent investigations (1954–61) of the pivots of the LTI has shown that the pivots undergo slight changes after regrinding and after a displacement of the working sections. The study of refraction anomalies is here also performed. The methods for accounting for a chromatic refraction were investigated. The corresponding tables of corrections for the colour of a star have been compiled. These tables are to be used in the compilation of the new Pulkovo tables of refraction. The observations of Solar system bodies is also continued. A re-reduction of the Dec. of the AGK3R stars ( $+70^\circ$  to  $+90^\circ$ ) has improved the accidental errors; the m.e. of one observation decreased from  $\pm 0''.60$  to  $\pm 0''.48$ . The catalogues of right ascensions of the SRS, BS and FK4 stars ( $-47^\circ$  to  $-90^\circ$ ) have been formed from the observations with the Repsold MC in Chile. These catalogues were compiled in the instrumental system by the 'quasi-absolute' method. In 1976, the reduction of the declinations will be completed. Observations are continued with the Ertel VC for 3600 latitude stars on the list of the Moscow Sternberg Institute, and will be completed in 1976. From observations with the LTI (period 1953–61) a compilation of the absolute catalogue of RA of 505 FK4 and 517 FKSZ stars is near completion. The m.s.e. of one observation is  $\pm 0^s.022 \text{ sec } \delta$ . From 70 000 observations made in Chile (Cerro-Calan) by the Pulkovo astronomers (1969–73) two absolute catalogues of RA of FK4 and FKSZ stars in the Southern hemisphere are being compiled.

#### 10. *Tashkent*

A catalogue of 297 stars has been compiled on the base of an analysis of the differences in RA between the observations obtained during 1961–65 and the FK4 (11.041.017). In 1974 absolute observations of RA of the FKSZ stars were completed. The catalogue is supposed to be compiled in 1975. The astrometric observations of the Sun and major planets are continued (A. A. Nemiro).

#### M. *Yugoslavia*

In *Belgrade* the examination of the stability of the observations of the meridian marks through the vacuum tubes erected between the Askania TI and the marks is continued. A new collimator (190/1000) has been delivered by the firm Opton. So far the results prove very satisfactory with regard to the quality and the diurnal and seasonal stability of the images. The reconstruction of the Askania VC was finished in 1974. The large instrumental errors previously noticed are now reduced to a minimum. Observations on FK4 stars were started with this instrument. The preparation of the catalogue of PZT stars, observed with the Askania MC (8000 observations in 136 series with 1100 observations on 30 Küstner series), is progressing. The r.m.s.e. of the FK4 stars are:  $\epsilon_\delta = \pm 0''.28$  and  $\epsilon_\alpha \cos \delta = \pm 0^s.022$  per observation, with

errors in the catalogue positions of  $\pm 0''.09$  and  $\pm 0''.007$  respectively. Two general catalogues have been finished; one of them is in print, together with the analysis of the catalogues on KSZ, BSKŠZ1 and BSKŠZ2 stars (see *Publ. Obs. Beograd No. 20, 1975*). (M. B. Protitch).

### 3. REFERENCE SYSTEM

#### A. Federal Republic of Germany

We received from the Headquarter for the Compilation of the next Fundamental System, in Heidelberg, the following report:

1. In accordance with resolutions adopted by the IAU in 1973 (*Trans. IAU 15B, 83–84*) work has been carried out at Heidelberg on the improvement of FK4 and its extension, in particular, to a fainter magnitude limit. The project which shall result in the new fundamental catalogue FK5 has been described by Fricke (11.012.014 and *IAU Coll. 26, 201–222, Toruń, Poland, 1975*).

The project consists of the following parts:

- a. Systematic and individual corrections to positions and proper motions of FK4 will be determined on the basis of catalogues of absolute and/or differential observations which have come available after the completion of FK4. Dr Billaud, Grasse (France), has kindly taken over the task of exploiting all available Astrolabe observations for FK5.
- b. The extension of FK4 to a fainter magnitude limit will be based on observations which can be reduced to FK4 without introducing errors depending on the magnitude and the neglect of latitude variations. A survey of observational material suitable for this task has been made in adopting a master catalogue, containing the AGK3R and SRS, from which stars are searched with a satisfactory history of observation. Stars in catalogues of observations since about 1900 have been identified with stars of the master catalogue. A second master catalogue contains all stars in FK4, FK4 Sup and the PZT stars in Yasuda's list.
- c. Observations of FK4 Sup stars and PZT stars are being examined for the purpose of including such stars in FK5 or FK5 Sup.
- d. Radio stars are being considered for inclusion in FK5 or FK5 Sup, and compact radio sources with optical and radio positions may enter the FK5 Sup.
- e. The equinox (zero point of RA) and equator of FK5 will be determined from observations of members of the Solar system since about 1900. Preliminary results have shown that older observations do not contribute to improvements.

Progress has been made with the documentation of the observational data. Numerous catalogues have been key-punched; the U.S. Naval Observatory and the Centre de Données Stellaires at Strasbourg have contributed to this task. At present, about 130 catalogues relevant to the project are available on punched cards. Key-punching of others is in progress. Lists of catalogues under consideration and a list of radio stars will be made available at the XVI General Assembly of the IAU with the request for comments and additions.

Progress in establishing the FK5 will much depend on the completion of several programs of observation which are, at present, still in the state of reduction at various observatories. Results should be transmitted on punched cards if possible, to the Astronomisches Rechen-Institut together with all information pertinent to the formation of the FK5.

It is hoped that the IAU will adopt at its XVI General Assembly a revised system of astronomical constants including a new value of general precession in longitude. The revised system has been prepared by Working Groups of IAU Commission 4, and this system will be recommended for use in the preparation of FK5.

In accordance with a resolution adopted by the IAU in 1973 (*Trans. IAU 15B, 83: Res. No. 5*) representatives of the Pulkovo-, the U.S. Naval- and the Copenhagen University Observatory, and the Astronomisches Rechen-Institut met in Heidelberg in November 1974. They have agreed on the following recommendations:

1. All SRS observations of each star for each night should be made available by the observa-

- tories together with the final positions derived from them.
2. The observations of the FK4 stars made with the SRS observations should be made available in the same way.
  3. The SRS observations should be reduced to an improved FK4 system which has been agreed is to be derived jointly by Pulkovo Observatory and U.S. Naval Observatory with consultations with the Astronomisches Rechen-Institute on the basis of absolute and/or semi-absolute observations available near the epoch of 1970. This system shall be called *SRS Preliminary System*. The relation between the SRS Preliminary System and the FK4 has to be explicitly given (tables and curves).
  4. At the U.S. Naval Observatory and the Pulkovo Observatory a complete SRS catalogue should be preserved and made available on request. In addition to the mean values for each star, this catalogue should include all individual observations with the weights and the systematic corrections which were used in forming the mean values.
  5. When FK5 is available, the AGK3R and SRS catalogues should be given in the system of FK5. The AGK3 catalogue should then be used in the FK5 system also.
  6. In order to ensure that the AGK3R and SRS will provide an adequate reference system in the future the observations of SRS must be repeated and it is strongly recommended that the AGK3R be also reobserved. As far as photographic astrometry is concerned photographic observations by means of overlapping plates covering the whole sky are of high priority.
  7. For the refinement of astrometric measurements for the establishment of a highly accurate inertial system we agree that the development and application of optical astrometric instruments (transit circles, astrolabes, etc.), radio interferometers and space telescopes is necessary (W. Fricke, W. Gliese, T. Lederle and H.G. Walter).

#### B. France

From *Strasbourg* we received: In the near future, space observations could give considerable progress to the establishment of a reference system. At ESA, projects of P. Lacroute are being studied. One could expect the development of a reference system in a period of two years, with accidental uncertainties of  $0''.001$  in the relative positions and with much smaller systematic errors. The errors in the relative proper motions are expected to be of the order of  $0.001''/a$ . Such a system could consist of 40 000 to 300 000 stars according to the project, depending on whether stars down to the 10th or to the 13th magnitude would be included. In a project comprising faint objects to the 16th magnitude, an accuracy of near  $0''.005$  can be reached.

One could immediately determine the absolute rotation of the system by comparing the proper motions in the system with those referred to the extra-galactic nebulae. The precision would be better than what is known from the present-day fundamental system.

To obtain a rapid amelioration of the precision with time, the system should be attached to radio sources by means of interferometer measurements at different wavelengths, or, to the brightest quasars (ESRO S.P.-108, March 1975) (P. Lacroute).

#### C. U.S.S.R.

In *Pulkovo*, according to recommendations of the Heidelberg meeting (November 1974), the systematic  $\Delta a_{\delta}$  corrections to the FK4 for the Southern hemisphere were derived from 8 absolute and semi-absolute catalogues. The r.m.s.e. of one correction is  $\pm 0''.0019 \text{ sec } \delta$ . The quasi-absolute catalogue of 671 bright stars in the  $+40^{\circ}$  to  $-90^{\circ}$  zone has been published. This catalogue was compiled from observations made in Santiago during 1963-64 with the small TI (13.041.038). At the Pulkovo and Golosseyevo Observatories a cooperated work on compiling a new general catalogue of faint stars (PFKSZ 2) is in progress. The catalogue includes the FKSZ stars with declinations from  $+90^{\circ}$  to  $-30^{\circ}$ . The coordinates of these stars are determined from 30 catalogues. The PFKSZ 2 will be compiled in the FK4 system. In this connection different methods of comparing star catalogues from the view-point of the accidental field theory were considered (13.041.017)

At the *Golosseyevo* Observatory, the problem of determining zeropoints of fundamental catalogues was studied. In order to account for the fact that the catalogue- and true equator do not run parallel, the authors recommended to make absolute observations of Solar system bodies (13.041.015). From the Washington (1941–1971), Greenwich (1941–1971) and Cape meridian observations of Mercury, Venus and Mars, and also from several series of meridian observations of Ceres, Pallas, Juno and Vesta, corrections to the zero-points of the FK4 have been determined.

At the *Institute for Theoretical Astronomy* 21 000 observations of 10 minor planets, 1, 2, 3, 4, 6, 7, 11, 18, 39 and 41) made at 21 observatories in different countries were collected and checked. A determination of the corrections to zero-points of the FK4 is being delayed due to the absence of the reference star coordinates in the FK4 system. A new program, enlarged, for 1974–1990, was set up – see this report earlier (A.A. Nemiro).

#### 4. REPORTS FROM GROUPS

##### A. *Study Group on Horizontal Meridian Circles*

The Study Group has exchanged information on published literature and on present studies of the subject which concern: Remote Control, the building, the mirror mounting, the horizontal refraction, a.o. Presently the HMC at Pulkovo is being prepared also for observation of declinations. The new metallic mirror is made in the Pulkovo workshop, and a new photoelectric circle reading has been designed. Development of a transportable horizontal meridian circle is part of a proposed Anglo-Danish Meridian Collaboration (09.031.033; 11.032.037; 13.032.030) (E. Høg).

##### B. *Study Group on Astronomical Refraction*

The first proceedings of the SGAR, *The Present State and Future of the Astronomical Refraction Investigations* were published in 1974 (11.012.023). The work contains 18 papers.

On the basis of resolution no 11, adopted by Commission 8 in 1973 in Sydney, the SGAR cooperates with the Soviet astronomers. A working group elaborates the new Pulkovo refraction tables, fifth edition, Chairman G. Teleki. The Table will be based on up to date results of meteorology and physics. The SGAR has started to cooperate with the International Association of Geodesy Special Study Group no. 1:2 also working on refraction problems. The International Symposium on Terrestrial Electromagnetic Distance Measurements and Atmospheric Effects on Angular Measurements, organized by the International Association of Geodesy in Stockholm, 1974, adopted a resolution (No. 4) which recommends that this cooperation should be intensified and that joint meetings should be arranged regularly. The members of the SGAR have published several papers on refraction problems. The number of investigations and publications has increased. Some of the researches were initiated by SGAR. Meetings on these problems were held in Leningrad in 1973, in Lvov in 1974 and in Stockholm in 1974 as well in Leningrad again in 1974 and 1975 (G. Teleki).

##### C. *Working Group on Results of Astrolables*

The work done in Grasse on the compilation of a catalogue of corrections to the FK4 positions, based on astrolable observations, has shown already some interesting results and is well in hand (G. Billaud).

#### 5. RESOLUTIONS

The astronomers from the U.S.S.R. propose the following resolutions to be considered by Commission 8. For the background of these resolutions reference is made to the various reports from the U.S.S.R.

1. The Commission 8 approves of the new program (proposed by the Institute of Theoretical Astronomy in Leningrad) concerning observations of the selected minor planets for solving the tasks of fundamental astrometry and asks the observatories having appropriate equipment to take part in the observations according to this program.

2. Commission 8 approves of the initiative of the Kiev University Observatory which has begun compilation of the general catalogue of the stars from the program Bright Stars (BS) and asks the observatories which have taken part in the observations of these stars to send their results to the Kiev Observatory (A.A. Nemiro).

G. VAN HERK  
*President of the Commission*