

## 8. POSITIONAL ASTRONOMY (ASTRONOMIE DE POSITION)

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### INTRODUCTION

The president thanks those members contributing material to this report. The volume of the material necessitated some editing, but no substantive omissions occurred. Whenever available, AAA numbers are used in lieu of complete titles of publications to help conserve space.

IAU Symposium No. 109 Astrometric Techniques, was held in Gainesville, Florida in January 1984. Although the Proceedings of that meeting are not now available (January 1985), commission members and other interested parties are urged to secure access to that volume when it appears since so many facets of the commission's work are addressed therein.

With regard to the coming 1985 General Assembly, a joint meeting of Commissions 8 and 24 and a Joint Discussion on Reference Frames involving Commissions 7, 8, 19, 24, 31, 33 and 40 will be scheduled.

The following material is arranged by country in alphabetical order followed by special reports of various groups and committees.

### REPORTS FROM OBSERVATORIES AND COMMISSION MEMBERS

**ARGENTINA** - The Meridian Circle Department of the Felix Aguilar Observatory, San Juan published, 1) The Second San Juan Meridian Circle (SJMC) Catalogue of positions of 617 FKSZ ( $+30^\circ$  to  $-90^\circ$ ) with std. dev.,  $\epsilon(\alpha) \cos \delta = \pm 0.021$ ,  $\epsilon(\delta) = \pm 0.39$ ; 2) San Juan 72 of positions of 7190 SRS ( $-40^\circ$  to  $-90^\circ$ ) with std. dev.  $\epsilon(\alpha) \cos \delta = \pm 0.024$ ,  $\epsilon(\delta) = \pm 0.46$ ; 3) The Fourth SJMC Catalogue of positions of 364 FK4 ( $-30^\circ$  to  $-90^\circ$ ) with std. dev.,  $\epsilon(\alpha) \cos \delta = \pm 0.023$ ,  $\epsilon(\delta) = \pm 0.33$ ; 4) The Fifth SJMC of positions of 689 FK4 ( $+30^\circ$  to  $-90^\circ$ ) with std. dev.  $\epsilon(\alpha) \cos \delta = \pm 0.020$ ,  $\epsilon(\delta) = \pm 0.31$ . The SJMC continues to observe FK4 and has also begun the observation of 54 radio stars. (CARESTIA)

Using both actual and simulated observation of major and minor planets, Branham has concluded that an  $L_1$  solution is competitive with classic least squares. He recommends the initial use of  $L_1$  together with criteria for the treatment of discordant observations, followed by solutions based upon either normal equations or orthogonal transformations. Simulated observations of the Sun, Moon and planets Mercury through Neptune for a period of ten years gauged the precision of equator and equinox determinations. Theoretically, the Moon should contribute strongly, but in practice this is not so. The Sun, Mercury and Venus give the best results, while a fundamental program using minor planets alone is possible. This follows from analysis of results from El Leoncito. (BRANHAM)

**CHILE** - At the Cerro Calan National Observatory 651 FKSZ and 1217 FK4 stars ( $+40^\circ$  to  $-90^\circ$ ) are being observed by the Repsold Meridian Circle. Observations are made in four zones with 40 FKSZ and 82 FK4 stars ( $-70^\circ$  to  $-90^\circ$ ) observed at both culminations. The intent is to obtain six observations of each star and complete the program in June 1985. A quasi-absolute method will be used to determine RA and DEC. The compilation of RA observations is in progress. Two additional programs involve 367 double stars ( $-25^\circ$  to  $-47^\circ$ ), and 31 radio sources recommended by Commission 24. The latter include 9 FK4 and 2 FK4 Supp. Mars, Jupiter, Saturn, Uranus and Neptune plus minor planets 1-4 have been observed since 1983. In all, a total of 16 233

observations were made by three observers in these programs during the reporting periods.

A grant was received from the Comision Nacional de Investigacion Cientifica y Technologica to improve RA data acquisition; and a grant from the Departamento de Investigacion y Bibliotecas Universidad de Chile to design and construct a machine using a photodiode array to measure divided circle films and thence to install a similar device on the telescope to measure the circle directly. Publications include: Santiago 67 Catalogue 7610 stars ( $-25^{\circ}$  to  $-47^{\circ}$ ), Carrasco and Loyola (33.002.064), and Meridian Circle Observations of FK4 Radio Stars, Carrasco, Costa and Loyola (33.041.012). (CARRASCO)

The program of the Danjon Astrolabe of Santiago is a joint project between the University of Chile and the European Southern Observatory (ESO) and has been in progress for the last three years. Observations for a Second Astrolabe Catalogue of 525 FK4 stars were completed during 1984. Four galactic radio sources: FK4 Nos. 306, 309, 616, and 9 Sgr of the list of IAU Commission 24 WG on identification of Radio/Optical Astrometric Sources, have been observed regularly since 1980. Some results were presented at Symposium 109. The Uranus observations campaign has been in progress during 1982-1984; Mars, Jupiter and Saturn have also been observed. The results of observations of Uranus obtained during the period 1980-1982 were published in A. and A. Suppl. Ser. 56, p. 281, 1984. (NOEL)

**CHINA, NANJING** - At the Beijing Observatory, a catalogue of absolute RA's of stars observed with the photoelectric transit instrument during 1981-1983, and reduced by the Gubanov chain method, is in press. The second photoelectric astrolabe catalogue of 905 stars (1976-1981) was compiled (34.002.070). Observations of more than 500 stars were obtained (during 1981-1984) with the photoelectric astrolabe Mark II. Reductions were started at the beginning of 1984. Observations of radio stars have continued since 1980. Other papers relating to fundamental astrometry are: 30.031.517; 31.041.041; 31.002.059.

In the Nanjing Astronomical Instrument Factory, development of the photoelectric astrolabe, Mark III continues. With the cooperation of Copenhagen University Observatory and Shaanxi Observatory, the construction of Hög's GMC is being done in Denmark and China.

At Shaanxi Observatory, a contribution to the celestial reference frame was presented (32.043.008). Mean positions of 1800 stars for the beginning of the years from 1051 BC to 2050 AD have been computed and published (Publ. of Shaanxi Observatory 6, 1983, No. 2,55). A photoelectric astrolabe catalogue of 820 stars has been published (34.041.041). Sixteen radio stars have been observed since 1981.

At Shanghai Observatory, observations of Mars, Jupiter and Saturn with the Danjon astrolabe in 1964-78 were published (33.041.041; 33.041.043). A synthetic catalogue of stars observed with the Danjon astrolabe, and proper motions of individual stars were presented (33.041.042). Five optical radio positions have been determined (33.041.044). A photoelectric astrolabe catalogue of 537 stars (1979-81), and observations of 15 radio stars with astrolabes have been published in the Annals of Shanghai Observatory, No. 4, 1982. For the study of the coordinate frame, photographic observation of radio sources and observations of solar system objects with astrolabes are under consideration.

At Tianjin Latitude Station, a declination catalogue of 99 zenith stars observed with the zenith telescope ZTL-180 has been presented (34.002.071). At Wuchang Time Observatory corrections for FK4 star positions were derived from observations by the Danjon astrolabe in 1965-1975 (Acta Geodaetica et Geophysica, No. 3, 1981, 27), and RA corrections for 464 stars were obtained with the photoelectric transit instrument in 1976-1979 (34.041.046).

At Yunnan Observatory, a method for the absolute determination of the azimuth of transit instruments at low-latitudes was presented (34.032.048). Five papers appeared in the Publ. of Yunnan Observatory, 1982, No. 2. A photoelectric astrolabe catalogue of 293 stars and a paper on astrolabe catalogues were in the same publication.

A catalogue of 1579 stars from photoelectric astrolabes in China (GCPA) (34.041.044; 34.002.069)

was compiled from astrolabe catalogues from Beijing, Shaanxi, Shanghai, Yunnan and Wuchang. A detailed summary of GCPA was given at the meeting of Commission 8 during the General Assembly XVIII IAU, 1982. A machine readable form of GCPA was sent to Heidelberg.

Papers presented at the IAU Symposium No. 109 included: Astrometry in China; A new method of determining absolute azimuth and latitude; The consideration of a new type of meridian circle; Application of vacuum chambers in astrometric instruments; Design of a large transit circle with reflecting optics; Determination of the equatorial plane of astrolabe catalogues by observations in the prime vertical; Linkage of radio and optical coordinate reference frames; On the implementation of absolute meridian observations at low-latitude stations; Photoelectric astrolabes and astrolabe star catalogues; The 1.56 meter astrometric telescope of Shanghai Observatory and the observing program.

**DENMARK AND GREAT BRITAIN** - The Carlsberg Automatic Transit Circle carried out two test programmes of observation from August 1981 to March 1983 at Brorfelde. The instrument has a photoelectric moving-slit micrometer, automatic setting and a circle reading system under computer control. Two catalogues of star positions and magnitudes resulting from these tests were published and discussed at IAU Symposium 109. The internal mean errors of a single observation are  $0.014^{\circ}$  in right ascension and  $0.022^{\circ}$  in declination.

Following this test period, the telescope was shipped to Spanish Observatorio del Roque de los Muchachos del Instituto de Astrofísica de Canarias situated on the island of La Palma at an altitude of 2400m. By December 1983 the telescope was assembled. Its building is a light-weight structure made of panels of wood and compressed glasswool with a steel framework to give it rigidity. A run-off section to the west gives a 2m opening on the meridian. This structure provides a stable thermal environment for the telescope. The telescope was linked to the two minicomputers in February 1984. It was aligned and the pivot and circle division errors measured during March and April. Regular observations began in May 1984, with almost 18 000 observations made by August. The CATC is operated jointly by Copenhagen University Observatory, Royal Greenwich Observatory and the Instituto y Observatorio de Marina, San Fernando.

The programme comprises the following, with a limiting declination of  $-56^{\circ}$  (in descending order of priority): major planets, 23 minor planets, FK4, IRS, faint reference stars in fields of some 250 radio sources, radio stars, NPZT + Stromlo, Gliese catalogue, AGK3, and SAO. The usual scan time of a star is about 15 s. This is increased fourfold for the faint reference stars in benchmark fields. The limiting magnitude is near 13.0 in Johnson V. The average internal rms error within  $50^{\circ}$  of the zenith is close to  $0.020^{\circ}$  in right ascension and declination. It is  $0.05^m$  in magnitude.

The Third Greenwich Catalogue of Stars, Sun, Planets and Moon for 1950.0 was published in 1983 as R. Gr. Obs. Bulletin No. 187. It contains results of observations made at Greenwich with the Airy Transit Circle from 1942 to 1954.

The First, Second and Third Herstmonceux Catalogues of Stars for 1950.0 were published in 1983 as R. Gr. Obs. Bulletin No. 189. These catalogues contain the results of observations of stars made at the Royal Greenwich Observatory (Herstmonceux) with the Cooke Transit Circle from 1957 to 1980. This instrument was taken out of operation in 1982. (MORRISON)

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**FRANCE** - The automation of the Bordeaux photoelectric meridian circle was completed in 1982 with accurate automatic setting. Two determinations of the division errors by the Benevides-Boczko method were carried out in December 1982 and in March 1983: the std. dev. between the two sets of corrections is about  $\pm 0.015$ . The reobservation of the NPZT programme has been completed (11 600 positions, m.s.e. =  $\pm 0.11$  in  $\alpha$  and  $\pm 0.16$  in  $\delta$ ). This new catalogue and the individual FK4 star deviations are available on magnetic tape and have been sent to the A.R.I. at Heidelberg for inclusion in the FK5 catalogue. Preliminary lists of faint HIPPARCOS stars with no astrometric history have been regularly observed. However, the observation rate (which is usually 15 000 positions/year) is drastically reduced by the very bad positions given in these lists of astrophysical stars. The automatic meridian circle has also been used for observations of Mars, Uranus and Neptune, Galilean satellites and the Saturnian satellites, Titan and Iapetus. Furthermore, 700 positions of 55 minor planets from the HIPPARCOS program have been obtained.

During the next three years, the instrument will be mainly devoted to the preparation of the HIPPARCOS Input catalogue (about 7000 northern faint stars). (REQUIEME)

Observations of the sun continues at CERGA with the solar astrolabe (31.041.29; 28.032.015). The analysis of the data involves not only the coordinates (equinox correction), but also the diameter (fluctuations of  $0.5 \pm 0.5$  in a period of 800-900 days); (31.041.035; 34.041.009). Preliminary observations of solar positions in June-July, 1984 gave a dispersion of order  $0.4$  for one observation. An improved mounting is being installed.

Analysis of observations of Mars (29.097.014; 30.097.036; 31.097.114) caused Chollet (31.097.001) to propose replacing the empirical correction for "phase effect" by one deduced from a model of the distribution of luminous intensity on the planet's surface (in press, Astron. and Astrophys.).

For these observations, and for stars, the HIPPARCOS catalog should permit reduction to a system free of internal error, and for which the residual rotation may be estimated from solar observations (31.043.019). Reduction to other reference systems, and finally to the FK4 (or FK5) will be facilitated by bright radio stars (28.041.078). Finally, possible other uses of astrolabes have been the object of a synthesis study. (CHOLLET)

During the last three years the CERGA astrolabe team has been mainly devoted to perfecting a strictly impersonal astrolabe. Observations of 188 groups of 40 stars each were made from July 1983 through June 1984. The results will soon be published. Comparison with B.I.H. results indicate a dispersion oscillating between 1.9 to 5.6 ms. (BILLAUD)

**FEDERAL REPUBLIC OF GERMANY** - At Heidelberg about 250 catalogues of observation thought to be suitable for contributing to the construction of the FK5 were placed on magnetic tape. For the improvement of the system of the FK4 about 40 catalogues with absolute or fundamental observations turned out to be qualified. For the determination of the equinox of the FK5 including the elimination of the motion of the equinox in the FK4, Fricke (31.041.002) has employed observations of the Sun and of planets from 1900 to 1977 and lunar occultations including the results of 42 authorities. For differential corrections to the FK4 about 80 catalogues were analyzed. The determination of the differences Cat-FK4 have been computed in all cases by other methods developed by Bien et al. (25.041.067). For the construction of a system of positions and proper motions Schwan (34.041.052) has compiled a pilot program which has been tested on the systematic differences between the FK4 and the Washington Six-inch Transit Circle catalogues from 1910 to 1975. The systematic differences between these catalogues and the FK4 were given by Schwan. Furthermore, the differences between Greenwich and the FK4 were determined for the catalogues from 1915 to 1981 by Bien (34.041.047), the differences Cape minus FK4 from 1918 to 1974 were determined by Jahreib (34.041.048), and the differences

Brorfelde minus FK4 from 1964 to 1976 by Roser and Fricke (31.041.004). The results of the analysis of other catalogues of observation will be published later. It is expected that the construction of the system of the FK5 can be completed in 1985 and the determination of the individual corrections to FK4 positions and proper motions in 1986. By that time the extension of the FK5 to fainter stars should be completed also. (FRICKE)

Additional work at Heidelberg included the compilation and examination of radio and optical astrometric data for radio stars in order to help determine the suitability of the latter for relating the HIPPARCOS and radio reference systems (31.041.038). Within the framework of HIPPARCOS data reduction the concept of the determination of astrometric parameters was described (34.036.229), (4.036.231). A data base containing meridian circle observations of nearly 50 000 stars was established by Hering and Walter with the objective of extending the FK4 to fainter stars (32.041.017). (WALTER)

At Hannover, Pilowski continued his study in astrometry. Due to high internal precision and considering systematic effects, Zenith Cameras offer excellent possibilities for fundamental optical observations. See Astron. Station, Universitat Hannover, Nos. 13 and 15, 1981 and 1983 and the Festschrift 100 Jahre Geodasie in Hannover, 1981. (PILOWSKI)

Observations of fundamental stars and major and minor planets have continued at the Munich Observatory using the vertical circle. Positions of multiple stars between  $+70^{\circ}$  and  $+90^{\circ}$  were measured to derive positions with sufficient accuracy for HIPPARCOS. (SCHMEIDLER)

At Hamburg the determination of precise optical positions of extragalactic sources and radio stars continues. Also continued is the work with the MERIT-PZT catalog  $+52^{\circ}5$ . The CPC2 catalog of the Cape Zone  $-40^{\circ}$  to  $-52^{\circ}$ , is finished and has been given to CDS-Strasbourg (Nicholson et al. MNRAS 208, 911; 1984). Extensive work has commenced for the HIPPARCOS Input Catalog, especially for the the extragalactic reference link (Subgroup 2130), and special objects, e.g., star clusters. (DE VEGT)

**ITALY** - Observations of FK4 and catalog stars were made with the Danjon astrolabe in the period 1982-84. Research continued to deduce the diurnal and anomalous refraction using observations of the solar disk. Publications by Poma, Proverbio and Mancuso appear in Sun and Planetary Systems, Reidel, 1982 pp. 477-82, and by Proverbio and Uras in Nota Tecnica, SAIL, 1984 (in press). PZT reference star lists were developed for observers on the international parallel. See, Proverbio, Pub., SAIL (in press). (PROVERBIO)

**JAPAN** - At the Tokyo Observatory, Prof. H. Yasuda retired as the director of the meridian astronomy division in April 1982. His successor is Prof. M. Miyamoto.

The Tokyo automated photoelectric meridian circle (TPMC), manufactured by Carl Zeiss Oberkochen, was installed at Mitaka in September 1982. The instrument was then investigated. Over 100 FK4 stars were observed in excess of ten times each in ideal weather, and preliminary results have shown average internal accuracies for a single observation of  $\pm 0.008$  in RA and  $\pm 0.013$  in DEC. These values coincide closely with the limiting values expected from image motion (Cf. Hög, 1968). Corrections for the graduated circle of the TPMC have been determined four times, twice within two weeks (end of May, beginning of June, 1984). Results show that the circle corrections are determined within an accuracy of  $\pm 0.01$ .

In order to detect and correct for the so-called anomalous (local) refraction, which occasionally reaches about  $0.1$ , and is caused by an inhomogeneous temperature distribution in the pavilion, more than 40 thermistors have been installed around the TPMC. They are located on lattice points separated by 3m, and have an accuracy of about  $\pm 0.05^{\circ}\text{C}$ . A correction for anomalous refraction is applied to each 2 minute observation made with the TPMC. Routine TPMC observations of stars to the 13th magnitude, the sun and planets will commence in 1985. Since 1982 the Gautier MC has not been active. (MIYAMOTO)

At the Mizusawa International Latitude Observatory (MILO) Fujii and Murakami (1982) derived position corrections for the MILO PZT star list using data from the new PZT. Sato et al.

(1984) compiled a PZT star catalog for the Mizusawa, Washington and ILS PZT chain to be used as a standard in recalculating past observations and for initial observations by the ILS instruments. Positions of stars observed by PZT's were corrected internally and reduced to the MC3 and MC3T systems referenced to the FK4 system.

Yokoyama (1984) presented a method of reducing optical astrometric observations of earth orientation parameters at individual stations and at international centers in accordance with the FK5 and the IAU (1976) System of Astronomical Constants. This method was presented at the 2nd MERIT workshop and was approved as the MERIT standard. Yokoyama and Tanikawa produced a FORTRAN program for computing apparent places based upon the new constants and sent it to all countries where optical astrometric instruments operate.

Aoki et al. (1984) presented a method of converting from the old to the new reference frame in order to establish the positions of radio sources. Sato et al. (1984) showed that internal corrections of star positions used for earth orientation parameters are related to the adopted nutation and they proposed the re-reduction of past observations in the new system.

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**ROMANIA** - The meridian team of the Bucharest Observatory completed the reduction of the observations for the Bucharest Stellar Catalogue of NPZT Stars for the zones  $+41^{\circ}$  to  $+63^{\circ}$ , and for  $+39^{\circ}$ . The material was prepared for publication and sent to interested astronomical observatories. Observations of reference stars for the Prague PZT were completed in May 1983. The reduction of these observations will be completed at the end of 1984. (TOMA)

**SPAIN** - Observations for the fifth catalog of the San Fernando Astrolabe (CASFS), and of 14 radio sources from the Commission 24 Working Group list continued through 10 May 1983. The astrolabe will be converted to a full pupil instrument. Difficulties with the micrometer

drive have hindered observations, but repairs are in progress.

The San Fernando Meridian Circle observed transits of the planets; Mars through Neptune in addition to stars. Observations of 38 radio sources from the first list of the C24WG were completed and a provisional catalog of positions in the FK4 system was formed and will be published. A campaign to observe 55 radio sources began in September 1982.

Cooperation with the CUO-RGO project for the CATC on La Palma island continues. Two observers from San Fernando have been assigned to the CATC. Pivot errors and their effect on instrumental constants were determined. The cooperation includes the calculation of astronomical refraction. A prepared selection of faint stars in 103 southern radio source fields is to be observed by the CATC. Star positions have been measured on transparencies of POSS and SERC plates and on plates from the Gautier Astrograph.

The "Carte du Ciel" astrograph is observing 20 minor planets of the ITA program and, beginning in 1983, 55 minor planets for the HIPPARCOS project. (QUIJANO, SANCHEZ)

USA - At the Univ. of Florida, Eichhorn published an outline of the theory of systems of standards (1982; 32.021.006). He defines a "system" as a set of estimates, and discusses the theoretical difficulties in stating that a particular set of estimates is on a particular system. With co-authors Googe, Lukac and Murphy, a catalog of 20 457 stars was published (1983; 33.041.004) with a std. error about  $0^{\circ}15$  in each coordinate, in the zone  $-48^{\circ}$  to  $-54^{\circ}$ . (EICHHORN)

Observations for the Six-inch Transit Circle W6(50) Washington catalog were completed at the U.S. Naval Observatory (USNO). The W5(50) of this series was published (Hughes and Scott) in 1982. Other published catalogs include: Precise Positions in the FK4 System for 120 Radio Source Reference Stars (Dick and Holdenried, AJ, 87, 1982, 1374-78) and, Precise Positions in the FK4 System for Ten Optical Counterparts of Extragalactic Radio Sources (Harrington, et al., AJ, 88, 1983, 1376). Smith made the selection of the IRS supplemental list. His work on the SRS with Jackson is covered in the appropriate committee report. Corbin selected possible candidates for the faintward extension of the FK5, and worked on the proper motions of the SRS. He presented a paper, The Determination of Fundamental Proper Motions at Sym. 111. The discussion included absolute, quasi-absolute and differential TC observations and the compilation of fundamental positions and proper motions from these data.

The Seven-inch Transit Circle was shipped to New Zealand in early 1984 and the Black Birch Astrometric Observatory (BBAO) was thus established. Observations should commence in early 1985; the eight-inch twin astrograph will be sent to BBAO in late 1985.

Proposals were submitted to ESA regarding observations of IRS, IRS Supp., NPZT and FFC stars by HIPPARCOS. Hughes and Smith collaborate with INCA.

A CCD array scanner is being constructed to read divided circles. It is anticipated that such a device will be used on all USNO TC's. The image dissector micrometer has performed well in its initial tests, but full evaluation awaits observations made at BBAO. The transit times of solar system objects will be determined in TAI as well as in LST. Precise siderostats and other components are being constructed in the USNO instrument shop for use on a 20m baseline, wide-band, optical interferometer to be installed at the Mt. Wilson Observatory. This work is in collaboration with the Smithsonian Astrophysical Observatory, Massachusetts Institute of Technology and the Naval Research Laboratory. A dual frequency laser interferometer has been set up at USNO to monitor the motion of settled concrete piers and its effect upon baseline stability. Stone published a detailed study of color effects in transit circle observations (Astron. Astrophys. 138, 2, 1984). The use of "two color" observations with the image dissector micrometer was discussed.

At University of California, Berkeley, Townes and his group are making good progress with the portable long baseline infrared (11 microns) interferometer. (HUGHES)

USSR - Present and future astrometry, especially inertial and other coordinate systems were considered by Yatskiv (34.041.010; 34.041.049). Polozhentsev and Yatskiv proposed ways of weighting catalogues for proper motions of faint fundamentals (FKSZ). Centennial proper motions were derived with errors,  $S(\mu) = \pm 0.162$  and  $S(\mu') = \pm 0.323$ . (YATSKIV)

The Sun and major planets were observed with the Wanschaff vertical circle at the Main Astronomical Observatory of the Academy of Sciences (MAOAS Ukr. SSR). Observation of an absolute catalogue of 2000 fundamental stars, bright and faint continues. Differential catalogues of 35 bright radio sources, 100 Mikhailov equatorial stars, and 254 reference stars for extragalactic radio sources were derived. Observations at zenith distances  $< 86^\circ$  checked the refraction tables. (KHARIN, MINYAILO, LASORENICO, NENAKHOVA)

A discussion of 40 000 observations of the Sun and major planets made by various instruments in 1960-80 to estimate the various precisions was completed. (KHARIN, MINYAILO, VORONKEVICH)

Current and future determinations of the orientation of coordinate systems, and the periodic errors of fundamental catalogues were discussed using optical observations. Recommendations and estimates of the correction to the equinox including its motion were given. Instruments for observing high-orbit satellites with errors of  $0.3$  to  $0.5$  have been designed. (DUMA)

Various southern catalogues were completed at MAOAS, Pulkovo, including: Absolute right ascensions of 2256 Blacklund-Hough stars ( $+32^\circ$  to  $-90^\circ$ ) observed in 1928-42 at Melbourne Observatory (MO) [1]; absolute right ascensions of 144 latitude stars of the Kimura list observed in 1933-35 at MO [2]; absolute right ascensions of 35 stars from the Kopff list ( $+32^\circ$  to  $-90^\circ$ ) observed in 1928-40 at MO [3]; absolute right ascensions of 1960 bright (FK4) and faint southern stars observed in 1969-73 at Cerro Calan Observatory (CCO) [4]; declinations of 5512 SRS, 829 BS, 513 DS, 280 FK4 stars ( $+47^\circ$  to  $-90^\circ$ ) observed in 1963-68 at CCO [5,6].

Catalogues of bright and faint fundamental stars include: a compiled catalogue of fundamental faint stars PFKSZ-2 ( $-20^\circ$  to  $+90^\circ$ ) [7] (MAO AS Ukr. SSR, Goloseevo); right ascensions of 567 FKSZ stars observed in 1954-55 in Pulkovo [8] the MAO AS USSR; right ascensions of 586 FKSZ stars ( $-20^\circ$  to  $+90^\circ$ ) observed in 1974-76 [9] at Nikolaev; right ascensions of 433 FK4 stars observed in 1971-73 and of 376 FK4 stars observed in 1976-78 ( $-20^\circ$  to  $+90^\circ$ ) [10,11] at the Astronomical Institute of the Uzbek Academy of Sciences (AI AS Uzb. SSR).

Other catalogues: right ascensions of 1244 PZT stars ( $+25^\circ$  to  $+56^\circ$ ) observed in 1968-70 [12] and declinations of 507 stars of Pulkovo latitude programs (starting from 1904) of the Pulkovo zenith telescope ZTF-135 [13]. From the Sternberg Astronomical Institute: compiled right ascensions of 187 circumpolar stars using over 100 catalogues published in 1790-1975; using Moscow observations, absolute right ascensions of 187 circumpolar stars observed in 1972-76 [14,15]; declinations of 200 bright stars ( $+70^\circ$  to  $+90^\circ$ ) and 51 Cepheids ( $-7^\circ$  to  $+70^\circ$ ) observed in 1974-77 [16]; declinations of 529 double stars and high luminosity stars observed in 1981-82 [17]; declinations of 3695 stars of the latitude programs for zenith telescopes and PZT's observed in 1965-75 [18]; declinations of 426 zenith zone stars observed in 1970-77 [19]. A catalogue of 9580 zodiacal stars within  $15^\circ$  of the ecliptic observed in 1969-72 at Nikolaev [20] and positions of 5976 SRS and 727 BS stars ( $0^\circ$  to  $-20^\circ$ ) also at Nikolaev [21] were prepared at the Nikolaev Department of the MAO AS USSR. From the V.P. Engelhardt Astronomical Observatory (Kazan): a compilation of positions of 10946 reference KCZ stars ( $-5^\circ$  to  $+90^\circ$ ) based on the improvement of the AGKSR catalogue using faint star observations at observatories in Bucharest, Kiev, Moscow and Kazan [22,23]; a compiled catalogue of declinations and proper motions of 75 stars of the latitude programs of the AOE and the Poltava gravimetric observatory of the Ukr. SSR AS [24,25]. MAO AS Ukr. SSR prepared declinations of 254 stars in the neighborhood of 72 extragalactic radio sources observed in 1979-82 in Goloseevo [26,27]. Positions of red variable stars observed in Odessa [28] were prepared at Odessa University; declinations of 1407 circumpolar stars and differential declinations of 75 circumpolar FK4 stars [29,31] were prepared at Kharkov University.

Observations of the Sun and major planets were carried out at Nikolaev and lately at the AI AS Uzb. SSR. Reductions and analysis were undertaken at the MAO AS Ukr. SSR [32-39]. Studies

of the orientation and zero points of fundamental systems were done at the MAO AS Ukr. SSR [40,42,43] and at the Institute of Theoretical Astronomy of the USSR Academy of Sciences (Leningrad) [41,44-46]. Studies of new observational program methods and reduction procedures were concentrated at the astronomical institutions of Moscow and Leningrad. Work by astrometrists from Pulkovo [46-49], Moscow [50,51] and others [52,53] are included.

Work on automating instruments and the observational process [54-62] done at the Sternberg Institute, MAO AS USSR and its Nikolaev Department, involve new observational programs as well as instrumentation, e.g., the design and construction of automatic meridian instruments, and moving instruments to sites with good observing conditions. In 1981, for the first time in the USSR, a stationary meridian instrument was installed at a high altitude [65,66]. This followed studies developing criteria for the choice of a site for an astrometric instrument [63,65]. The first observational results obtained with the Repsold meridian circle of the Sternberg Institute High Altitude Middle Asia Observatory have been published [67]. (SHAMAEV)

#### References for USSR

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#### Note for numbered references ([1] to [67]) for USSR

Since the latter portion of the information from the USSR was unfortunately received by the President after the commission material had been delivered to the General Secretary on 31 January 1985, it proved impossible to accommodate the numbered references in the space allotted to the commission, although re-editing and revision did finally make it possible to include the additional text. The reference list is available upon request by post from the President, or finally, at the XIX General Assembly.

**YUGOSLAVIA** - Finishing the observation of 308 bright stars ( $+70^{\circ}$  to  $+90^{\circ}$ ) with the Belgrade Vertical Circle, Bozhichkovich and Trajkovska started observations of the Sun, planets and FK4 stars in 1983. Teleki continued his refraction research. Atanachkovich began investigations of the effect of atmospheric turbulence on astrometric observations. (TELEKI)

Sadzakov and Dacic finished the observations of 1750 Double Stars and 523 FK4 stars, with the Belgrade Meridian Circle. Positions will be published in *Publ. Obs. Astron. Belgrade (POAB)*. They also finished observations of 315 stars in 87 planes with extragalactic radio sources. The positions will be published in POAB. Sadzakov and Dacic regularly observe the Sun, Mercury, Venus and Mars with the Meridian Circle. Results are published in *Bull. OAB*. (SADZAKOV)

The vacuum meridian marks were fully used for the first time for observations (completed early in 1983) of 308 bright polar stars ( $+65^{\circ}$  to  $+90^{\circ}$ ) made by the Belgrade Large Transit Inst. for absolute right ascensions. Reductions will be finished by the end of the year in Pulkovo. The std. dev. of a reading of a vacuum meridian mark is  $0.005$ . (PAKVOR)

### References for Yugoslavia

Kolaczek and Teleki discussed reference systems (29.045.024). Sevarlic, Teleki and Knezevic published bibliographies on photographic catalogues, stellar atlases, etc. (34.002.061, 34.002.062). Teleki (31.082.078), and Teleki and Saastamoinen (31.082.074), reported on problems with refraction and the former published material on historical astronomical activity (31.004.090) and developments in Yugoslavia (33.013.095). Teleki and Atanackovich wrote on refraction (33.082.074); while Mijatov, Bozhichkovich, and Trajkovska published investigations of the Belgrade Vertical Circle. Sadzakov published several papers concerning catalogues of NPZT stars (29.041.044), (31.041.026, (32.041.016), (33.041.009), (33.041.017), (33.041.045), (33.041.052), (27.041.031). Additional reports by the same author on solar and planetary observations appear in (31.041.036), (32.041.012), (33.041.053), (34.041.034), while work involving catalogue comparisons (e.g., AGK3, latitude star observations, etc.) and proper motions is found in (32.041.024), (27.111.023). Other publications include (33.013.009) and (32.014.018).

### SPECIAL REPORTS

#### HIPPARCOS-TYCHO PROJECT

In 1984 the project entered phase C/D, i.e., the final design stage and hardware construction with launch scheduled for 1988 for a 2.5 yr. mission. The HIPPARCOS and TYCHO catalogues are expected in 1993. Expected accuracies are detailed in earlier reports. Details of observing lists are given in the following. Four Consortia are responsible for producing the catalogues: INCA will form the Input Catalogue (IC) based on over 200 proposals from the international scientific community and on priorities assigned by the ESA Selection Committee; FAST, and NDAC, will analyze data from the main mission, working independently, but comparing data and results during the development and execution of the analysis to ensure producing a single, unique HIPPARCOS catalogue; TDAC will produce the TYCHO catalogue. (HOG)

The INCA (INput Catalogue) Consortium involves institutes in Belgium, France, Western Germany, Netherlands, Spain, Switzerland, the UK and USA. Task leaders are: Turon (Team leader, Paris-Meudon), Gomez (Paris-Meudon, proposal management and successive versions of the IC), Fricke (Heidelberg, astrometric data), Requieme (Bordeaux, astrometric observations), Egret (Strasbourg, photometric data), Grenon (Geneve, photometric observations), Creze (Besancon, mission simulation). Working groups coordinate activities related to double stars (Dommanget, Bruxelles), variable stars (Mennessier, Montpellier), minor planets (Bec-Borsenberger, Paris), and the link to an extragalactic reference frame (Argue, Cambridge). Reports are in the Bulletin d'Information du Centre de Donnees Stellaires (Strasbourg).

Due to constraints resulting from the basic principles of the satellite (two fields of view, continuous scanning, etc.) stars must be carefully selected in advance, evenly distributed over the sky, respect a given magnitude repartition (most brighter than 11), and their positions and magnitudes must be known with a precision of  $\pm 1''5$  and  $\pm 0.5$  or better. Moreover, as many stars as possible rated "high-priority" stars by the ESA Selection Committee should be included in the IC. In order to optimize the IC with respect to the satellite's observing possibilities, and the scientific return of the mission, it will be improved by successive iterations after numerical simulations of the mission. Details are given in IAU Symposium No. 109 and the Codata Int. Course on Data Handling in Astron. and Astrophys. (Trieste, July 1984, Crifo et al.) The IC will contain two basic parts: a "survey" including about 60 000 stars complete to about 1.5 stars/square degree (limiting magnitude ranging from  $V=7.7$  in the galactic plane to  $V=8.7$  towards the poles), and a selection of about 40 000 fainter stars chosen for their specific astronomical and/or astrophysical interest.

About 20 000 stars need astrometric measurements to obtain precise positions; new northern observations will come from automatic Meridian Circles (mainly Bordeaux); southern measurements will be made on Schmidt Sky Survey plates (mainly ESO Survey). Cooperation with the Space Telescope Astrometry Team and with the VLBI JPL observers will select the objects best suited for linking the HIPPARCOS system to an extragalactic reference frame. (TURON)

The **FAST** (Fundamental Astronomy by Space Techniques) Consortium for the reduction of HIPPARCOS data includes 17 teams from 5 countries. It started in 1981 under Kovalevsky. The work is divided into 14 tasks. The main reduction chain involves 6 teams: 1) Satellite/attitude determination using the star-mapper data (Donati, Torino); 2) Computation of image positions on the grid from observed photon counts (Donati, Torino); 3) Determination of the abscissae on a fixed great circle of all stars observed during 6 to 12 consecutive hours (Van Daalen, Delft); 4) Synthesis of all observations and determination of the reference system (Galligani, Bologna); 5) Computation of the positions, proper motions and parallaxes (Walter, Heidelberg); and 6) Construction of the software system controlling the reduction (J-L. Pieplu, Toulouse). For all these tasks, studies have been conducted and mock-up programs have been written and are being verified. The methods are described in the report of the FAST Thinkshop held in Asiago in May 1983 (P.L. Bernacca, ed., published by the Padova University).

In addition to the main tasks, a simulation of the mission has been programmed (Froeschle, Grasse). Other tasks underway include: 1) Reduction of double star data (Delaney, Bari); 2) Reduction of minor planet data (Morando, Paris); 3) Reduction of photometric data (Wesselius, Groningen); 4) Modelling of the optics and calibration (J-Y. Le Gall, Marseille); 5) First look examination of data (Schrijver, Utrecht); 6) Connection with FK5 system (Rosser, Heidelberg); 7) Connection with the VLBI extragalactic system of reference (Preston, Pasadena). (KOVALEVSKY)

The **NDAC** (Northern Data Analysis Consortium) includes 15 members from institutes in Denmark, the UK and Sweden. Task leaders are: Høg (chairman, Copenhagen); Cruise (Holmbury St. Mary, London); Lindgren (Lund); Murray and van Leeuwen (Herstmonceux), Lund (Lyngby, Copenhagen).

Tasks are divided into major blocks. The British reduce the raw data into a compact form, describing the observations relative to the smooth scanning motion of the instrument which is still inaccurately known. The observations are then synthesized by the Danish/Swedish group, using a method akin to the photographic plate overlap technique, yielding an accurate instrumental motion and astrometric parameters. The tasks of algorithm development, coding and testing are similarly divided. Work to date includes computer simulation of some processes, a description of reduction tasks and data interfaces, and coding of basic routines, e.g., for data management, estimation methods, and various transformations. The astrometric effects of general relativity will be given particular attention. Numerical experiments show that six non-isotropic metric coefficients according to a theory by S. Cowling can be solved for, in addition to the isotropic light-deflection, without weakening the astrometric solution. (HØG)

The **TYCHO** Data Analysis Consortium (TDAC) involves institutes in Denmark, France, Holland, Italy, Sweden, Western Germany, UK, and USA.

Working from a TYCHO Input Catalogue to contain the two million brightest stars in the sky, star mapper signals will be extracted and analyzed in order to derive magnitudes and positions for stars brighter than  $B=11$  (about 500 000 stars). The Input Catalogue will be a subset of the Guide Star Catalogue, at the Space Telescope Science Institute, supplemented with stars from the Centre de Données Stellaires at Strasbourg. Using coarse attitude information, the photon records from the star mapper slits will be used for a point-source deconvolution in small maps of  $12'' \times 12''$  centered on each star position of the Input Catalogue. The deconvolution includes components of double or multiple systems down to about  $B=11$  and  $V=10.3$ , and will be fairly complete for separations  $>2''$ . The two million stars will correspond to a data extraction from 22 square degrees, (0.05% of the sky). To increase the coverage, data extraction from the original full data set using a signal-to-noise criterion is conceived but will not be pursued with full priority. The photometry will be calibrated by available ground-based photometric standard stars. The reference frame will be that of HIPPARCOS. (GREWING)

STUDY GROUP ON HORIZONTAL MERIDIAN CIRCLES

Chairman: Høg; Members: van Herk, Leiden; Klock, USA; Li Zhigang, Shaanxi; Morrison, RGO; Osorio, Oporto; Pinigin/Timashkova, Pulkovo; Xu Tong-qi, Shanghai; and Hu Ning-sheng, Nanjing.

Pinigin reports that the Pulkovo HMC, after being automated, is expected to determine coordinates of fundamental stars plus faint stars in the neighborhood of radio sources. A horizontal transit circle for observing in the prime vertical has been described by Pinigin and Shornikov in *Astrometria i Astrofizika*, Vol. 49, 1983, p. 75-82. An axial meridian circle is being constructed at Kiev, Main Astronomical Observatory. Yatskiv reports that the telescope tube is placed horizontally in the prime vertical and revolves in bearings located at each end of the tube. In front of the 18 cm objective a 45° flat mirror is mounted in rigid connection with the tube. Osorio reports from Oporto that a new automatic device to collect data from the micrometer is being implemented. A new study of the stability of the mirror is underway. Høg reports that the Glass Meridian Circle (GMC) is being manufactured in China in cooperation with astronomical institutes in China (Shaanxi and Nanjing) and Denmark. The instrument will be tested in Brorfelde before it is put into operation at Shaanxi.

Internal refraction was detected during the development of the GMC and has been confirmed in the flexure measurements at the USNO by Høg and Miller. A tangential ventilation system to remove the effect will be installed on the CAMC on La Palma. (HØG)

SRS PROJECT

The SRS Committee is charged with the task of furthering cooperation between the various observatories participating in observations and reductions. The Committee consists of the following members: Fomin, Pulkovo; Fricke, Heidelberg (Chairman); Hughes, Washington; Lederle, Heidelberg; Polozhentsev, Pulkovo; Smith, Washington. The SRS Committee will meet at the Pulkovo Observatory in the summer of 1985 for a discussion of the results of the SRS project. The discussions and conclusions will be reported to Commission 8 at the XIX General Assembly.

The SRS project has reached its final phase, the construction of the SRS catalogue. The Pulkovo and U.S. Naval Observatories have completed the exchange of data such that both were enabled to complete the analysis of the observations. The U. S. Naval Observatory will present a catalogue of observed positions on the system of the FK4. The Pulkovo Observatory has followed a plan to present the SRS catalogue on an improved FK4 system where the improvements shall result from absolute observations made within the SRS project. The SRS catalogue will be transformed to the system of the FK5 as soon as the transformation is known. (FRICKE)

WORKING GROUP ON ASTRONOMICAL REFRACTION

The Group consists of: Teleki (Chairman), Brunner, Currie, Garfinkel, Hu Ningsheng, Huang Kun-Yi, Hughes, Kolchinskij, Mavridis, Nefed'eva, Saastamoinen, Sergienko, Spoelstra, Sugawa and Tengstrom. The proceedings of the Workshop, "Three-dimensional Refraction," were published by Reidel in "Sun and Planetary System," 1982, pp. 453-530. Teleki (Bull. Obs. Astron. Belgrade, 134, 1984, pp. 39-77) reported on investigations published during 1979-82. This report was presented in part to Commission 8 in Patras in 1982. Shamaev published (Itogi Nauki i Tehniki, *Astronomiya*, Tom 23, Ed. VINITI, Moscow, 1983, pp. 61-101) a review paper on refraction investigations (bibliography of 264 papers).

The Group has begun organizing a Workshop on the Determination of Refraction in Optical and Radio Astrometry, to be held at the Pulkovo Observatory, Leningrad, in May 1985. The Scientific Organizing Committee: Hughes, Sergienko and Teleki (chairman). Two main topics are suggested: 1) Refractional standards (terminology, tables, atmosphere models, algorithms, etc.); and 2) Determination of refraction in the real atmosphere. The new Pulkovo Refraction Tables (Fifth Edition) will be finished in 1984 and will be discussed as part of topic No. 1.

J. A. HUGHES  
PRESIDENT OF THE COMMISSION