ABSTRACTS OF POSTER PAPERS

1. The International Celestial Reference System (ICRS)

The International Celestial Reference System, ICRS

M. Feissel, F. Arias

Bureau Central de l'IERS, Observatoire de Paris, 61 Av. de l'Observatoire, 75014 Paris , France <feissel@obspm.fr>

Taking advantage of the participation of worldwide Very Long Baseline radio Interferometry (VLBI) in its activities, the International Earth Rotation Service (IERS) has defined and realized an extragalactic celestial reference system, proposed for adoption by IAU as the International Celestial Reference System (ICRS). Its origin is at the barycentre of the solar system. The directions of its axes are fixed with respect to the distant quasars to better than ±20 microarcseconds; they are aligned with those of the FK5 within the uncertainty of the latter (±80 milliarcseconds). The ICRS is realized by estimates of the coordinates of a set of quasars, the International Celestial Reference Frame (ICRF). The Hipparcos catalogue of directions and proper motions of galactic objects, and the Jet Propulsion Laboratory ephemerides of the solar system bodies are referred to the ICRS.

Reference:

Arias E. F., Charlot P., Feissel M., Lestrade J.-F., 1995, The Extragalactic Reference System of the International Earth Rotation Service, ICRS, Astron. Astrophys., 303, pp. 604–608.

2. Accuracy of the International Celestial Reference Frame

Internal analyses of the International Celestial Reference Frame (ICRF)

F. Arias, C. Mercuri-Moreau, A.-M. Gontier, M. Feissel, P. Charlot

Bureau Central de l'IERS, Observatoire de Paris, 61 Av. de l'Observatoire, 75014 Paris , France <felicitas@obspm.fr>

The celestial reference system of the IERS and its materialization by the International Celestial Reference Frame (ICRF), is proposed to the IAU for adoption as the conventional celestial system, under the name International Celestial Reference System (ICRS). The ICRF includes about 200 extragalactic radio emitting objects (mostly quasars) selected from a list of 600 objects that are monitored by VLBI. The selection process that was implemented by the IAU Working Group on Reference Frames involved a number of criteria. This presentation concentrates on statistical analyses of systematic and random errors based on comparison of catalogues.

Modeling Radio Source Structures for the Maintenance of the Celestial Reference Frame

P. Charlot[1], O. J. Sovers[2]

[1] Observatoire de Paris - CNRS/URA 1125, France <charlot@obspm.fr>

[2] Jet Propulsion Laboratory, Pasadena, CA <ojs@logos.jpl.nasa.gov>

One of the largest error sources in astrometric VLBI analyses is caused by internal milliarcsecond-scale structures of extragalactic radio sources. Such errors show up, in particular, through systematic trends in the time variation of the estimated source coordinates, likely caused by time variation of the structural features. These trends, however, are difficult to model because some radio sources are known to eject fast moving components on time scales of months, while maps are seldom available more frequently than once or twice a year. To overcome this limitation, we have devised a scheme that permits calculation of structure delay and delay rate corrections at any epochs, based

J. Andersen (ed.), Highlights of Astronomy, Volume 11A, 329–338.

on interpolation between maps. Tests of the validity of this interpolation scheme, implemented in the JPL VLBI analysis software MODEST, have been carried out for the extended source 3C273, using VLBI observations collected during the years 1984–1988 and dual-frequency (S and X) models of the structure of 3C273 generated twice a year during this period. By comparing monthly positions of 3C273 estimated, both with and without structure corrections, we demonstrate that such processing largely accounts and removes the effects of varying source structure in astrometric VLBI analyses.

On the consistency of the ICRF and the reference frame realized by RSC(GAO UA)97 C 01

O.Molotaj[1], V.Tel'nyuk-Adamchuk[1], Ya.Yatskiv[2]
[1]Kyiv Taras Shevchenko Univ., Ukraine <vtel@aoku.freenet.kiev.ua>
[2]Main Astronomical Observatory, National Academy of Sciences, Ukraine
<yatskiv@mao.kiev.ua>

Using the method of arcs between the radio sources (RS) developed by Yatskiv and Kuryanova, the Kyiv series of compiled catalogues of RS positions has been continued. This method provides the possibilities of deriving the uncertainty of source catalogues and of detecting inconsistencies in the separation of RS positions. A comparison between the constructed catalogue RSC(GAO UA)97 C 01, on the one hand, and the reference frames ICRF94 and RSC(WGRF)95 R 02, on the other hand, has been carried out. Systematic differences and the consistency of these frames are discussed.

Fluctuation of Extragalactic Reference Frame due to Gravitational Lensing in Our Galaxy

Mizuhiko Hosokawa[1], Toshio Fukushima[2], Kouji Ohnishi[3]
[1] Communications Research Laboratory, Japan <hosokawa@crl.go.jp>
[2] National Astronomical Observatory, Japan <toshio@spacetime.mtk.nao.ac.jp>
[3] Nagano National College of Technology <ohnishi@ge.nagano-nct.ac.jp>

When we observe the extragalactic objects through our galaxy, their positions will be fluctuate due to the gravitational lensing of matter in our galaxy. The positional shift will set a limit to the accuracy of the extragalactic reference frame and the variation of that will cause the aging of the frame. We calculate the expected values of these shifts on the stars and MACHOs in our galaxy. Their typical values are 10 microarcsecond(μas) and several μas/y, respectively.

The optical depth of such fluctuations are also calculated as a function of the positional shift or its variation. It is found that the fluctuations at 10 μas level would occur rather rarely. In such cases, they are considered to be induced mainly by the nearest single source to the line of sight and would be correctable to some extent. At the same time, the detection of these effects will be useful for probing the components of our galaxy.

Consistency of IERS global references

P. Sillard[1], F. Arias[2], M. Feissel[2], Z. Altamimi[1], C. Boucher[1], D. Gambis[2]
[1] Institut Géographique National, ENSG, 77455 Marne la Vallée Cedex 2, France
<sillard@ensg.ign.fr>
[2] Bureau Central de l'IERS, Observatoire de Paris, 61 Av. de l'Observatoire, 75014 Paris
<feissel@obspm.fr>

Classically, general spatial references involve three main components that have to be considered as a whole: the Celestial Reference System, the Terrestrial Reference System and the link between them, the Earth's Orientation. The International Earth Rotation Service (IERS) is in charge of maintaining mutually consistent numerical realizations of these three components: the International Celestial and Terrestrial Reference Frame (ICRF, ITRF) and Earth Orientation Parameters (EOP) time series. These are constructed by combining results from VLBI, GPS, SLR, LLR and DORIS,for which the Terrestrial Reference Frame, the EOP series and, in the case of VLBI, the Celestial Reference Frame are simultaneously available.

Currently the IERS EOP series, the Celestial and the Terrestrial Frames are combined separately. These combinations involve the estimation of rotation angles from each individual solution to the IERS one that should be in agreement with each other, although they are obtained from

different subsets of the same global solution. We give some realistic present-day evaluations of the consistency of the ICRF, ITRF and IERS EOP. This approach as proved successful to identify and correct sources of inconsistencies between the various individual analyses, a necessary step in view of the future implementation of the simultaneous computation of a global set of spatial references.

3. Linking Hipparcos to the ICRF

Future control of the Hipparcos frame using MERLIN

L.V. Morrison[1], S.T. Garrington[2], R.W. Argyle[1], R.J. Davis[2]

[1] Royal Greenwich Observatory <merlp@ast.cam.ac.uk>

[2] Nuffield Radio Astronomy Laboratories, Jodrell Bank <stg@jb.man.ac.uk>

The equatorial cartesian axes of the Hipparcos Catalogue have been fixed relative to those of the International Celestial Reference Frame (ICRF) with an accuracy of ±0.6 milliarcseconds (mas) at the epoch 1991.25 and with a constraint of ±0.25 mas/yr on their rotation. The maintenance of the Hipparcos frame will depend on periodic checks of its alignment to the ICRF. One of the most effective ways of doing this will be to compare the radio positions of Hipparcos stars with the Hipparcos optical positions brought forward with Hipparcos proper motions.

¿From the radio positions of 11 Hipparcos radio stars, the MERLIN connected-element radio interferometer confirmed that the alignment of the Hipparcos frame at epoch ∼1994 was within 2.3 mas of the ICRF. Ten years from the mean epoch of Hipparcos (2001) the misalignment of the Hipparcos frame to the ICRF could reach 3 mas. By doubling the number of measurable radio stars to ∼20 and improving corrections for atmospheric phase errors, MERLIN will be capable of testing the alignment of Hipparcos to the ICRF with an accuracy of about ±1 mas. We discuss some new MERLIN positions of radio stars, which is the next step towards the realization of this objective.

The orientation of the Hipparcos celestial system with respect to ICRS as induced from the Earth orientation parameters

J. Vondrák[1], C. Ron[1]

[1] Astronomical Institute, Prague, Czech Republic <vondrak@ig.cas.cz, ron@ig.cas.cz>

The new solution of Earth orientation parameters is worked out in the Hipparcos reference frame, based on the observations of latitude/universal time made in the years 1899.7–1992.0 with nearly fifty astrometrical instruments at about thirty observatories. The individual values of polar motion, celestial pole offset and UT1–TAI are determined at 5-day intervals. These parameters are used to determine the time-dependent orientation of the Hipparcos reference system with respect to extragalactic system ICRS. The orientation and slow rotation of the Hipparcos reference system is usually defined by six independent parameters. We make use of only the values of the celestial pole offset, that are virtually independent of the terrestrial reference system. Therefore, we obtain only four (out of the six) parameters, defining the orientation and slow rotation of the Hipparcos system around the x and y axes.

Investigation of the relative orientation of reference frames: HIPPARCOS- FK5–ICRF

I.I. Kumkova, A.M. Kolomietz

Institute of Applied Astronomy, Russian Academy of Sciences, 8 Zhdanovskaya st.,St.Petersburg, 196042 Russia <kumkova@isida.ipa.rssi.ru>

Three main reference frames used at present in astronomy are considered. These are: FK5 – a classical fundamental reference frame being the only one in use during the last decade; HIPPARCOS – the most modern, precise and complete optical frame; and ICRF – International Celestial Reference Frame – recommended to be the new IAU system. These reference systems are based on different types of objects (FK5 and HIPPARCOS on optical stars, and ICRF on extragalactic radio sources), and are obtained by different techniques.

These differences lead to the need to determine the relative orientation of their frames. In the work presented here, we investigate the relative orientation of FK5 – HIPPARCOS – ICRF. The comparison between radio and optical frames was made possible by the availability of photographic astrometry of extragalactic radio sources made with respect to the FK5 and HIPPARCOS catalogues. Values of rotation angles are estimated from this comparison. New results for the de-

termination of relative orientation parameters for HIPPARCOS – FK5 – ICRF are presented and discussion and comparison with the results of the other authors are made.

Determinations of high precision proper motions for 32 Hipparcos stars from photographic plates

Shuhua WANG, Zhenghong TANG, Wenjing JIN, Jiaji WANG
Shanghai Observatory, Chinese Academy of Sciences, China <jwj@center.shao.ac.cn>

Seventy exposures on 32 photographic plates of four areas of the sky – around the radio source 0316+413; the extragalactic nebula NGC7302; the Pleiades astrometric standard region, and so on – taken with the 40*cm* astrographic refractor at SheShan(Zô-Sè) station of Shanghai Observatory, are reduced. Using the PPM catalogue as the initial reference catalogue and the central overlapping method with the iteration process, we obtain high-precision positions and proper motions for 32 Hipparcos stars.

Due to the large epoch differences of up to 86 years, the mean internal consistencies of the proper motions for 32 stars are ± 0.59 mas/yr and ± 0.53 mas/yr in right ascension and declination. While the positional accuracies in RA and Dec are ± 23 mas and ± 18 mas, respectively. Comparisons between our results and those of other catalogues are made.

Residual rotation of the Hipparcos Reference Frame, or a new class of Galactic interior motion ?

Masanori Miyamoto, Zhu Zi
National Astronomical Observatory, Mitaka, Tokyo <zhuzi@c00.cc.nao.ac.jp>

The HIPPARCOS Reference Frame has been constructed on the extragalactic reference frame, ICRS. The nominal value of the proper motion deviation from inertial is 0.25 mas/yr, which means that the overall pattern analysis of HIPPARCOS proper motions should reveal the new class of the galactic interior motion other than the classical galactic rotation, such as the non-axisymmetric stream of stars, the warping motions, and the oscillatory motions of the Galaxy.

We have analysed HIPPARCOS proper motions, on the basis of the 3-D Ogorodnikov-Milne model (Miyamoto and Soma 1993). Two populations of stars, K-M giants and O-B stars, have been examined. We have found statistically meaningful shear and vorticity, including the classical galactic rotation. If we accept these motions, then we need a new concept of the galactic interior motion. However, the possibility of a remaining rotation of the HIPPARCOS Reference Frame larger than 0.25 mas/yr should be considered. To examine the remaining rotation, we have carefully investigated the systematic difference between the HIPPARCOS and NPM proper motion systems.

Effect on EOP of the systematic differences between the ICRS and the previous reference system

Tongqi XU, Peizhen LU
Shanghai Observatory, Chinese Academy of Sciences, China <lpz@center.shao.ac.cn>

Since 1984 the FK5 fundamental catalogue and the IAU 1976 astronomical constants have been used in astronomical calculations. The changes brought about by this system directly affected the Earth Orientation Parameters(EOP) determined from observations made by optical instruments. The effects of these changes on the EOP were calculated in the 1990s. Following the adoption of the ICRS for the Hipparcos Catalogue, the effects on EOP will have to be recalculated. The purpose of this paper is to calculate and analyse the systematic differences between the ICRS system and the previous system in order to establish a uniform system of EOPs since 1957.

Mykolayiv AMC positions of faint stars in selected fields around extragalactic radio sources for linking the optical and radio reference frames

A. Kovalchuk, G. Pinigin, Yu. Protsyuk, A. Shulga
Mykolayiv Astronomical Observatory, Ministry of Science and Technology of Ukraine
<root@mao.nikolaev.ua>

The principal features and technical possibilities of the Mykolayiv Automatic Meridian Circle (AMC) permit it to be used efficiently for improving the accuracy of the link between the optical (stellar) and radio (extragalactic radio sources - IERS) reference frames. A technical description of the AMC was presented at IAU Symposium 166. From 1996, the observation of reference stars in

fields around 400 IERS sources in declination zone +90 to -20 and in magnitude range 12-14 was started with the AMC. The reference stars were selected from the Guide Star Catalogue and the measured positions are derived in the Hipparcos frame.

Additionally, Tycho stars were observed in the selected fields. The observations were carried out in short strips using a CCD camera. At present, about 2000 strips have been observed around 200 IERS sources containing 60 000 stars from the GSC, TC, and 2500 strips with HC stars. The observation and current reduction are described. It needs about three years of observation to complete the catalogue with an accuracy of 0."02–0."05.

4. Linking the dynamical frame to the ICRF

Link between the dynamical reference system and the ICRS, with Hipparcos minor planets

J.-F. Bange[1], A. Bec-Borsenberger[2], M. L. Bougeard[34]

[1] Bureau des Longitudes, URA 707 CNRS, Paris [bange@bdl.fr]

[2] Bureau des Longitudes, URA 707 CNRS, Paris [borsen@bdl.fr]

[3] UFR Maths., Université des Sciences, LYON I

[4] URA 1125 CNRS, Observatoire de Paris [bougeard@bdl.fr]

We used the observations of eighty-eight minor planets by Hipparcos to position the dynamical reference system with respect to the ICRS. The dynamical reference system is materialized by ephemerides of Bureau des Longitudes or ephemerides of JPL and the ICRS frame at optical wavelength is given by Hipparcos data. The data reduction consortia FAST and NDAC gave two sets of data for the observed positions of minor planets. We will present the results of the link obtained from these two sets using algorithms based on the least absolute value and the Huber M-estimators. Accuracy will be discussed.

Future study of minor planets' motion with respect to the ICRF

O.P. Bykov

Pulkovo Astronomical Observatory, Russia <bykov@venvi.usr.pu.ru>

To study the motions of the Minor Planets in the system of the ICRF one needs to know the accuracy the modern CCD observations are able to give.

The CERES software package created at the Institute of Theoretical Astronomy (Russia) was applied to calculate (O–C) differencies for more than 1000 numbered Minor Planets observed irregularly and quasi- simultaneously in 1995-96 with CCD as well as photographic techniques at nearly 70 observatories.

The accuracy of observations was estimated by analysing the dispersion of the average (O–C) for each type of observation obtained by each telescope. The star catalogue GSC was used by practically all the observers for the astrometric reduction of their CCD-scans. A representative sample of the considered observations was statistically reliable. To eliminate errors of the theory, short arc observations were made during one or several adjacent nights.

On the whole, the CCD observations of the numbered Minor Planets published in the Minor Planet Circulars from 06.1995 to 06.1996 are more accurate than the photographic ones.

Results of internal and external accuracy will be given for each observatory.

Linking Hipparcos with DE200/DE403 reference frame by photoelectric observations of the occultation of ϵ *Gem* by Mars (1976 April 8)

G. Krasinsky

Inst. of Applied Astronomy, Russian Acad. of Sciences <kra@ipa.rssi.ru>

There are two ways to link radio and optical realizations of ICRS. In the direct method, when coordinates of common sources are compared, a number of well-known problems arise. Now that very accurate ephemerides DE200/DE403 are linked to the radio system, an alternative approach may be realized in which inner planets are used as intermediate targets. In the optical band milliarcsecond accuracy is reached in photoelectric observations of occultations of stars by planets. Thus, it appears possible to tie Hipparcos with the frame of DE ephemerides, and thus with the VLBI radio frame.

We have tried this approach by making use of 16 published timings of contacts made during the occultation of the bright Hipparcos star ϵ *Gem* by Mars in 1976. Normal places for the differences

in right ascension and declination were constructed which give the following residuals for DE403 (in the sense Mars minus star) :

$d\alpha = -60 \pm 2\,mas,\ d\delta = -7 \pm 9\,mas$ (Hipparcos coordinates)

$d\alpha = -45 \pm 2\,mas,\ d\delta = 103 \pm 9\,mas$ (FK5 coordinates)

Though with these observations it is possible to determine only two linear combinations of three unknowns, the residuals show that the system of Hipparcos needs corrections up to 60 mas. Even with a single additional observation of this type, it would be possible to determine the orientation of the Hipparcos frame with the milliarcseond accuracy. The large number of stars in Hipparcos makes reasonable the task to search for such events in near future.

5. Extending the Hipparcos frame to fainter magnitudes

CCD positions for extragalatic radio sources

M. Assafim[1], R. Vieira Martins[2], A.H. Andrei[2]

[1] Depto. Astronomia - Obs. Valongo, Rio de Janeiro, Brazil <massaf@on.br>

[2] Observatorio Nacional, Rio de Janeiro, Brazil <rvm@on.br and <at1@on.br>

We discuss a method to obtain on local area in the sky, precise positions for the stars of the Guide Star Catalog (GSC), referred to more precise catalogues. The corrections to the right ascensions and declinations are carried out in the tangent plane in a fashion similar to that of standard photographic astrometry.

We applied this method for CCD observations made at the 1.60m Telescope of the Laboratorio Nacional de Astrofisica, Itajuba, Brazil. We observed one hundred extragalatic radio sources uniformly distributed over $-80° < \delta < +20°$ declination, from the IAU list of objects scheduled to materialize the International Celestial Reference System (ICRS). The positions are referred to the Carlsberg Series (CAMC), PPM, ACRS and Hipparcos and Tycho catalogues. A set of fiducial sources was selected by means of their positional arclength differences, to link and compare the optical results and the VLBI radio source positions. Relative orientation angles between the optical and the radio frames were found within 0".02 precision. Comparison of positions on both frames for all radiosources has shown a dispersion consistent with the errors in the reference catalogues used.

Transferring the Hipparcos frame to Schmidt surveys

M.J. Irwin[1], L.V. Morrison[2], R.W. Argyle[3]

[1] Royal Greenwich Observatory, Cambridge, UK. <mike@ast.cam.ac.uk>

[2] Royal Greenwich Observatory, Cambridge, UK. <merlp@ast.cam.ac.uk>

[3] Royal Greenwich Observatory, Cambridge, UK. <rwa@ast.cam.ac.uk>

A series of faint astrometric standards obtained on the Carlsberg Meridian Telescope and a zonal astrometric sequence obtained by Stone for the Sloan Digitial Sky Survey, have been used to investigate the magnitude-dependent astrometric errors on sky survey Schmidt telescope photographic plates. In conjunction with the PPM and Tycho astrometric catalogues this has enabled us to characterise and quantify problems related to transferring the Hipparcos frame at V $\approx$ 9th magnitude to the limit of sky survey plates, V $\approx$ 21st magnitude.

As expected, the generally asymmetric image profiles on Schmidt plates lead to pronounced magnitude-dependent astrometric distortion terms of up to $\approx$1 arcsec in size. We demonstrate that most of this distortion is caused by the complex image structure of saturated stars, mainly caused by the appearance of diffraction spikes and low light level halos due to multpiple reflections in the telescope optics. Fainter than V $\approx$ 14–15th magnitude, the magnitude-dependent astrometric distortion rapidly declines to a level of order $\approx$0.1 arcsec.

USNO-A and the ICRF

D. Monet[1] and T. Corbin[2]

[1] U.S. Naval Observatory <dgm@nofs.navy.mil>

[2] U.S. Naval Observatory <tec@sicon.usno.navy.mil>

USNO-A is a catalog of 488 006 860 sources detected on both the red and blue first-epoch Schmidt survey plates (POSS-I in the north, SRC-J+ESO-R in the south). The currently available release, USNO-A1.0, is tied to the system of GSC1.1 because that was the only option. As soon as

the Hipparcos and Tycho catalogs are released, the task of compiling USNO-A2.0 will be begin, and the expected release date is summer of 1998. Because of its depth, density, and accuracy, USNO-A is a useful catalog for a variety of astrometric applications. The astrometric accuracy is typically 0.25 arcseconds, and the photometric accuracy ranges from 0.2 to 0.4 magnitudes (depending on declination and distance from the nearest available calibration data), and objects as faint as (O=21,E=20) are included.

Please consult the USNO Web page *http : //www.usno.navy.mil/pmm/* for further details and ordering information.

The U.S. Naval Observatory Pole–to–Pole Program

T.J. Rafferty[1], E.R Holdenried[2]

[1] U.S. Naval Observatory, Washington DC <tjr@sicon.usno.navy.mil>

[2] U.S. Naval Observatory, Washington DC <erh@sicon.usno.navy.mil>

Between the years 1985 and 1996 the U.S. Naval Observatory carried out a program of absolute transit circle observations covering the entire sky. Two transit circles were involved, one located in Washington, DC (USA) and the other in Blenheim (New Zealand). Over 660 000 observations were made, primarily of International Reference Stars (IRS), as well as all the major planets (except Pluto) and nine minor planets. Over 37 000 observations were obtained of day-time objects including the Sun, Mercury, Venus, and Mars. The final objective is a self-consistent, all-sky catalog of absolute positions which can be linked by rigid rotations to the dynamical system.

The optical coordinates of 150 galactic radio sources

N.G. Rizvanov, V.N. Kitkin, L.I. Rakhimov, I.A. Dautov

Engehardt Astronomical Observatory <rng@astro.ksu.ras.ru>

Using the astrograph Zeiss 400/2000 at the Zelenchuk mountain station, plates of 150 galactic radio-sources were taken. A new method of reduction of the wide-angle plates was developed. Through their reduction, the optical coordinates of the target objects were obtained in the systems of the catalogues PPM and ACRS. These optical coordinates are compared with the radio-coordinates. In the future the radio stars' coordinates will be reduced on the system of the Hipparcos Catalogue.

The accuracy of the optical coordinates corresponds to the typical accuracy obtained by the photographic method.

Linking QSOs to the Carlsberg AMC

R.L. Smart, B. Bucciarelli, R. Casalegno, G. Chiumiento, G. Massone, F. Marocco and M.G. Lattanzi

Osservatorio Astronomico di Torino, Pino Torinese, Italy <smart@to.astro.it>

Procedures used to directly determine the positions of twelve radio sources in the frame of the Carlsberg Automatic Meridian Catalogues are discussed. We show that the precision and accuracy of these positions is solely limited by the CAMC and that this will remain the case when the CAMC is rereduced using the results from the Hipparcos mission.

We discuss how this data will help the ultimate tie of the Hipparcos coordinate system to the extragalactic reference frame and other ongoing projects at Torino to address this problem.

AC 2000: The Astrographic Catalogue on the Hipparcos System

S.E. Urban, T.E. Corbin, G.L. Wycoff

U.S. Naval Observatory, Washington, D.C. <seu@pyxis.usno.navy.mil>

The United States Naval Observatory has completed new reductions of the Astrographic Catalogue data. This catalog, called AC 2000, contains 4 660 000 stars distributed globally. Since the density of Hipparcos stars is inadequate to reduce the AC data on a plate-by-plate basis, the measures have been initially reduced using the Astrographic Catalog Reference Stars (ACRS). All positions have been converted to the Hipparcos system using systematic differences computed for those stars in common between Hipparcos and the AC.

Since each participating observatory used different instruments in photographing and measuring the plates, data from each were reduced as if they comprised an independent catalog. Measured images from each plate have been analyzed for scale, rotation, non-perpendicularity of measuring

axes, differences in scale between measuring axes and plate tilt. Presence of radial and non-radial optical distortions, coma and magnitude equation were investigated and corrected, where applicable. Every attempt has been made to apply all published errata to the data, and a detailed search for previously unknown typographical errors was performed. All data have been combined and the final catalog contains positions, magnitudes, epochs, error estimates, and cross reference information. All positions are on the Hipparcos system for equinox J2000.0.

A CD-ROM containing the catalog and the reduction details is being distributed at this meeting. For additional information visit WWW site *http://aries.usno.navy.mil/ad/ac.html.*

Instrumentation for the U.S. Naval Observatory CCD Astrograph

T.J. Rafferty[1], M.E.Germain[2], N. Zacharias[3]

[1] U.S. Naval Observatory, Washington DC <tjr@sicon.usno.navy.mil>

[2] U.S. Naval Observatory, Washington DC <meg@crux.usno.navy.mil>

[3] with Universities Space Research Assoc., Washington DC <nz@pyxis.usno.navy.mil>

The U.S. Naval Observatory CCD Astrograph will start an observing program in mid-1997 on Cerro Tololo (CTIO) in Chile to produce a high density, high accuracy, astrometric catalog of the southern hemisphere stars down to 16th magnitude. The program will be done using a robotic, refracting telescope with a 8-inch five-element red-corrected lens. A Kodak 4k x 4k (9 micron pixels) CCD camera will allow a one square-degree field of view, which is large enough to provide the necessary reference stars. The dome rotation, setting and clamping the X-Y slide for the guidescope, setting and clamping the focus, telescope setting, and use of a Hartman screen for determining the focus will be done automatically. The system is controlled via an embedded single-board computer. A host PC sends commands to the embedded computer, receives status information, controls the camera, saves the images to disk, and does the on-line reduction of the previous CCD frame.

Extension of the ICRF: US Naval Observatory CCD Astrograph Catalog South (UCAC-S)

N. Zacharias[1], T.J. Rafferty[2], M.E. Germain[3]

[1] with Universities Space Research Assoc., Washington DC <nz@pyxis.usno.navy.mil>

[2] U.S. Naval Observatory, Washington DC <tjr@sicon.usno.navy.mil>

[3] U.S. Naval Observatory, Washington DC <meg@crux.usno.navy.mil>

The U.S. Naval Observatory CCD Astrograph Catalog project is about to start in July 1997 at Cerro Tololo (CTIO), Chile, to cover the entire Southern Hemisphere in a 2–fold overlap down to 16th magnitude. The program should be completed with 2 years of observing. The goal is to produce a high density, high accuracy, astrometric catalog in the Southern Hemisphere.

A 4k CCD camera will be used in combination with the 5–element, 206mm lens in a 579–642nm bandpass covering 61' at 0.9"/pixel. The Kodak chip is of high cosmetic quality with no dead pixels in the light sensitive area. Tycho stars will be used for preliminary reductions, and a direct tie to the Hipparcos stars is feasible with block adjustment techniques. A catalog accuracy of20 mas per coordinate is expected for stars in the 7 to 14 magnitude range.

In addition to the program fields, longer exposures around extragalactic reference frame sources, calibration fields and minor planet observations are planned.

6. Extending the Hipparcos frame to the Infrared

First step of an Infrared Reference Catalogue based on the FK5 and the creation of an IR Reference System after Hipparcos

A.S. Kharin

Main Astronomical Observatory Ukrainian National Academy of Sciences <kharin@mao.kiev.ua>

Recently, an IR reference catalogue (CPIRSS) was compiled at the USNO (R.Hindsly and R. Harrington, 1994, AJ 207). The second version available on CD-ROM includes 37700 stars from the basic and supplement FK5, IRS, ACRS and WCC catalogues which were also observed by IRAS and were included in IRAS PSC. This catalogue is not homogeneous in accuracy and, as with optical catalogues, it may be naturally divided into two hierarchical catalogues. The first of these is the IR analogue of the FK5, and the second, based on the IRS, ACRS and WCC stars, is

the analogue of the photographic reference catalogues. But after the FK5 is replaced by Hipparcos, the first step of the IR hierarchical coordinate system must be also recompiled, based on the IR stars from the Hipparcos catalogue.

We found from direct comparison of the HIC with the IRAS PSC that more then 25 000 HIC stars have IR counterparts. Therefore, these IR stars with positions and proper motions in the Hipparcos Catalogue must represent the first stage of a new IR coordinate system. Evidently, the first stage of the new IR catalogue, based on the Hipparcos Catalogue, will be ten times denser and practically two orders of magnitude more precise than that based on the FK5. The stars in the second stage of the CPIRSS should be adjusted to the Hipparcos (ICRF) reference frame, and they must represent the second stage of the new IR coordinate system.

A Milli–arcsecond Astrometric Interferometer: Mitaka Optical and Infrared Array (MIRA) Project

J. Nishikawa[1], K. Sato[1], T. Fukushima[1], Y. Machida[1], T. Miyazawa[2], Y. Honma[2], M. Yoshizawa[1], and M. Miyamoto[1]

[1] National Astronomical Observatory, Japan <nisikawa@optik.mtk.nao.ac.jp, toshio@spacetime.mtk.nao.ac.jp, koichi@optik, machida@optik, yoshzwms@cc.nao.ac.jp>

[2] Hosei Univ., Faculty of Engineering, Japan <miyazawa@ksg.sc.hosei.ac.jp, honma@ksg.sc.hosei.ac.jp>

A series of interferometer projects, called MIRA, is in progress in NAO. We are now making experiments of stellar fringe detection and fringe tracking at Mitaka optical and infrared array called MIRA–I. MIRA–I has two 25 cm coude telescopes with a 4 m N–S baseline. Recently we started upgrading the interferometer to achieve 10 milliarcsec astrometry by using vacuum delaylines and temperature stabilized optics, which is called MIRA-I.2.

We are planning the next version of Mitaka array as MIRA–II. We use 30 cm siderostats and 20 cm beam reducing telescopes there. Four fixed astrometric stations with from 16 m to 32 m baselines and three movable ones from 8 m to 256 m are placed in a T–configuration array. We hope to construct an interferometer array with 1.5 m siderostats and about 1.4 km baselines at a good site like Mauna Kea, which we call MIRA–III. It will have some fixed and movable stations in a Y–configuration array. MIRA–II and MIRA–III aim at 1mas astrometry and 1mas or more resolution imaging. Wavelength between 400 nm and 2500 nm will be used.

MIRA–II data will maintain the Hipparcos catalog and MIRA–III would be able to make global astrometry of many quasars and optical to near–IR sources, thus contributing to the new ICRF.

Astrometry with Optical and Infrared Interferometers

K. Sato, J. Nishikawa, M. Yoshizawa, T. Fukushima, Y. Machida, M. Miyamoto

National Astronomical Observatory, <koichi@optik.mtk.nao.ac.jp nisikawa@optik.mtk.nao.ac.jp, yoshzwms@cc.nao.ac.jp toshio@spacetime.mtk.nao.ac.jp machida@optik.mtk.nao.ac.jp>

We are promoting the construction of the ground–based optical and infrared interferometers, called MIRA Project(I, II, and III), at the National Astronomical Observatory of Japan. The outline of the MIRA Project is given in the paper by Nishikawa et al. (this JD). Siderostats are used in order to carry out precise astrometric observations. The aperture will be large enough to reach a limiting magnitude fainter than 12 or 13 mag at K–band.

The scientific impacts of the astrometry with MIRAs are discussed in this paper. It is very important to link the optical positions of stars to the radio reference frame determined by VLBI through the observations of quasars and stars with the interferometers. It is also interesting to compare the positions of central stars of maser sources to individual maser-spot positions of VLBI. With K band, the proper motions of the red supergiants within 20 kpc from the sun can be observed even through the galactic disk because the interstellar absorption at K–band is very small. The dynamics of the bulge and disk of the Galaxy studied by using these observations will provide a new global kinematic scope to the formation and evolution of the Galaxy.

7. Astrolabe catalogues

Second Catalogue of Stars with the Photoelectric Astrolabe in San Juan

W.T. Manrique[1], Lu. Lizhi[2], R. Perdomo[3] Wang Zezhi[2], R.A. Podesta[1], Zeng Zhifang[2]

E.L. Actis[1], Zeng Fanmiao[2], E. Alonso[1]
[1] Observatorio Astronomico Felix Aguilar, Argentina <postmaster@unsjfa. edu.ar>
[2] Beijing Astronomical Observatory, China <nrd@bao01.bao.ac.cn>
[3] Observatorio Astronomico de La Plata, Argentina <perdomo@fcaglp.unlp. edu.ar>

According to the cooperation between Beijing, San Juan and La Plata Astronomical Observatories, the photoelectric astrolabe mark II(PA II) of Beijing Astronomical Observatory was moved and installed at San Juan Observatory in Argentina in January, 1992 for the observation of the catalogue of stars in the southern hemisphere.

On the basis of the observations in San Juan made with the instrument from Feb. 23, 1992 to January 12, 1997, residuals of 10 930 stars were formed from about 390 000 observations of stars made on 1458 days. The mean accuracy of a star position derived from these residuals is 0".045. Using these data, the Second Catalogue of 5195 stars (CPASJ2) has been compiled. The mean accuracies are ±3.1 ms and ±0.059" in right ascension and declination, respectively. The magnitudes of stars are from 2.0 to 11.5. The declinations are from –3° to –60°. The mean epoch is 1994.8. Finally, systematic corrections (CPASJ2–FK5) are given.

Preliminary results from the new astrolabe in Bucharest

Radu Popescu, Petre Popescu, Petre Paraschiv
Astronomical Institute of Romanian Academy <ppopescu@imar.ro>

The Danjon astrolabe transferred from the Royal Observatory of Brussels to Bucharest has been upgraded. The wollaston micrometer was replaced by an illuminated reticle that serves for the determination of astrolabe tilt versus the local vertical (the mercury pool). The transparent prism was replaced with a reflecting one, cut from a Zerodur block; it contains two pieces glued at the contact surfaces. The left piece has the reflecting surface tilted at 45 degrees to the optical axis of the astrolabe, and is the autocollimating mirror. The right piece has the reflecting surface tilted at 22.5 degrees to the astrolabe objective, and serves for star observations. The camera used is a COHU 4710 (borrowed from Paris Observatory, DANOF). The images are obtained in the CINE–CCD mode. The software was written in Pascal, based on advice received from Dr. F. Chollet. In the first step we have determined the inner parameters of the new astrolabe. We hope to observe by this technique stars fainter than 8 mag with a new intensified CCD camera.