MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
RESEARCH INSTITUTE “NIKOLAEV ASTRONOMICAL OBSERVATORY”

METHODS AND INSTRUMENTS IN ASTRONOMY: FROM GALILEO TELESCOPES TO SPACE PROJECTS

International Workshop

ABSTRACT BOOK

May 17-20, 2010,
Mykolaiv, Ukraine

Organizers:

Ministry of Education and Science of Ukraine
Research Institute “Nikolaev Astronomical Observatory”
Ukrainian Astronomical Association
National Space Facilities Control and Test Center

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The Book of Abstracts contains abstracts of presentations to the International Workshop “Methods and Instruments in Astronomy: from Galileo Telescopes to Space Projects” to be held in Mykolaiv, Ukraine, on May 17-20, 2010. Aspects of the kinematics and dynamics of the small Solar system bodies, research of near-Earth space, VO tools in astronomical research, etc. are given in it.

GENERAL INFORMATION

The International Workshop “Methods and Instruments in Astronomy: from Galileo Telescopes to Space Projects” (NAO2010) will be held in Research Institute “Nikolaev Astronomical Observatory”, Mykolaiv, Ukraine on May 17-20, 2010. It is organized to discuss the international projects in research of Solar system small bodies and the near-Earth artificial bodies. Application of virtual observatory tools in various fields of Astronomy and Astrophysics is also discussed.

Main Topics of the Workshop:

- Kinematics and Dynamics of the Small Solar System Bodies;
- Research of Near-Earth Space;
- Virtual Observatory Tools in Astronomical Research.

Information about Participants:

- General number of represented organizations – 27;
- Number of submitted papers – 62;
- Number of authors of submitted papers – 111.

ASTRONOMICAL TELEVISION COMPLEX OF THE SCIENCE RESEARCH INSTITUTE "CRIMEAN ASTROPHYSICAL OBSERVATORY" AND METHODS OF OBSERVATIONS

A.N. Abramenko, V.V. Prokofjeva-Mikhailovskaya

SRI "Crimean Astrophysical Observatory", Nauchny, Crimea, Ukraine; prok@crao.crimea.ua.

The development of the television method of astronomical observation has began in summer of 1963, when the television mounting, made by request of Crimean Astrophysical Observatory in the laboratory of Research Institute of Applied Physics under the direction of V.F. Anisimov was brought from Moscow to the observatory. Possibilities of the regulation of contrast and brightness of television images of stars were provided, as well as their visual monitoring and photo registration from the screen of the video control device (VCD). The opportunity of accumulation of a potential relief on the target of the peak up tube was foreseen. The test observations were carried out on the telescope MTM-500. Television images were registered on a film with a photo camera. In the beginning of 1964th with the telescope MTM-500, the stellar images as faint as 20^m were registered during the exposure of 4 sec. This world record was marked by O.A. Melnikov in the book "Modern telescope".

This TV device differs from any industrial television mounting only in using electron-optical amplification of brightness by image converter UM-92. In order to use of this mounting for photometric purposes, it was necessary to make changes in its scheme. The progressive scanning was introduced into practice, and the number of TV lines in one frame was increased up to 1200. The duration of TV frame was increased up to 0.92 sec. The connection between the frequency of lines and frames was made asynchronous, with a quartz stabilizing frequency. Stability of power voltages of feed of the peak up tube and amplifying circuits was reduced to 0.2%. Cooling of the peak up tube was introduced by dry cold air, which resulted in increase of the tube's sensitivity by 5-10 times. A temperature in area of the target of peak up tube's during the observations was maintained constant, equal $0^o \pm 1^o$. Such temperature provided efficiency of accumulation of potential relief on a target during several seconds. The power voltage of peak up tube was set and controlled by means of digital voltmeter.

For calibration and control of the sensitivity of the television mounting, a special star test were projected on the photocathode together with observed object. Light-emitting diodes were used. The dependence of brightness on the current was tested in the laboratory by means of the photometer. The thermal stabilization of light-emitting diodes was done to avoid influence of temperature variations on their brightness.

For the improvement of the characteristics of the video amplifier its first cascade was mounted inside the knot of connection of the peak up tube. Step regulation of voltage of the multiplier of the peak up tube was implemented.

From the beginning of application of TV tubes with the preliminary electron-optical amplifier of brightness (LI-217, LI-804), a device was created allowing to observe object in 3-4 regions of spectra simultaneously. Due to all these works it was succeeded to gain an accuracy of photometric and spectral observations up to 4-5% using the photo registration of observed image. The exit signal varied by no more than 3% during five hours of continuous work of television complex.

Since 1977, a new peak up tube superizocon was used for astronomical observations. This tube permitted to register images in more wide light range than before and it possessed a high absolute sensitivity ($5x10^{-7}$ lx) and contrast sensitivity, provided a high ratio of signal to noise. The dynamic range of the calibrated curve was increased. However it is necessary to note, that the use of this tube requires considerably more complicated control of potentials on its electrodes and maintenance of constancy of these potentials.

At the beginning of 80^{th} of the last century, digital registration of video-signal of the part of the TV frame, limited by the strobe. was implemented at the Crimean Astrophysical Observatory. Application of PCs has allowed to refuse from the photographic registration of images. The opportunity to sum up information from a large number of television frames in computer memory has appeared. It provided a considerable increase in the accuracy of the photometry of stars and their spectra up to 0.3% (at their high brightnesses, by summing up of 2000 frames). Due to these improvements, television photometry at the SRI “Crimean Astrophysical Observatory” went on a leading position in the world.

So, from the beginning of 80^{th} of the last century and to the present time the television apparatus with vacuum television tubes, have already allowed and still allows astronomers to conduct the newest research of astronomic objects.

STRUVE'S ARCHIVE OF THE INSTITUTE OF ASTRONOMY IN KHARKIV UNIVERSITY AS A PART OF "GEODETIC STRUVE ARC" UNESCO HERITAGE

***M.A. Balyshev*[1]*, P.N. Fedorov*[2]*, I.B. Vavilova*[3]**

[1]*Central State Scientific Technical Archive of Ukraine, Kharkiv, Ukraine.*

[2]*Institute of Astronomy of V.N. Karazin Kharkiv National University, Kharkiv, Ukraine.*

[3]*Main Astronomical Observatory of NAS of Ukraine, Kyiv, Ukraine; irivav@mao.kiev.ua.*

The history of the Struve dynasty's archive, which has been preserved in the Institute of Astronomy of the V.N. Karazin Kharkiv National University, is connected, first of all, with the name of the famous astronomer, professor Ludwig Ottonovych Struve, a director of Astronomical Observatory of the Kharkiv University since 1897. In 1919, during the Civil War, L.O. Struve and his family had to temporarily leave Kharkiv and move to Simferopol where he was assigned to a position of professor of Tavria University by V.I. Vernadsky's invitation. He had to resort to these steps due to the German origin of the Struve family and the fact that his son, Otto Struve, (in future – the famous American astronomer) had been fighting at that time in the volunteer army. In Kharkiv observatory the family left a collection of archive documents. Today it contains hundreds of valuable papers from the epistolary heritage of Friedrich Georg Wilhelm and Otto Wilhelm von Struve (totally about 1400 letters). The history of this document collection is quite interesting itself. Its major part arrived at Kharkiv in 1902. In this period members of O.W. Struve family left St. Petersburg completely and moved to Germany. The last one to leave was his younger daughter – Eva Ottonivna Struve – who delivered the documents to her brother, Ludwig Ottonovych. The further fate of the Struve family document collection is literally connected with the walls of Kharkiv observatory. In 1919, during his temporary absence, Professor L.O. Struve left many of his family heirlooms in Kharkiv. Only several books from Professor Struve's collection survived in the library of Tavrida National V.I. Vernadsky University in Simferopol. One may assume that if Ludwig Ottonovych had been able to take his family archive with him, it would have been lost forever to the world history. Kharkiv astronomers preserved L.O. Struve's archive during the hard time of the Civil War, and the observatory archive as well as the observatory library and most of the instruments escaped destruction only thanks to the selflessness of Associate Professor V.O. Mykhailov during German occupation of Kharkiv (1941-1943).

The Struve dynasty archive consists of many documents which may be classified as following: correspondence by Friedrich Georg Wilhelm and his son, Otto Willhelm with the well known astronomers of the XVIII century (W.G.W. with Airy, Argelander, Gould, Ertel, Savich, Cabura and others; O.W. with Clark, Eresch, Hershel, Auwers, Hoffman, Osten-Saken and others); documents of the biographies of representative of Struve dynasty (for example, F.G.W. Struve diary, diplomas, etc. and genealogical tree compiled by O.W. Struve); documents by L.W. Struve (manuscripts, lections, reports, collection of his papers and papers of other astronomers, etc.); materials from the history of the Kharkiv University; collection of photos and gravures; rarity issues of books, for example, "Catalogue of stars for 1830.0 epoch compiled by F.G.W. Struve" (1852, in Latin); documents on the activity of the International Committee for Weights and Measures (1870-ties), of the chronometric expeditions (1847-1848 yrs). Some documents are related to the activity of German Struve.

With the aim to put in good order, to classify and to health these unique documents, the authors under support of the Ukrainian Astronomical Association initiated a project for preserving the Struve dynasty archive and its following acquaintance for the wide scientific community. This initiative was primarily supported as a small project within the "Geodetic Struve Arc" UNESCO World Heritage.

NEAR-EARTH OBJECTS ASTROMETRY WITH GAIA AND BEYOND

D. Bancelin, D. Hestroffer, W. Thuillot

IMCCE, Paris Observatory, Paris, France;
bancelin@imcce.fr, hestroffer@imcce.fr, thuillot@imcce.fr.

The Gaia is an astrometric mission that will be launched in 2012, which will observe a large number of Solar System Objects [Hestroffer & Thuillot, this conference] down to magnitude V≤20. The solar system science mission is to map thousands of MBA, NEO, comets (and also planetary satellites) with the principal purpose of orbital determination (better than 5 mas astrometric precision), determination of asteroids' masses, spin properties, and taxonomy. Besides Gaia will be able to discover new objects, in particular Near-Earth Objects (NEOs) in the region below solar elongation of 90º, which are harder to detect with the current ground-based surveys.

During the 5-year mission, Gaia will continuously scan the sky with a specific strategy: objects will be observed from two lines of sight separated with a constant basic angle. Five constants – already fixed – determine the nominal scanning law of Gaia: the inertial spin rate (1°/min) which describes a rotation of the spacecraft around the axis perpendicular to those of the two fields of view, the solar-aspect angle (45°) which is the angle between the Sun and the spacecraft rotation axis, the precession-period (63.12 days) which is the precession of the spin axis around the Sun-Earth direction. Two other constants are still free parameters: the initial spin phase, and the initial precession angle that will be fixed at the start of the nominal science operations. They are constrained by a scientific outcome (possibility of performing test of fundamental physics) together with operational requirements (downlink to the Earth windows).

Several sets of observations of specific NEOs will hence be provided according to the initial precession angle. The purpose is to study the statistical impact of the initial precession angle on the error propagation and on the collision probability, especially for PHAs. We will also analyze the advantage of combining space-based to ground-based observation over long term, as well as in short term from observations in alert.

SCIENTIFIC AND RESEARCH COMPLEX OF INSTRUMENTS FOR OBSERVATIONS OF ARTIFICIAL SATELLITES

Ya. Blahodyr, K. Martynyuk-Lototsky, A. Bilinsky, N. Virun, Ye. Vovchyk, A. Kurylo

Astronomical Observatory of Ivan Franko National University of Lviv, Lviv, Ukraine; blagod@astro.franko.lviv.ua.

There are more than 10000 artificial objects, which are visible by the instruments from the Earth. Some of them are operational (about 6%) and the rest are space debris. There is a necessity to observe active satellites and space debris by all available methods.

For artificial bodies, positional observations are the most informative ones because the orbital data can be determined on the base of such observations. Adding the laser ranging data to the positional data, one can get a more precise orbit of the object. If there is an informational need about a shape and state of the object, the photometric and polarymetric observations should be made. Besides, from the photometric observations of artificial satellites, one can get also some geophysical data and data of the Earth atmosphere.

It is quite evident that the special hardware for each method of observations is needed and it is desirable to have all instruments for observations in one place. Such situation is created in Lviv, where the hardware for complex (positional, laser ranging and photometric-polarimetric) observations is placed in one astronomical dome.

The objective “Uran-9” (D = 100 mm, F = 250 mm) and TV CCD camera installed on the 4-axis mounting and/or on the guide of the telescope TPL-1M are used for the positional observations.

The laser ranging observations are made with the telescope TPL-1M (F = 11600 mm, D = 1000 mm, focus Coude, alt-azimuthal mounting); laser SL212 (λ = 532 nm, power 100 mG); start-stop system (photomultipliers FEU-136, H6780-20); registration (Riga Event timer A911-E); accurate time (GPS-receiver Motorola UTOncore).

The photometric-polarymetric observations are made on the self made instrument with two 35 cm telescopes placed on the four axes mounting. The computer records the output signal in the real time.

MODERNIZATION OF THE GUIDING MOUNTING FOR OBSERVATIONS OF ARTIFICIAL SATELLITES OF THE EARTH

Ya. Blahodyr[1], K. Martynyuk-Lototsky[1], A. Bilinsky[1], N. Virun[1], Ye. Vovchyk[1], R. Deineka[2]

[1]Astronomical Observatory of Ivan Franko National University of Lviv, Lviv, Ukraine.

[2]National University “Lvivska Politechnika”, Lviv, Ukraine; langure@mail.ru.

Artificial satellites' observations is technically a very difficult task because the satellites, which are on the comparatively close distance to the Earth, move very fast on the celestial sphere. That’s why many different mountings for the satellites guiding were constructed since the moment of launching the first satellite.

All guiding mountings are divided into three types:

- Two axes;
- Three axes;
- Four axes.

Each type has its own merits and demerits and is used for different tasks.

We made an attempt to modernize the four-axial mounting from the instrument LD-2. As long as from the time of making of the mounting to the present moment it has passed a plenty of time, and the electronic part of the mounting has essentially become out of date, we decided to substitute all the electronic part, as well as to produce changes in the mechanical part. At this stage we performed some tests and proving of presented guiding mounting.

ABOUT THE HERITAGE OF THE CRIMEAN ASTROPHYSICAL OBSERVATORY

N.I. Bondar'

Scientific Research Institute "Crimean Astrophysical Observatory", Nauchny, Crimea, Ukraine; bondar@crao.crimea.ua.

Scientific research institute CrAO, the largest astrophysical observatory of Ukraine, well-known in the world, is located in the Crimean mountains on a plateau at the height of 570 m; the radio astronomy laboratory is located on the Southern coast of the Black Sea. The observatory has a modern technical base for research of various astronomical objects; it participates in space projects; the telescope RT-22 and the station «Simeiz-1873" are working in the international network. The observatory has significant objects of the cultural and historical environment at a level of the world heritage. Its scientific activity covers a period in hundred years, therefore, it remains modern, it is interesting to study the historical stages of astrophysics and space research development in the XXth century. The scientific future of the observatory is impossible without preservation of its historical and architectural complex, the astroclimate and local ecology.

INVESTIGATION OF THE EFFECTS OF IONOSPHERIC DISTURBANCES OVER THE EARTHQUAKE PREPARATION ZONES AND THE PHENOMENA PRECEDED TO THE ARRIVAL OF SEISMIC WAVES OCCURRED IN NIKOLAEV IN 2004-2009

F.I. Bushuev[1], N.A. Kalyuzhny[1,2], A.P. Slivinsky[1,2], A V. Shulga[1]

[1]Research Institute "Nikolaev Astronomical Observatory", Nikolaev, Ukraine; bushuev@mao.nikolaev.ua.

[2]Ukrainian Radio Technical Institute, Nikolaev, Ukraine.

Regular monitoring of the LF signals' amplitude of the radio stations DCF-77 (Mainflingen, Germany) and RBU-66 (Moscow, Russia) services of the standard frequency and time is carried out in RI NAO in the past several years. Observations are carried out in order to study ionospheric forecasts of earthquakes in the Vrancea seismic zone in Romania and the North-Western Black Sea. Simultaneously with the observations in the low-frequency diapason of the radio spectrum, regular monitoring of the ionosphere is carried out using data of the permanent GPS station MIKL (the GPS receiver Trimble 4700) operating in the microwave range and installed in NAO. Data of other Eurasian permanent GPS stations is also used owing to free Internet access to them.

The significant anomalies of ionosphere have been repeatedly detected in few days before the earthquakes with magnitude $M \geq 5$ as a result of the joint processing of the data banks. The anomalies revealed themselves in displacements of the terminator time (TT) which was determined by the amplitude of the DCF-77 signal relatively to the average curve of the TT and in abnormal changes of the amplitude of the signals during the daytime and night-time relatively to their average values. It was found out that the ionospheric anomalies observed by the GPS and LF data are correlated with a coefficient equal to 0.7. On the eve of the earthquakes, the occurrence of pulsed radio noise was reaffirmed by a broadband pulse amplifier with a Hertzian antenna. Also the pulsed radio noise within the structure of received LF signals was reaffirmed. Appearances of the acoustic-gravity waves with oscillation periods about 20-30 minutes before earthquakes have been experimentally confirmed in the research results.

Furthermore, the readings of the astronomical vertical pendulum clock of Fedchenko construction (ACF) are used for registration of seismic disturbances and the Earth's free oscillations caused by strong earthquakes. The ACF readings are obtained by comparison to the rubidium frequency standard of the NAO service of time. The scale of time of the system is controlled by 1 pulse-per-second (1 PPS) timing signal of the Trimble’s Resolution-T GPS receiver accurate to 15 nanoseconds.

Few minutes before the arrival of a seismic wave the effect interpreted by us as a "precursor" has been repeatedly observed. This effect is manifested in a significant reduction of the ACF background readings.

COMPARISON OF DIFFERENT DISTANCE FUNCTIONS FOR SIMILARITY OF ORBITS

Yu.V. Cherkas

Kharkov National University of Radio and Electronics, Kharkov, Ukraine; Jura_Cherkas@meta.ua.

The purpose of research of meteor complex and its connection with asteroids and comets causes a necessity to compare similarity of orbits of separate small bodies of the Solar system. Researchers offer about ten distance functions between the orbits of small bodies. Each of them has own pluses and minuses, which show the problem tied with it. The very first is a distance function called *D*-criterion of Southworth & Hawkins (1963), it is the most frequent criterion used in literature. They made an analogy with a five-dimensional orthogonal coordinate system and considered each orbital heliocentric element as a coordinate. In this space, an orbit of small body is represented as a point, and the distance between two points is a measure of the degree of similarity between two meteoroid orbits. Many researchers criticize this criterion. Anyway, it is still used. Few modifications of this distance function has been proposes [Drummond (1981), Jopek (1993)]. The Fig. 1 shows a correlation of estimations of *D*-criterion (Southworth & Hawkins) and *Dr*-criterion (Drummond), got at search of connections between the individual orbits of meteoroids and orbits of asteroids. So as we can see from the figure,

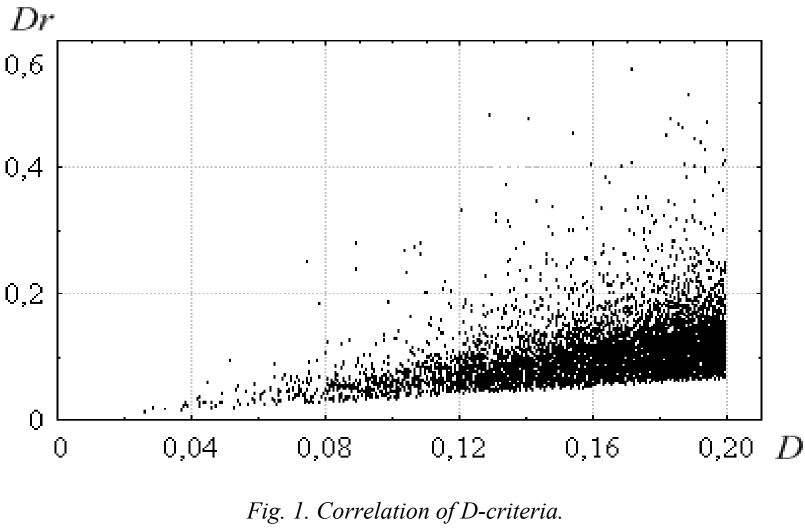

Fig. 1. Correlation of D-criteria.

sometimes they can give very different values of distance for the same pair of orbits.

The most recent *D*-criterion is that introduced by Valsecchi, Jopek & Froeschle (1999). This function is the most transparently based on the physical difference between orbits. It is based on geocentric parameters, which are near-invariants for those orbits for which it is possible to find own elements. The same calculation as shown in the figure has been made for other distance functions. A conclusion, which can be made out of comparison of the criteria is that one type of orbits is better divided by one criterion, while another – by another. And sometimes it is necessary to use several criteria to be more sure that orbits of considered objects are connected.

MASSES OF ASTEROIDS 10 HYGIEA AND 152 ATALA

Yu.A. Chernetenko[1], A.V. Ivantsov[2]

[1] *Institute of Applied Astronomy of RAS, St. Petersburg, Russia; cya@ipa.nw.ru.*

[2] *Research Institute "Nikolaev Astronomical Observatory", Nikolaev, Ukraine.*

Masses of asteroids 10 Hygiea and 152 Atala were determined using observations of perturbed asteroids (PA) since 1900. PA were considered as test particles. Calculations were fulfilled using two independent programs however models of motion and the observations were the same. PA were selected in accordance with the errors of the mass values of perturbing asteroids. Gravitational perturbations from all of major planets and Pluto were taken into account in the equations of motion of the asteroids. The coordinates of the perturbing bodies were calculated using DE405 ephemeris. The relativistic perturbations from the Sun and perturbations from Ceres, Pallas and Vesta or from 307 asteroids were also included into the model of motion. The erroneous observations were excluded in accordance with the criterion 3 σ and application of the robust regression. The final mass values were obtained in common solutions using observations of all selected PA for each perturbing asteroids. The LMS was used to fit conditional equations. Two variants were considered: all observations were supposed 1) to have equal weights and 2) weight $1/\sqrt{2}$ was fixed for observations before 1950.

Our results show the appreciable contribution of the different sets of perturbing bodies on the mass values of 10 Hygiea when perturbed asteroids 20, 111, 1287, 1965, 13266 were used. The estimations of contribution of Yarkovsky effect into the mass values of 10 Hygiea and 152 Atala were obtained for some PA. One should note in some cases strong correlation between corrections to mass values and values of acceleration due to Yarkovsky effect.

The mass of 10 Hygiea is equal to $(4.07 \pm 0.10) \times 10^{-11}$ M_{Sun}, mean density is equal to 2.0 g cm^{-3}. Observations of PA 20, 3946, 6143, 11215, 15187, 24433, 48499, 113976 were used for this solution.

For asteroid 152 Atala, the mass value $(1.00 \pm 0.26) \times 10^{-11}$ M_{Sun} was obtained using observations of PA 250, 264, 651. Taking into account its diameter (287 km), the mean density is equal to 2.8 g cm^{-3}.

APPLICATION OF THE EMCCD CAMERAS FOR OBSERVATION OF AURORA AND NIGHTGLOW IN ARCTIC RESEARCH

S.A. Chernous

Polar Geophysical Institute of Kola Science Centre of RAS,
Apatity, Murmansk region, Russia.

The optical instruments based on the EM CCD cameras for optical observations of aurora and nightglow are under discussion. This kind of measurements is widely used in the Polar Geophysical Institute (Russia); Institute of Space Physics and Royal Technological Institute (Sweden); Oulu University and Finnish Meteorological Institute (Finland); HAARP, Geophysical Institute University of Alaska and others in the USA. The main part of the report is a description of equipment and methods used in the Polar Geophysical Institute (PGI) at Kola Peninsula and Barentsburg (Spitsbergen). PGI uses EM CCD cameras of the Princeton Instruments.

PhotonMAX EMCCD camera is designed to be a no-compromise EMCCD camera for ultra low-light level imaging applications. This camera utilizes a 512 × 512-pixel, back-illuminated EMCCD with >90% quantum efficiency and < 1 e^{-} rms read noise, achieving this high-QE, low-noise performance at faster-than-video frame rates. This groundbreaking technology comes equipped with a durable vacuum guaranteed for the lifetime of the camera. There were constructed several devices for field measurements using this camera.

The **All-sky image camera** permits to register temporal and spatial auroral variations in the dynamic range 16 Mb with time resolution from 0.01 to 1 second in dependence on intensity of different auroral forms in a full spectral range of the EM CCD spectral response.

The **Camera for observing of ionospheric heating** by a power ground-based transmitter**.** Optical signature of the ionospheric heating should be seen in the red atomic oxygen emission. This device is based on coupling of a Fabry-Perrot Interferometer (FPI) and PhotonMax camera as an Image Sensor. FPI works as a narrow-band filter at λ = 30 nm with HPBW=0.018 nm. FPI field of view is about 28°. The virtues of EMCCD camera used in our FPI allow to sample nightglow images quite fast - every 10 seconds with a reasonable quality. Some results of the heating experiment along with optical effects at Spitsbergen are presented. The results presented clearly demonstrate that if we use the Fabry-Perrot interferometer equipped with the EMCCD camera, the weak optical effects of ionosphere heating can be detected and even evaluated. Our estimate gives that the optical effect of ionosphere heating in 630.0 emission is about 20-30 times less than the intensity of nightglow in average.

The **Camera for observing auroral form during twilight** is based on the previous idea of coupling FPI as a narrow band filter with the PhotonMax camera. In this case we use all-sky front lens and one of the main auroral emission λ = 557.7 nm. The narrow band filter permits to cut off scattering solar radiation at small negative solar elevation angles. The telecentric lens installed after all-sky lens provides a possibility to form a near parallel ray bundle through FPI. A movie of twilight aurora observation is demonstrated. The result opens a possibility to observe aurora during the day light conditions.

The **Near Infra-Red Spectrograph** S180 NIR works in spectral range 730-890 nm with a field of view along slit about 180° and cross slit 0.5°. The angle resolution (along slit) is about 0.6° and spectral resolution is about 0.6 nm.

Using of the PhotonMax camera as a sensor gives us a possibility to reach sensitivity about 100 R at λ = 844 nm. This device works in a patrol way with speed 4 frame/min. First observations of the OH and molecular oxygen emissions by the S190 NIR are shown.

Comparison of the PGI instruments with modern foreign optical instruments, as ASK, HAARP, IRF and others based on the EM CCD is under consideration.

PRIORITY OF ASTRONOMER JOSEF SYKORA IN OBTAINING OF WELL-DOCUMENTED PHOTOGRAPHIC IMAGES AND SPECTRA OF THE AURORA IN ARCTIC DURING SPITSBERGEN EXPEDITION IN 1899-1900

S.A. Chernous, O.V. Shabalina

Polar Geophysical Institute of Kola Science Centre of RAS, Apatity, Murmansk region, Russia.

Barents Centre of the Humanities of Kola Science Centre of RAS Apatity, Murmansk region, Russia.

This report presents data and analysis of visual, photographic and spectral auroral data, obtained by Pulkovo astronomer J. Sykora from the Russian-Swedish expedition to Spitsbergen in 1899-1900 winter season and concerns of auroral studies history. This data was reported by him partially in the Memories of Russian Imperial Academy of Sciences. The expedition was based at Hornsund of the Western part of Spitsbergen Archipelago, in a settlement Konstantinovka (76.8 N, 15.4 E). There were obtained first world photos of Aurora in the Arctic sea and undoubtedly the first ones in the geomagnetic latitudes of Spitsbergen Archipelago. The results of the expedition are discussed from the modern point of view and compared with our knowledge of XXI century. Description of the equipment and methods that have been used by Russian astronomers are presented. There were used both photographic and spectral devices with registration by photographic plates and special methods of their development and enhancement. Auroral images and spectra were obtained by photo-camera equipped by Planar-Zeiss lens with F=110 mm and D/F = 1/3.6. The camera could be mechanically rotated both in zenith and azimuth angles to view aurora in different positions. There were obtained about 70 negatives of aurora during October 1899 – February 1900. Optical spectroscopy of Aurora was based on a spectrograph coupled with the camera. The spectrograph has used two prisms in visible region of spectrum and a slit about 0.3 mm. Spectral resolution deviation could be estimated as about 1 nm on the basis of spectral lines positions calculated using special spectral calibration lamp sources. There were obtained 5 negatives of auroral spectrum with exposure from 4 to 28 hours. Some statistical analysis was done on the basis of the expedition reports and diaries. This analysis shows that by means of Sykora data, it was possible to recognize features of the

auroral oval or instant position of aurora distribution over the polar region. Analysis of the photographic samples and instant sketches of aurora demonstrated typical auroral forms outlines as they are described in modern time. Spectral plates were exposed during several hours under auroral lights. It permits to reveal not only the main auroral emissions well-known in that time, but several other unidentified weak emissions in the near UV range, which were rediscovered and interpreted later. The authors thank the *Russian Foundation* for *Humanities,* grant *09-01-43101a/C* for the support of this study.

TWO NEW TELESCOPES AT TUBITAK NATIONAL OBSERVATORY FOR GAIA FOLLOW UP

Z. Eker

TUBITAK National Observatory, Akdeniz University Campus, Antalya, Turkey.

Akdeniz University, Faculty of Sciences and Literature, Physics Department, Antalya, Turkey.

In addition to the Russian-Turkish telescope RTT150 and 40 cm Meade LX200GPS, TUBITAK National Observatory Bakirlitepe Complex gained two new telescopes; one with a focal ratio f/10 and 60 cm diameter main mirror, is named T60 and the another with the same focal ratio (f/10) of 100 cm main mirror is named T100. Both telescopes have recently been installed on the site and now started to do scientific observations. Especially T100 of the Ritchey-Chretien type with a relatively large (21.5′ x 21.5′) field of view (FOV) will be dedicated to the observations of NEO (Near Earth Objects) within the GAIA follow up program with a reasonable fraction of its schedule (10-20%) for observing. Infrastructure, and new telescope facilities of TUBITAK National Observatory will be presented.

THE XPM CATALOGUE AS A REALISATION OF THE EXTRAGALACTIC REFERENCE SYSTEM IN OPTICAL AND NEAR INFRARED RANGE

P.N. Fedorov, V.S. Akhmetov

Institute of Astronomy of Kharkiv National University, Kharkiv, Ukraine; pnf@astron.kharkov.ua.

We present a final version of the XPM catalogue. The XPM catalogue contains approximately 300 million objects covering the whole sky in the magnitude range $10^m < B < 22^m$. Their positions and absolute proper motions are presented, as well as the standard J, H, K, B and R magnitudes taken from 2MASS and USNO-A2.0. It should be emphasized that the XPM catalogue is obtained using the data of two ground-based catalogues - 2MASS and USNO-A2.0, and contains *absolute* proper motions. Positions in XPM are given in the International Celestial Reference System (ICRS), since the stars from the 2MASS catalogue are given in this system. Unlike the previous version, the XPM contains the proper motions over the whole sky without gaps. In the fields that cover the zone of avoidance or contain less than of 25 galaxies a quasi absolute calibration was performed. The proper motion errors are varying from 3 to 10 mas/yr, depending on a specific field. The zero-point of the absolute proper motion frame (the absolute calibration) was specified with more than 1 million galaxies from 2MASS and USNO-A2.0. The mean formal error of absolute calibration is less than 1 mas/yr.

We present also some investigations of the absolute proper motions of XPM-1.0 catalogue and important information for the users of the catalogue.

TV METEORS' ANGULAR VELOCITY AND RADIANT COORDINATES DETERMINATION USING STANYUKOVICH METHOD

Yu.M. Gorbanev

Astronomical Observatory of Odessa National University named after I.I. Mechnikov, Ukraine; skydust@rambler.ru.

We present a method of TV meteors reduction and the results of determination of angular lengths, angular velocities and equatorial coordinates using the long-term patrol observations that were carried out in Odessa Astronomical Observatory.

TV images with a time resolution of 20 ms were photometrically reduced. The slit profiles of the meteor images were calculated, then using the method of reciprocal correlation (cross correlation) for such profiles, the angular length and angular velocity of meteor were determined. The accuracy of the angular length determination for the images obtained with Schmidt telescope (equivalent focal length is 50 cm) is about 2-3 arcsec. Coordinates of the beginning and the end of each meteor frames were calculated together with angular length and angular velocity. This data is used for determination of the equatorial coordinates of individual radiants using the Stanyukovich method. The single condition of this method application is a fixation of three and more strokes of the meteor image.

We present the results of the observational material reduction obtained at Kryzhanovka station in 2003-2009 and annual expedition to Zmeiny Island.

We analyze and interpret calculated radiant coordinates and estimate perspectives of the weak meteor streams monitoring at the long time intervals.

OBSERVATIONS OF ASTEROIDS WITH GAIA AND BEYOND

D. Hestroffer, W. Thuillot

IMCCE, Paris Observatory, Paris, France;
hestroffer@imcce.fr, thuillot@imcce.fr.

Gaia is an astrometric mission from the European Space Agency (ESA) that will be launched in Spring 2012. The Gaia telescope and spectrometer will operate in the visible wavelength scanning the whole sky during 5 years (nominal mission duration). It will observe about one billion stars and QSOs, but also a large number of solar system bodies, mainly asteroids, and few comets and planetary satellites. The unprecedented accuracy of the measures both astrometric and photometric (note that the spectroscopic observations are of a little scientific value for the Solar System objects science) will enable to significantly improve the knowledge of the dynamics and physical properties for a large number of asteroids. With a relatively limiting magnitude somewhat reduced to V≤20 (compared to other future or ongoing surveys) Gaia will mainly observe main-belt asteroids (MBAs), and very few TNOs or Centaurs.

The Gaia telescope will also be able to observe several thousands of Near-Earth Objects (NEOs) down to low solar elongation (observation of solar system objects are performed with elongation $45° \leq L \leq 135°$). Gaia will not be a "big" NEO discover, however it can possibly discover inner-Earth orbiting objects (IEOs) or sub-Atens, using atmosphereless low solar-elongation observations. In the case of discovering a new NEO target, the ground–based observations in network could be needed to avoid confusion in identifying the object in the database, or loss of the target. We are aiming to generate a VO-alert for such eventuality. The ground-based observations of NEOs would also more generally enter into the operational centre in construction at the IMCCE that will deal with data mining, astrometric reduction, orbit computation, alerts, etc. On the other hand, in the framework of ESA Space Situational Awareness (SSA), ground-based astrometry, possibly complemented by Gaia data, is needed to refine the orbits and collision assessment of PHAs [Bancelin, this conference].

High accuracy astrometric and colour-photometry observations of NEOs will provide information on their taxonomy, spin state and shape, and detailed information of their orbits. Small effects acting on their dynamics can then be measured; these include link of reference frame (kinematically non rotating and dynamically non rotating one), local tests of the General Relativity and measure of the solar quadrupole J_2 basically from the drift of the perihelion, test of the variation of the constant of gravity dG/dt, and detection of non gravitational effect such as the thermal Yarkovsky effect and cometary activity. Dedicated ground-based observations can be used on specific targets to complement the limited wavelength, time resolution and imaging capabilities of the Gaia telescope.

FROM AN EXPERIMENT IN 1925 TO THE HIPPARCOS AND GAIA SPACE MISSIONS

E. Høg

Niels Bohr Institute, Copenhagen University, Denmark; erik.hoeg@get2net.dk.

A teenager, Bengt Strömgren, made an astrometric experiment in 1925 which had wide-reaching consequences. The direct connection from Strömgren's photoelectric recording of stellar transits on the old meridian circle in Copenhagen to the Hipparcos and Gaia space missions is presented in the lecture. Peter Naur was astronomer and later became the first professor of computer sciences in Denmark, but during 1953-58 I was his astronomy student and collaborator and I was very interested in techniques. Working in the Hamburg Observatory 1958-73 I invented and developed a semi-automatic meridian circle for an expedition to Perth in Western Australia and a GIER computer of Danish design went with it. Pierre Lacroute worked on ideas about space astrometry since 1965 which led ESA to begin a study in 1975. I joined the study group and the same year I made a new design of an astrometric space mission which developed into the Hipparcos mission. In 1973 I found Lennart Lindegren as a young student in Lund and from 1976 he was the key person in the Hipparcos data reduction.

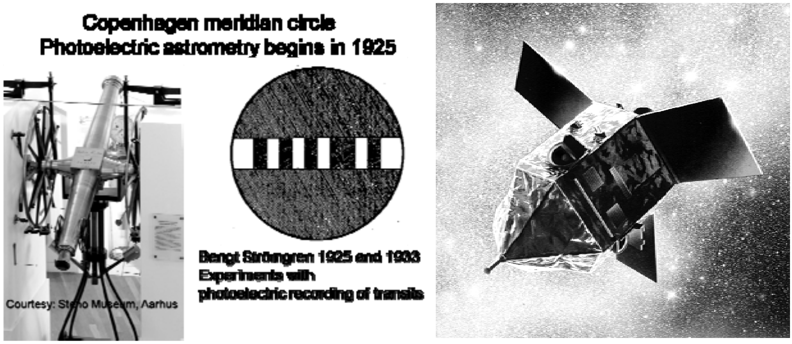

Fig. 1. From the experiment in 1925 to the Hipparcos launch in 1989.

This development must be seen on the astronomical background of the past century. Astrophysics flourished, but this brought astrometry almost to extinction because it was considered to be dull and old-fashioned, especially by young astronomers. Astrometry is the distinguished old branch of astronomy, in fact 2000 years of age, which performs accurate measurements of positions, motions and distances of stars and other celestial bodies, and astrometric data are of great scientific and practical importance for investigation of celestial phenomena and also for control of telescopes and satellites and for monitoring of Earth rotation.

400 YEARS OF ASTROMETRY: FROM TYCHO BRAHE TO HIPPARCOS

E. Høg

Niels Bohr Institute, Copenhagen University, Denmark; erik.hoeg@get2net.dk.

Galileo Galilei's use of the newly invented telescope for astronomical observation resulted immediately in epochal discoveries about the physical nature of celestial bodies, but the advantage for astrometry came much later. The quadrant and sextant were pre-telescopic instruments for measurement of large angles between stars, improved by Tycho Brahe in the years 1570-1590. Fitted with telescopic sights after 1660, such instruments were quite successful, especially in the hands of John Flamsteed. The meridian circle was a new type of astrometric instrument, already invented and used by Ole Rømer in about 1705, but it took a hundred years before it could fully take over. The centuries-long evolution of techniques is reviewed, including the use of photoelectric astrometry and space technology in the first astrometry satellite, Hipparcos, launched by ESA in 1989. Hipparcos

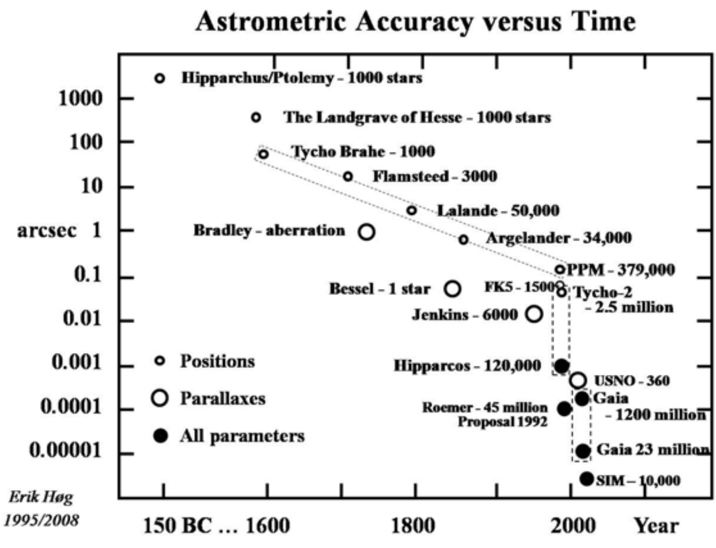

Fig. 1. Astrometric accuracy during the past 2000 years. The accuracy was greatly improved shortly before 1600 by Tycho Brahe. The following 400 years brought even larger but much more gradual improvement before space techniques with the Hipparcos satellite started a new era of astrometry.

made accurate measurement of large angles a million times more efficiently than could be done in about 1950 from the ground, and it will soon be followed by Gaia which is expected to be another one million times more efficient for optical astrometry.

ASTROMETRY AND PHOTOMETRY OF ASTEROIDS AT THE RTT150 TELESCOPE

A.V. Ivantsov[1], R.I. Gumerov[2], Z. Aslan[3], A. Galeev[2], W. Thuillot[4], G.I. Pinigin[1], D. Hestroffer[4], L.A. Hudkova[1], I.M. Khamitov[5], S. Mouret[6]

[1]Research Institute "Nikolaev Astronomical Observatory", Nikolaev, Ukraine; anatoly@mao.nikolaev.ua.

[2]Kazan State University, Kazan, Russia.

[3]Istanbul Kültür University, Istanbul, Turkey.

[4]Institut de Mécanique Céleste et de Calcul des Éphémérides, France.

[5]TÜBITAK National Observatory, Antalya, Turkey.

[6]Lohrmann Observatorium, Technische Universität Dresden, Dresden, Germany.

The space astrometric mission Gaia, a cornerstone of the European Space Agency, will be launched in the beginning of 2012 with the objective to make a 3D precise map of our Galaxy, http:// www.esa.int/science/gaia. Besides stars, the Gaia will observe asteroids with unprecedented precision from 0.5 to 3 mas, allowing the extremely fine orbit determinations. This precision has principal significance for the determination of small effects influencing the dynamics (relativistic, gravitational, non-gravitational, etc.) of Solar system bodies. The determination of masses of 150 asteroids is expected in 5 years of Gaia operation through the analysis of mutual perturbations between asteroids.

Considering the time length of the Gaia mission, there will be encounters between some asteroids occurring either at the beginning or the end of the mission, so the maximum of deflection angle pertained to the perturbation maximum will not be observed. The precision of mass determinations based solely on the Gaia observations will deteriorate in such cases.

The observational programme of Institut de Mécanique Céleste et de Calcul des Ephémérides (IMCCE, Paris) for astrometry of asteroids consists of the list of perturbed asteroids which positions are of a great value for being used in Gaia analysis, so these observations may be considered good for initial “unperturbed” orbit evaluation. Few asteroids of the dedicated list are regularly observed at the RTT150 within the framework of international cooperation between our institutions since 2006, e.g. in 2008, there have been observed 21 main belt asteroids which will be perturbed greatly by 11 different asteroids (not considering Ceres, Pallas, Vesta in this number) at about 2011-2012, the time of Gaia launch.

For the current analysis, we have chosen the series of 5 and more observations, made in 2006-2008. There are 2081 positions of 38 asteroids. The positions of asteroids (astrometric topocentric) were

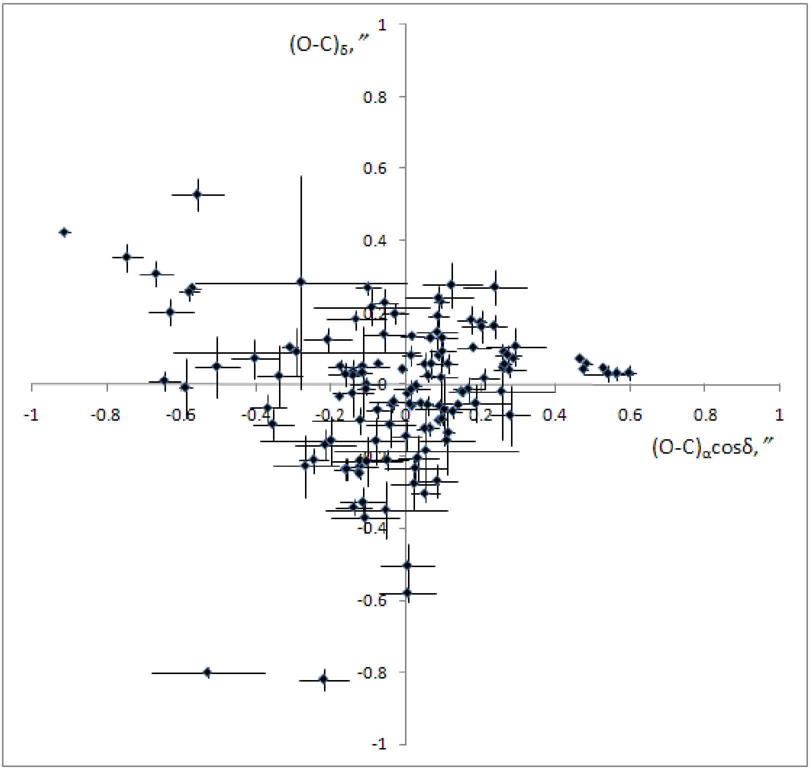

Fig. 1. (O–C) in right ascension and declination.

determined with the UCAC2 catalogue using Astrometrica software. The weighted standard error of a single measurement in right ascension is 0.15″ and 0.11″ in declination. The standard error was calculated as a standard deviation of a single position from the mean one in the series of observation images in one night, so it shouldn't depend upon the chosen reference catalogue. There is no sure positive evidence on the error dependence from asteroid magnitude, that is a good sign of observation homogeneity. This fact can be explained by the small values of visible speed of main belt asteroids. *(O–C)* for the subsequent analysis were calculated using ephemerides of the HORIZONS service, http://ssd.jpl.nasa.gov/?horizons. These values with their standard errors are given in Fig. 1. Considering standard errors of the *(O–C)*, one can make conclusion that the positions are useful for the improvement of present day orbital elements of observed asteroids.

The light curve of one of the observed NEAs (35107) 1991 VH belonging to Apollo group is given below, Fig. 2. Photometrical data consists of 550 points in R Cousins band representing observations from March 1 till July 5, 2008. The observations were made before an encounter with the Earth at 0.0457 a.u., which has occurred on August 15, 2008. The light curves show changes of brightness 1991 VH

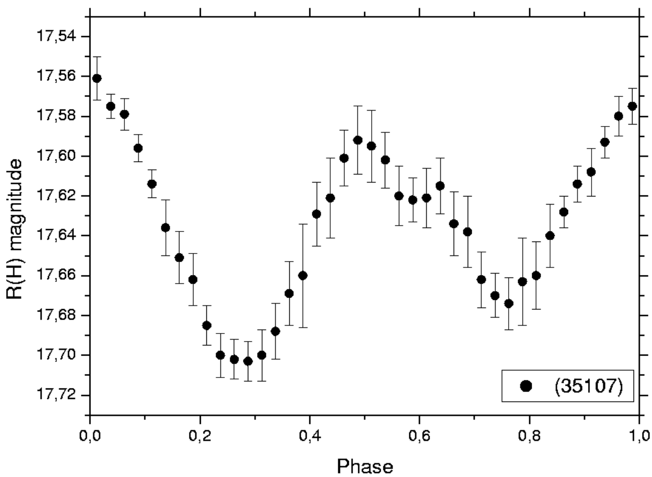

Fig. 2. Light curve of (35107) 1991 VH asteroid.

with the period of variability about 0.1 days and amplitude of 0.15 mag. Changes of the form of a curve of light curve in different nights of the observations are found out also. Light curves has shown the rotational changes and transition events from a satellite of the asteroid. Also processing of photometric data of few asteroids (15518, 5564, 6006) is made.

PROGRAMS OF OBSERVING SMALL CELESTIAL BODIES IN THE SOLAR SYSTEM BY SMALL TELESCOPES IN CHINA

W. Jin[1], Q. Peng[2], Zh. Tang[1], H. Zhao[3]

[1]Shanghai Astronomical Observatory, Shanghai, China; jwj@shao.ac.cn.
[2]Department of Computer Science, Guangzhou, Jinan University, China.
[3]Purple Mountain Observatory, Nanjing, China.

Several observing programs, including astrometric observations of the natural planetary satellites, astrometric and photometric observations of NEOs using small telescopes in China are reviewed. The observations of satellites with laser ranging system and GPS are briefly described. The important scientific results obtained from these observations are given. The research programs, including orbital determinations for binary and satellites, construction of planets/lunar ephemeris are introduced. The other projects including establishment of astrometric calibration regions, linkage between optical and radio reference frames through observations of the optical counterparts of radio sources and determinations of the precise proper motions of membership of star cluster are briefly described. A new program proposed by SHAO and Torino Astronomical Observatory, Italy, on the improvements for GSC2.3 such as eliminating systematic errors, (e.g. magnitude-dependent errors, spatial dependent errors, systematic proper motion error in the Southern hemisphere), and accidental errors, adding new observations as data at third epoch for POSS and SERC projects as well as deriving absolute proper motions referred extragalactic galaxies is presented.

A CONVEX INVERSION APPLICATION FOR 201 PENELOPE'S PHOTOMETRIC OBSERVATION DATA OBTAINED FROM CARC & UPO, TUG AND LITERATURE

A. Kabas, O. Demircan

Canakkale Onsekiz Mart University Astrophysics Research Center and Ulupinar Observatory, Canakkale, Turkey; akabas@comu.edu.tr.

Knowledge of shapes, spin states and orbits of asteroids are important to study their collisional history, the early evolution of the Solar system and to calculate the accurate orbits.

There are few different types of techniques to derive information about the shapes and the spin states. The most common observing technique for this purpose is photometry with ground–based optical telescopes, because usually it isn't required a large financial or technical support for this.

The bright and fast rotator main-belt asteroid 201 Penelope was observed photometrically for the first sample application since it has a convenient observability.

Actually, this asteroid has a shape and a spin state model presented in literature; however, since it's always needed for large photometric data spanned over a period of time which is derived from a sufficiently wide range of observing geometries, we had to take into account our limited photometric data together with those in literature to obtain these parameters.

The observations for 201 Penelope were carried out between the years 2006 – 2008 at Canakkale Onsekiz Mart University Astrophysics Research Center & Ulupinar Observatory (CARC & UPO) and TUBITAK National Observatory of Turkey (TUG).

The convex inversion method described in Kaasalainen & Torppa (2001) and Kaasalainen et al. (2001) was performed on these obtained light curves along with the light curves in literature for redetermining the photometric convex hull and spin state of 201 Penelope using the code developed by Kaasalainen & Durech and MPO LCInvert provided by Warner, a Windows-based program which is based on the original code. The consistent solutions were found with those in literature and model curves were fitted to obtained observational light curves by means of the convex inversion method.

THE FIRST RESUTS OF ASTROMETRY AND PHOTOMETRY PLATES FROM KYIV UNIVERSITY OBSERVATORY PHOTOGRAPH COLLECTION, DIGITIZED BY THE SCANER MICROTEK SCANMAKER 9800XL TMA

L.V. Kazantseva[1], V.M. Andruk[2], L.K. Pakuliak[2], A.I. Yatsenko[2]

[1]Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine; likaz@observ.univ.kiev.ua.

[2]Main Astronomical Observatory of NAS of Ukraine, Kyiv, Ukraine; andruk@mao.kiev.ua, pakuliak@mao.kiev.ua, yatsenko@mao.kiev.ua.

Cataloguing and digitizing a collection of photographic plates of Astronomical Observatory of Kiev University is carrying out. The detailed description of 20 thousands negatives of the period 1898-1996 received under various observational programs using several tens of instruments of the observatory and in expeditions is systematized and has begun.

For estimation of astrometric and photometric quality of the digitized images, the plates received with the Merc-Repsold astrograph (D=0.2 m, F=4.28 m) under the program PIRS (star fields with radio sources) have been researched. Scanning and processing scans were made using a technique and software, developed in MAO. For matching the area of the sky with the infra-red one, the double radio source ICRS 1807+698 has been selected. The photometric stars have been researched by the authors earlier. The plates with the image of Pleiades received on the same instrument are used as photometric standards.

After several stages of processing, the results have shown enough excellence of a photographic material.

ASTRONOMICAL HERITAGE OF UKRAINE IN WORLD TIME SPACE

L.V. Kazantseva

Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine; likaz@observ.univ.kiev.ua.

The International Year of Astronomy has allowed an occasion to comprehend a position of Ukraine not only from the point of view of equipment of our observatories new devices, our researches in different astronomical directions, but, also in a question of preservation of our astronomical heritage. There was no attempt of the description of material monuments of the history of development of astronomy in Ukraine before. It allows to popularize these objects, their histories; the current state and degree of preservation demand discussion. Possibilities of studying and popularization of this heritage are considered. In 2008 the observatory was included to the Tentative list of UNESCO under №5267, named "Astronomical Observatories of Ukraine".

Thus it is necessary to make use of the long-term world experience actively. Hundreds museums of the world have astronomical collections and are proud of them, including the interactive ones. More than hundred years visiting of observatories is included necessarily into the international tourist routes. Old telescopes, sundials, places of falling of meteorites are protected and esteemed.

LUNAR OCCULTATIONS OF STARS AS ONE OF METHODS OF KINEMATICS OF MULTIPLE STARS

L.V. Kazantseva

Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine; likaz@observ.univ.kiev.ua.

One of the most ancient methods of observations is still used since the time of Ptolemey and in some questions it remains actual. Several thousands of double stars discovered by this way, hundreds of orbital elements of binaries, measurements of distances between close double stars have become accessible simple enough by the inexpensive means. Processing of observations of the Kyiv network of observations of occultations gives the new data.

IS TUG READY ON GAIA FOLLOW UP?

I. Khamitov

[5]*TÜBITAK National Observatory, Antalya, Turkey.*

Scheduled launch date of GAIA mission is 2012. TUG is one of the observatories of the ground-based network of GAIA follow up. Not to lose newly discovered near-Earth objects by GAIA, they must be observed immediately in the alert-mode. For better characterization of new objects, the astrometric and photometric observations on long-time scale must be performed as well. This "fast responded" observations constrains defined requirements on an observatory of the ground-based follow-up network. In the report the focal plane instruments, image and data processing software and man-power of TUG observatory to successfully carry out the given problem is discussed.

PROJECT OF IR REFERENCE CATALOGUE COMPILATION ON THE BASE OF IR/OPTICAL CROSS-IDENTIFICATIONS

A.S. Kharin, L.K. Pakuliak

Main Astronomical Observatory of NAS of Ukraine, Kyiv, Ukraine; kharin@mao.kiev.ua.

ICRS, represented by ICRF in radio diapason and by HIPPARCOS, transferred into ICRF system in optical diapason has to be expanded to other diapasons of electromagnetic spectrum. The methods and tools of its expansion to IR range are discussed.

In particular the problem can be solved by a composing of IR reference catalogue from available IR catalogues, obtained by the identification of IR sources of all-sky surveys (2MASS, DENNIS, etc.) with their optical counterparts in modern astrometric ones with ICRS as reference system. The demands to the reference catalogue of this type and to its accuracy in particular are discussed.

MAO NAS of Ukraine has initiated IR reference catalogue compilation. As the first step the project of construction of a database of available IR sources on the cluster resources of MAO NASU is considered.

SELECTOR OF LONGITUDINAL MODES FOR FORMATION OF SPACE POLARIZATION MODULATION LASER SIGNALS

A.V. Kolomiytsev

Science Research Department of Kozhedub Air Forces Science Center, Kharkiv, Ukraine; ckkp@spacecenter.gov.ua.

Analysis of space evolution tendencies allows to draw a conclusion about multiple increase in a number of space objects in the near-Earth space. In such circumstances, safety information concerning spacecraft operation becomes more and more important. This data includes the number, origin, size and mass of non-collisional space objects. Search and identification of such objects are rather difficult. It is desired to use all existing sources and devices of non-coordinate information on space objects, in particular laser equipped optic-electronic devices.

If parameters of the sounding signal with a complex space-time structure are known, then this information must be used for research of images and their processing for space objects. Application of laser signals with space polarization modulation for vector image formation will enable to select and to identify space objects. So, the longitudinal modes selector is proposed for the synthesis of the transmitted part of the information and measurement system with a modified frequency-time measurement method. It will provide:

- Extraction the signals in the form of four pairs of carrier frequencies ν_5, ν_4; ν_9, ν_7; ν_6, ν_3; ν_8, ν_2 from the synchronized one-mode multi-frequency laser emission spectrum;
- Establishing a multi-channel data communication with a spacecraft using signals at the carrier frequencies $\nu_1, \dots \nu_n$;
- Laser signals with space polarization modulation for making spacecraft image and its processing;
- - Creation of the equal-signal direction using a general direction diagram of laser emission due to the partially crossing direction diagrams: $\Delta\nu_{54}=\nu_5-\nu_4=\Delta\nu_М$, $\Delta\nu_{97}=\nu_9-\nu_7=2\,\Delta\nu_М$, $\Delta\nu_{63}=\nu_6-\nu_3=3\,\Delta\nu_М$, $\Delta\nu_{82}=\nu_8-\nu_2=6\,\Delta\nu_М$;

Creation of the transmitted part of information-measurement system with a modified frequency-time measurements.

Using the longitudinal modes selector a laser signal with space polarization modulation is formed by splitting laser emission of carrier frequency in two rays with the 90˚- polarization plane in one of them. In this case apertures of the first and second channels are distantly separated.

When the space polarization modulation laser signal is reflected from a spacecraft surface, amplitude and phase ratios between orthogonally polarized components, the complex coherence coefficients of the reflected field are changing. The space distribution of the polarization characteristics of a reflected signal has information on the contrast variation of the modulation image, types of spacecraft surface materials, their features, etc.

SEARCH OF NEW ASTEROIDS AND TNO'S USING OBSERVATIONS OF THE SHORT PERIOD OF TIME

A.A. Koltsov, A.V. Ivantsov

Research Institute "Nikolaev Astronomical Observatory",
Mykolaiv, Ukraine; alexkoltsov@mao.nikolaev.ua.

Search of new asteroids and TNO's can be executed from comparison either direct CCD images got in a short interval of time (matching, and then making differences for each pixel) or objects lists containing measured coordinates. The last method as compared to the first one assumes simple automation of search of new objects, and also classification of objects using a reference catalogue.

At short exposures (less than 10 seconds), typical for the modern CCD-observations, the track from a moving asteroid or TNO can be insignificant, and the object looks star-shaped. For the interval of time in one minute between observations, asteroids of the main belt are displaced for 0.2÷1.3″, and TNO's less than 0.015″ in equatorial coordinates. These values can be used as three times bounds for standard errors of measurements and also for the initial identification.

Objects, not present on other images, are chosen for the later analysis. The essence of an algorithm consists in comparison of the measured coordinates of all objects using various ε-distances. The found dependence can be used for identifying both stars and new objects. The problems of search using this algorithm are also discussed.

O.ORLOV AND HISTORY OF PIP IVAN OBSERVATORY (TO THE 130TH ANNIVERSARY OF O.ORLOV)

A. Korsun'

Main Astronomical Observatory of NAS Ukraine; akorsun@mao.kiev.ua.

The paper gives information on the history of Pip Ivan Observatory in Czornohora (mount 2022 m, Carpathian mountings), which was designed and built by Polish constructors in 1936-1938.

In the end of 1939 academic O.Ya.Orlov visited the mount Pip Ivan and in 1940 he was the head of the Observatory. The dramatic history of Pip Ivan Observatory after the Second World War and its contemporary state are described.

ABOUT REALIZATION AND JOINT REDUCTION OF ASTROMETRIC NET OBSERVATIONS OF LEO IN UKRAINE

N. Koshkin, L. Shakun, V. Dragomiretsky, E. Korobeinikova

Astronomical Observatory of Odessa National University named after I.I. Mechnikov, Ukraine; nikkoshkin@yahoo.com.

In this paper we report results of our research of perturbed motion of low-Earth orbit satellites (LEO).

Astrometric observations for a general list of LEO have been taken for the period of September 2000 − November 2000. Few observatories of the Ukrainian network of optical observations of the near-Earth bodies took part in campaign (Nikolaev, Odessa, Lvov and Uzhgorod).

Using 0.5 m KT-50 telescope, we observed LEO in the classic mode of tracking of fast moving objects. In other observatories the observations and measurements were carried out in “immobile telescope” mode. It is supposed to obtain the evaluation of errors of measurements.

The obtained measurements together with SGP4 model were used to derive elements of orbit in the TLE format. We obtain a set of rejections by combining our results with data from other observatories. The results of separate and joint reduction of measurements are presented. Our analysis of this data has revealed also a contribution of SGP4 propagation model in the forecast of satellite motion. The obtained knowledge can be used for optimization of the system of space situation monitoring.

EFFECT OF INFLUENCE OF MOON DISTURBING FORCE ON THE PERIOD OF OWN ROTATION OF “MIDAS” SATELLITES

V.I. Kudak

Laboratory of Space Research, Uzhgorod National University, Uzhgorod, Ukraine; lkd.uzhgorod@gmail.com.

There are many forces of different nature acting on a satellite in space; they cause changes in a motion of the object in orbit and rotation around its own axis. In this article Moon disturbing moments acting on the “MIDAS” satellites are computed. Having wide array of coordinate and photometric data on objects of this series, and knowing the shape and physical size of satellites, it is shown as changes in these moments affect the value of own satellite's rotation. The periods of own rotation of the objects are calculated using the light curves of more than 35 years.

ASTROMETRY OF DYNAMICALLY NEW DISTANT COMETS WITH THE 2-M TELESCOPE OF PEAK TERSKOL OBSERVATORY

***I. Kulyk*[1], *N. Maigurova*[2], *A. Sergeev*[3]**

[1]*Main Astronomical Observatory of NAS of Ukraine, Kyiv, Ukraine; irinakulyk@yahoo.com.*

[2]*Reseach Institute "Nikolaev Astronomical Observatory", Mykolaiv, Ukraine.*

[3]*International Center for Astronomical, Medical and Ecological Research, Kyiv Department, Ukraine.*

Three dynamically new comets C/2008 S3 (Boattini), C/2006 S3 (LONEOS), C/2006 W3 (Christensen) were observed at Peak Terskol observatory in October 2008. These long period comets are thought to belong to the population of Oort Cloud, one of two main reservoirs supplying the inner region of the Solar System with comet nuclei. Being scattered in the inner region of the Solar System, these objects often experience perturbations from the planets, therefore, their dynamical history is sometimes complicated. In order to contribute to the better knowledge of the orbital elements of these dynamically new comets, we astrometrically processed the CCD images obtained with the 2-m telescope in the frame of the project of spectrophotometric investigations of distant active comets.

We used the focal reducer that converts the initial focal ratio of f/8 to f/2.8 providing an image scale of 0.89″/pxl. B, V, R broadband filters allow us to investigate a possible displacement of the photometric centers of the cometary comae at the different wavelengths. The images were processed with IZMCCD software developed by I. Izmailov at Pulkovo. The reference star positions were taken from 2MASS catalogue. The derived positions of the comets were compared with ephemerides provided by the HORIZONS system. The RMS residuals of comet C/2006 S3 do not exceed of 0.2 arcsec in the V and R bands and amount to 0.4 arcsec in the B band. The detectable displacements of photo centers at the different bands were not recorded for this comet.

Comet C/2008 S3 was at large heliocentric distance and, therefore, it was faint enough with the magnitude around 17.5. The accuracy of the derived positions was at the level of 0.3 arcsec. C/2006 W3 (Christensen) was approaching its perihelion at the time of the observations and therefore it showed a high level of the activity with considerable outgassing. The analysis of comet's positions derived through the different filters shows both the good measurement accuracy, less then 0.1 arcsec, and the dependence of (O–C) values on the wavelength. This may be attributed to the fact that the photo centers of the images obtained in the blue and red wavelength regions belong to the gaseous and dust components of the cometary coma respectively.

FRACTALS IN THE GEOMETRIC CONFIGURATIONS OF SATELLITE (ASTEROID) SYSTEMS

G.S. Kurbasova

Research Institute "Crimean Astrophysical Observatory", Nauchny, Crimea; gskurb@gmail.com.

In the limited domain of existence of the structure of "planet-satellite (asteroid)", stable proportions between the physical and geometrical parameters are generated, which ensures their mutual determination. The present paper deals with geometric shapes and structures in the satellite (asteroid) systems with fractional spatial dimension possessing the property of self-similarity (fractals). The results of calculating basic quantitative characteristics of self-similar structures - fractal dimension are given. The connection between the geometrical and physical parameters in the satellite (asteroid) systems based on the calculated fractal dimensions is presented to test the method which is using physical and geometrical characteristics of the shapes and the orbits of the Earth system – Moon, Jupiter, Galilean satellites, obtained by the spacecraft mission. Differences in definitions of the mass ratios of the satellite (asteroid) / planet of the geometric and dynamic methods do not exceed 0.001%.

GAIA – SOLVING NON-LINEAR EQUATIONS WITH A BILLION UNKNOWNS

L. Lindegren

Lund Observatory, Lund University, Sweden; lennart@astro.lu.se.

Gaia builds on the extremely successful Hipparcos mission, launched in 1989 by the European Space Agency, in order to map the sky with unprecedented accuracy and detail. Taking advantage of the latest detector technology, manufacturing methods, and high-power computing, Gaia will outperform Hipparcos by many orders of magnitude in terms of accuracy, number of objects, and volume of space surveyed. Gaia is to be launched in September 2012, and will after a few months take up its observing position at the Lagrange point L2, 1.5 million km away from the Earth. During five or six years it will continuously scan the whole sky, registering the exact positions and motions of a billion stars, and dispatch an enormous quantity of data back to the Earth. The processing of this data, converting it to a star catalogue eagerly awaited by astronomers around the world, is by itself a great challenge, perhaps as large and difficult as the making of the satellite. It currently engages more than 400 astronomers and software engineers around Europe. It is estimated that the data analysis effort to produce the Gaia catalogue is about one sextillion (10^{21}) floating point operations. A significant part of this is the simultaneous determination of the positions, proper motions and parallaxes of more than one billion stars, which requires the solution of a

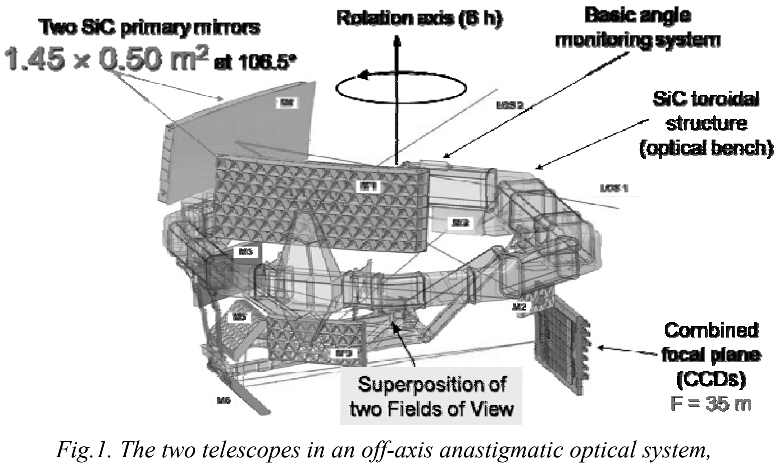

Fig.1. The two telescopes in an off-axis anastigmatic optical system, focal plane with CCDs at lower right. Courtesy EADS-Astrium.

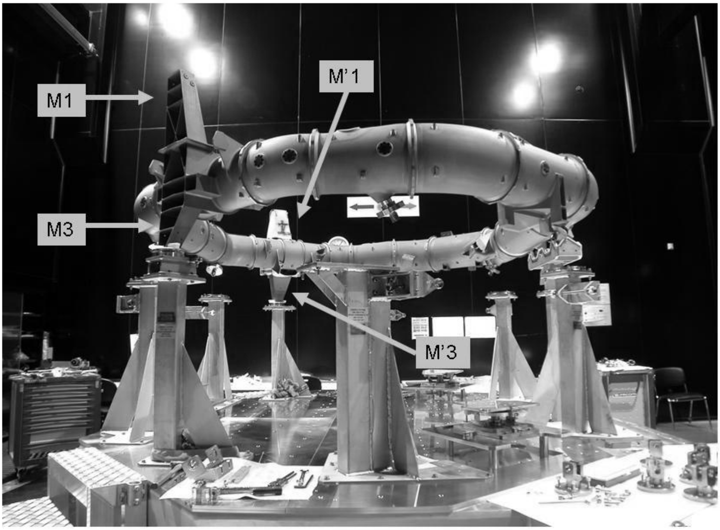

Fig.2. The Gaia torus, a 3-meter diameter structure which will support the two Gaia telescopes and the focal plane assembly. Torus and telescope mirrors are built in Silicon Carbide and therefore light-weight, robust and ultra stable. Courtesy EADS-Astrium.

non-linear least-squares problem with several billion unknowns. In this talk I will give a general overview of Gaia and its current status, and explain why the data analysis must involve the solution of extremely large systems of equations. In fact, it is only thanks to the steady increase in computing power, following Moore's law, that this problem can practically be solved in time for the launch of Gaia.

THE RESULTS OF PHOTOMETRICAL OBSERVATIONS OF F9402 (1999 AP10) ASTEROID WITH AZT-8 TELESCOPE

V. Lopachenko

National Space Facilities Control and Test Center, Evpatoria, Ukraine; volod@planar.biz.

AZT-8 telescope is the base of the astronomical optical system, which purpose is to detect faint artificial satellites in the near-Earth space and obtain astrometric and photometric data. Research of asteroids and other natural objects is not the primary objective of AZT-8 telescope; however, hardware and software facilities of the instrument allow to reach this objective. For example during Sept 15-23, 2009, the series of observations of F9402, F2664 and 17274 asteroids, which where the targets for radiolocation for Arecibo radio telescope in September-October of 2009, were carried out at the AZT-8 telescope. Obtained astrometric data was sent to MPC. For F9402 asteroid, photometric analysis was carried out in addition.

As a result of processing photometric data, there was discovered that a visible rotation period of F9402 asteroid can be $17^h52^m16^s$. However, this result needs to be checked because of insufficient data sample. Recalculation of the measured magnitudes into the radii of the equivalent diffusive sphere located into the space-time coordinates of

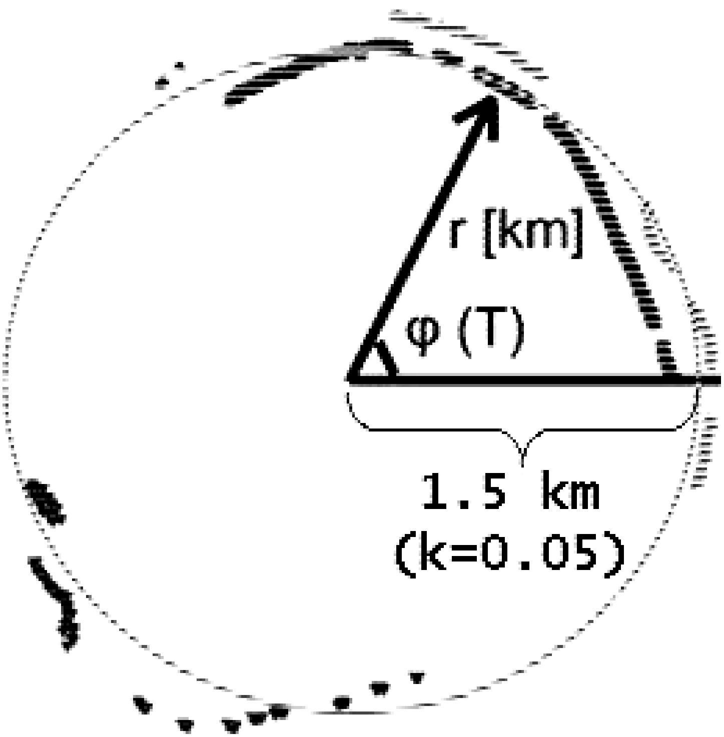

Fig.1. Dependence of the equivalent radius of F9402 asteroid from the phase of visible rotation with albedo 0.05.

the studied object was performed. It was found out that the mean asteroid diameter can be about 20 and 40 km using the most probable values of albedo 0.2 and 0.05. The dependence of the radius of equivalent sphere from the visible rotation angel of asteroid was plotted in polar coordinates, Fig.1. In that way the concept of a possible shape of visible perspective of asteroid was obtained.

METHOD OF POLARIMETRY IN REMOTE SENSING STUDIES OF ASTEROIDS

D.F. Lupishko

Institute of Astronomy of Kharkiv V. N. Karazin National University, Ukraine; lupishko@astron.kharkov.ua.

For a long time studies of the Solar system bodies have been based only on measurements of the intensity of electromagnetic radiation, and its spectral dependence. However, it was revealed that polarimetric characteristics of the scattered radiation, described by four Stokes parameters, contain much more information about such key properties of scattering particles as their size, shape, orientation in space and index of refraction.

In the first half of 1970^{th} in the University of Arizona (USA) B. Zellner and J. Gradie realized an extensive program of polarimetric observations of about a hundred asteroids. Obtained parameters of polarization-phase dependences have been used for determination of asteroid albedos and diameters. At the same time the physical interpretation of obtained data remains to be insufficient. A new stage in asteroid polarimetry has started in 1983, when Crimean Astrophysical Observatory, Astronomical Observatory of Kharkiv State University and Institute of Astrophysics in Dushanbe (Tajikistan) have begun their collaborative observations of asteroids in order to study their polarization-phase dependences in a wide interval of phase angles, spectral dependences of asteroid polarization, polarization of near-Earth asteroids, polarimetric peculiarities of selected asteroids and so on. Now in collaboration with the Institute of Astronomy of Kharkiv V.N. Karazin National University the active polarimetric observations of asteroids are carried out in Main Astronomical Observatory of NASU (Ukraine), Torino Astronomical and Asiago Astrophysical observatories (Italy), Complejo Astronomico El Leoncito Argentina) and other places.

Since 1983 about 200 asteroids were observed polarimetrically that gives nearly 70% of worldwide data on asteroid polarimetry in the international database Planetary Data System (NASA). Among the most of essential new results of the extensive observational programs one can note the next ones:

- detailed phase dependences of polarization have been obtained for asteroids of different compositional types which allowed us to determine albedos and diameters of individual asteroids and derive and analyze the average phase curves for basic asteroid types;
- for the first time spectral dependences of asteroid negative polarization have been obtained. It was shown, that such dependences are determined by the asteroid compositional type and qualitatively they are similar to those of corresponding meteoritic analogues. This result is important both for establishing a genetic relationship between asteroids and meteorites and for the classification of asteroids into types;
- the extensive program of polarimetry of near-Earth asteroids have been realized which gives a unique possibility to study the polarization behavior in the wide range of phase angles; for the first time the complete phase dependences of polarization, including positive polarization maximum, were obtained for asteroids of S and E types, which allowed us to determine the average sizes of their regolith particles;
- discovery and investigation of the so-called polarization opposition effects for the high-albedo objects of E-type, which was predicted theoretically;
- it was shown for the first time that surfaces of the largest M-type asteroids, which are supposed to be the remnant cores of differentiated bodies lost their silicate mantles as a result of collisions, are not purely metallic (as it was considered before), but contain a considerable silicate component. The most suitable meteoritic analogues of their surface composition can be stony-iron meteorites and enstatite chondrites;
- discovery and study the unique polarimetric properties and new polarization effects of some individual asteroids (1 Ceres, 4 Vesta, 4179 Toutatis); detection of asteroids with extremely small (~14°) and large (~28°) inversion angles of linear polarization and peculiarities of polarization of F-type asteroids, which stimulated their detailed study;
- the detailed polarimetric observations and estimation of physical parameters of asteroids 1 Ceres, 4 Vesta, 21 Lutetia, and 2867 Steins, which are the targets of successfully started space missions Rosetta and

Dawn. Based on the spectral and polarimetric observation data the possible composition of asteroids Lutetia and Steins has been proposed. The albedo of asteroid Steins recently obtained by Rosetta mission confirmed well the reliability of polarimetric method of albedo determination;

- the Asteroid Polarimetric Database (APD) has been created, which contains all published and the majority of unpublished results of polarimetric observations of about 280 asteroids and is updated annually. The APD, as a part of database Planetary Data System (NASA), is freely accessible to users via the links http:// PDS.jpl.nasa.gov and http://www.psi.edu/pds/resource/apd.html and extensively used in planetary astrophysics.

USING VO TOOLS FOR RESEARCH OF STARS WITH HIGH-PROPER MOTIONS

N. Maigurova, M. Martynov, G. Pinigin

Research Institute "Nikolaev Astronomical Observatory", Mykolaiv, Ukraine; nadija@mao.nikolaev.ua.

The Axial Meridian Circle (AMC) of Nikolaev Observatory carries out regular CCD-observations of the stars in the ecliptical zone in drift scan mode since 2003 year. AMC (diameter D=180 mm, focal length F=2480 mm) is equipped with a CCD-camera with a matrix of size 1040 x 1160 pixels. The motivation for this project was to make the astrometric fields in the ecliptical zone within the framework of maintenance of the Hipparcos reference frame and research of high proper motion stars. At present the catalogues of astrometric positions on epoch of observation can be used for getting more specific information about stellar proper motions. All observational data over a period of time 2008-2009 years was cross–identified with the 2MASS catalogue to find out early epoch positions of our data. The cross-matching was made with a 1 x 1 arcsec window, which gave 95.5% identifications. There is no enlargement of windows size whereas no photometric criteria used. There were obtained proper motions in calibration fields of the ecliptical zone for 48883 stars that have been observed in 2008 and for 84666 stars that have been observed in 2009. The TYCHO2 and PPMX catalogues were used for estimating the external accuracy of our data. Cross-identification with PPMX gave about 43% identifications. The comparison of our proper motions with the PPMX data shows that the external accuracy is 8mas/year for ARIHIP and AC2002.2 stars and 14 mas/year for GSC1.2 stars, and it changes in depending on the index of source catalogue stars. Additional cross-identification of our data with CMC14 will make further improvement to the problems with false entries, and it will increase the accuracy of the obtained proper motion. Cross-matching with the TYCHO2 catalogue gave about 3800 common stars. The external accuracy of our data with TYCHO2 is 12 mas/year.

The LSPM catalogues and the compiled catalogue of stars with high proper motions by Ivanov G.A. were used for search and identifications of stars with high proper motions. There were mark out two samples of stars. There are about 100 stars with proper motions more than 150 mas/year and about 1500 stars with proper motions more than 40 mas/year.

The cross-matching our sample of high proper motion stars with the LSPM and PPMX catalogues shows no significant differences in the proper motions. The external accuracy obtained in result of cross comparison is about 20 mas/year.

INTERNATIONAL VIRTUAL OBSERVATORY: 10 YEARS LATER

O.Yu. Malkov[1,2], O.B. Dluzhnevskaya[1], O.S. Bartunov[3], I.Yu. Zolotukhin[3]

[1] *Institute of Astronomy of the Russian Acad. Sci., Moscow; malkov@inasan.ru.*

[2] *Faculty of Physics, Moscow State University, Moscow, Russia.*

[3] *Sternberg Astronomical Institute, Moscow State University, Moscow, Russia.*

International Virtual Observatory (IVO) is a collection of integrated astronomical data archives and software tools that utilize computer networks to create an environment in which research can be conducted. Several countries have initiated national virtual observatory programs that will combine existing databases from ground-based and orbiting observatories and make them easily accessible to researchers. As a result, data from all the world's major observatories will be available to all users and to the public. This is significant not only because of the immense volume of astronomical data but also because the data on stars and galaxies have been compiled from observations in a variety of wavelengths: optical, radio, infrared, gamma ray, X-ray and more. Each wavelength can provide different information about a celestial event or object, but also requires a special expertise to interpret. In a virtual observatory environment, all of this data is integrated so that it can be synthesized and used in a given study.

The International Virtual Observatory project was launched about ten years ago, and major IVO achievements in science and technology in recent years are discussed in this presentation. Standards for accessing large astronomical data sets were developed. Such data sets can accommodate the full range of wavelengths and observational techniques for all types of astronomical data: catalogues, images, spectra and time series. The described standards include standards for metadata, data formats, query language, etc. Services for the federation of massive, distributed data sets, regardless of the wavelength, resolution and type of data were developed. Effective mechanisms for publishing huge data sets and data products, as well as data analysis toolkits and services are provided. The services include source extraction, parameter measurements and classification from data bases, data mining from image, spectra and catalogue domains, multivariate statistical tools and multidimensional visualization techniques. Development of prototype VO services and capabilities implemented within the existing data centers, surveys and observatories are also discussed.

We show that the VO has evolved beyond the demonstration level to become a real research tool. Scientific results based on end-to-end use of VO tools are discussed in the presentation.

FIRST RESULTS OF DATA REDUCTION OF NIKOLAEV PHOTOPLATE ARCHIVE

M. Martynov[1], Yu. Protsyuk[1], V. Andruk[2]

[1] *Research Institute "Nikolaev Astronomical Observatory", Mykolaiv, Ukraine; yuri@mao.nikolaev.ua.*

[2] *Main Astronomical Observatory of NAS of Ukraine, Kyiv, Ukraine.*

The results of plate scanning and image processing are presented. An archive of RI NAO consists of more than 8000 plates obtained with the Zonal Astrograph (D=160 mm, F=2.04 m, FOV= 5^o x 5^o). The plates with the image of the star cluster Pleiades obtained in 1962 and images of the Zodiac stars obtained in 1975 were scanned in series of 10 scans with three household scanners: Epson Perfection 3200 Photo and two models of Epson Perfection V200 Photo with a resolution power of

1200 DPI. Raw data processing, including image filtration and recovery of bright stars were made using MIDAS software package. Further reduction and results analysis were carried out using our own software and the Tycho-2 reference catalogue.

All three scanners have shown low stability of moving cartridge. It has linear biases up to 20 pixels per 10000 pixels of motion and a periodic counterpart from 2 to 5 pixels. After taking into account the features of scanners and data reduction, the following results were obtained: the standard deviations of stellar positions are from ± 0.04 ″ to ± 0.12 ″ in right ascension and from ± 0.06 ″ to ± 0.13 ″ in declination, depending on the image quality and stellar magnitude. The error came from repeating measurements (RE) is from ± 0.02 ″ to ± 0.07 ″ for both coordinates. The standard deviation of stellar magnitude is from $\pm 0.2^m$ to $\pm 0.5^m$ for stars of $9^m - 13^m$. RE is from $\pm 0.03^m$ to $\pm 0.05^m$ for stars of 10^m - 13^m.

Using the results of a preliminary research, we have scanned 50 plates in series of 5 scans with Epson Perfection V200 Photo with the same parameters. We have made data reduction and compiled a catalogue of positions and proper motions for 17350 stars in ecliptic zone. The catalogue contains stars in the ICRS system from 7 to 14 magnitude, the majority them have 11^m to 13^m, on the mean epoch of observation 1977.4. Mean standard error of one position measurement is about 0.062 ″ in RA and 0.067 ″ in DEC, RMS of (O–C) is about 0.084 ″ for coordinates and 0.005 ″/year for proper motions.

Further work in this direction is being successfully continuing.

ASTRONOMICAL DATABASES AND VO-TOOLS OF NIKOLAEV ASTRONOMICAL OBSERVATORY AS A BASIS FOR DEVELOPMENT OF UKRAINIAN VIRTUAL OBSERVATORY

A. Mazhaev, Yu. Protsyuk

Research Institute "Nikolaev Astronomical Observatory", Mykolaiv, Ukraine; mazhaev@mao.nikolaev.ua.

Results of work in 2006-2009 on creation of astronomical databases aiming at development of Nikolaev Virtual Observatory (NVO) are presented in this abstract. Results of observations and their reduction, which were obtained during the whole history of Nikolaev Astronomical Observatory (NAO), are included in the databases.

The databases may be considered as a basis for construction of a data centre. Images of different regions of the celestial sphere have been stored in NAO since 1929. About 8000 photo plates were obtained during observations in the 20th century. Observations with CCD have been started since 1996. Annually, telescopes of NAO, using CCD cameras, create data volume of several tens of gigabytes (GB) in the form of CCD images and up to 100 GB of video records. At the end of 2008, the volume of accumulated data in the form of CCD images was about 300 GB. Problems of data volume growth are common in astronomy, nuclear physics and bioinformatics. Therefore, the astronomical community needs to use archives, databases and distributed grid computing to cope with this problem in astronomy.

The International Virtual Observatory Alliance (IVOA) was formed in June 2002 with a mission to "enable the international utilization of astronomical archives..."

The NVO was created at the NAO website in 2008, and consists of three main parts.

The first part contains 27 astrometric stellar catalogues with short descriptions. The files of catalogues were compiled in the standard VOTable format using eXtensible Markup Language (XML), and they are available for downloading. This is an example of the so-called science-ready product. The VOTable format was developed by the International Virtual Observatory Alliance (IVOA) for exchange of tabular data. A user may download these catalogues and open them using any standalone application that supports standards of the IVOA. There are several directions of development for such applications, for example, search of catalogues and images, search and visualisation of spectra, spectral energy distribution (SED) building, search of cross-correlation between objects in different catalogues, statistical data processing of large data volumes etc.

The second part includes database of observations, accumulated in NAO, with access via a browser. The database has a common interface for searching of textual and graphical information concerning photographic and CCD observations. The database contains: textual information about 7437 plates as well as 2700 preview images in JPEG format with resolution of 300 DPI (dots per inch); textual information about 16660 CCD frames as well as 1100 preview images in JPEG format. Absent preview images will be added to the database as soon as they will be ready after plates scanning and CCD frames processing. The user has to define the equatorial coordinates of search centre, a search radius and a period of observations. Then he or she may also specify additional filters, such as: any combination of objects given separately for plates and CCD frames, output parameters for plates, telescope names for CCD observations. Results of search are generated in the form of two tables for photographic and CCD observations. To obtain access to the source images in FITS format with support of World Coordinate System (WCS), the user has to fill and submit electronic form given after the tables.

The third part includes database of observations with access via a standalone application such as Aladin, which has been developed by Strasbourg Astronomical Data Centre. To obtain access to the database, the user has to perform a series of simple actions, which are described on a corresponding site page. Then he or she may get access to the database via a server selector of Aladin, which has a menu with wide range of image and catalogue servers located world wide, including two menu items for photographic and CCD observations of a NVO image server. The user has to define the equatorial coordinates of search centre and a search radius. The search results are outputted into a main window of Aladin in textual and graphical forms using XML and Simple Object Access Protocol (SOAP). In this way, the NVO image server is integrated with other astronomical servers, using a special configuration file. The user may conveniently request information from many servers using the same server selector of Aladin, although the servers are located in different countries. Aladin has a wide range of special tools for data analysis and handling, including connection with other standalone applications.

As a conclusion, we should note that a research team of a data centre, which provides the infrastructure for data output to the internet, is responsible for creation of corresponding archives. Therefore, each observatory or data centre has to provide an access to its archives in accordance with the IVOA standards and a resolution adopted by the IAU XXV General Assembly #B.1, titled: Public Access to Astronomical Archives. A research team of NAO copes successfully with this task and continues to develop the NVO. Using our databases and VO-tools, we also take part in development of the Ukrainian Virtual Observatory (UkrVO). All three main parts of the NVO are used as prototypes for the UkrVO. Informational resources provided by other astronomical institutions from Ukraine will be included in corresponding databases and VO interfaces.

DETERMINATION OF GEOSTATIONARY SATELLITE LOCATION USING DIVERSED BASE OPTICAL DEVICES

S.S. Moskalenko, A.N. Bogdanovskiy,

A.L. Polyakov, A.L. Pavlovskiy

National Center of Control and Test of Space Facilities, Evpatoria; ckkp@spacecenter.gov.ua.

About 425 stationary points of satellites are in the geostationary orbit. The angular distances between these points are different, and these differences are significant. One or few satellites can be positioned in any of these points. The alternative sources do not contain information on the orbital parameters of many geostationary satellites, that´s why the orbital parameters must be determined by means of the space control devices to compose a catalogue of the visible part of the geostationary arc.

It should be mentioned that only a limited number of satellites may be positioned in the geostationary orbit, because the radio equipment of the satellites can cause interferences for their operation, if the satellites are very close to each other. Besides there is a great danger to collide with an uncontrolled satellite or debris.

The operating state of the orbiting geostationary satellite is interested in the international agreements keeping a concern to the used satellite stationary points, in forecasting a safe distance and in information on the satellite location in the desired moment of time for correct planning of the appropriate activity.

In this connection much attention is paid to observing and cataloging of geostationary satellites.

The method of using optical devices has been developed for more precise determination of orbital parameters; the optical devices must be used in this case as a long or short base interferometer. The separation of the observation points allows to get more accurate measurements due to the virtual increase of the optical resolution.

The method of determination of a of geostationary satellite location using diversed base optical devices is presented in this report.

THE USE OF TELESCOPE TPL-1M FOR ELEKTROPHOTOMETRICAL AND POSITIONAL OBSERVATIONS OF SATELLITES

Ya.M. Motrunych, I.F. Naybauer,

V.M. Perih, V.I. Kudak

Laboratory for Space Research, Uzhgorod National University, Ukraine; lkd.uzhgorod@gmail.com.

Single channel V-electrophotometer based on a telescope TPL-1M (D = 1000 mm, F = 11600 mm) is made for photometry of celestial point-type objects in Derenovka. Electrophotometer works in digital mode, which allows to put measurement results of light curves directly into computer. The relation coefficient of electrophotometer to the standard Johnson-Morgan photometric system and efficient wavelength $\lambda_{ef\,V}$ of the photometric system are $C_V = -0.1294 \pm 0.0181$, $\lambda_{ef\,V} = 5663 \pm 23$ Å. Standard error of determination of magnitude from $4^m.4$ to $12^{.}.5^m$ varies from 0.01^m to 0.41^m.

Elektrophotometrical observation of low satellites at the telescope TPL-1M began in August 2008. There were obtained 75 curves of various objects: 86061 (Ajisai) - 14, 92052 (Topex / Poseidon) - 16, 61018 (Midas-3) - 5, 61028 (Midas-4) - 13, 63014 (Midas-6) - 10, 63030 (Midas-7) - 17.

There was found a period of rotation of the satellite Ajisai using new light curves which have good agreement with LKD data of the previous years and foreign archives. The results fit the general trend of increasing the period of rotation of the satellite around its own axis. The increased rotation period in the first approximation can be represented by linear relationship y = Ax + B, where A = 0.02589; B = –49.95236. The coefficient “A” is actually the average annual rotation slowing of AJISAI satellite in seconds.

There were obtained the first test results of positional observations of low satellites held by a separate objective with a CCD receiver, mounted on the telescope TPL-1M. Research of the feasibility of using CCD receiver in the main channel of the visual telescope is made also.

DBGPA-UKRVO: SOFTWARE FOR PLATE IMAGE MANIPULATION

L.K. Pakuliak, D.O. Lazarenko

Main Astronomical Observatory of NAS of Ukraine, Kyiv, Ukraine; pakuliak@nip.net.ua.

A process of Golosiiv Plate Archive digitization and inclusion of digitized preview images into DBGPA has been started last year and is now under its way. The problem, we encountered, is absence of proper software for digitized image manipulation, i.e. the means for detailed viewing, zooming, transformation of the image and so on, which could be integrated into DBGPA V2.0 online software.

We have started to design and develop supplemental modules as Java-applets, using the standard graphic libraries of Java, which contain all the necessary functions for manipulation of JPEG,TIFF and FITS graphic formats.

THE ONLINE PLATE ARCHIVE: THE FIRST STEP TO THE NATIONAL VO

L.K. Pakuliak

Main Astronomical Observatory of NAS of Ukraine, Kyiv, Ukraine; pakuliak@nip.net.ua.

The primary goal of the Database of Golosiiv Plate Archive (DBGPA) project is the development of tools and methods for opening the remote access to ukrainian archives of astronomic glass plates with the aim of their consolidating on the idea of the future entry of the Ukrainian astronomical society into the International Virtual Observatory Alliance. So we have started from the solving next problems:

- tools and methods of homogeneous electronic archives creation by standartization of data about astronomic glass plates.
- assignment of online access to these informatic resources, development of search engines, visualization and verification instruments and tools for data analysis.

The current version of DBGPA has been built on the principles of WFPDB, spreaded to observational archives of any types not only for wide-angle ones whereas they allow to present all the archives as a single whole with strictly formalized structure of information in view of inclusion of this project into projected Ukrainian VO.

The software package (SP) DBGPA V2.0 includes User Interface (UI), Editor Interface (EI) and Administrative Interface (AI). UI provides options of user output customization, search of plates in three modes, visualization of search results, digital previews viewing, reference data, special options for the treatment of archives in total. AI provides administrative tools of DB monitoring, backup and restoration. EI provides means of data updating and correction as well as digitized images database administration and new archives integration into DB. The last function can be applied by other Ukrainian observatories which just start the digitization of their glass archives in collaboration with WFPDB group, because the special options of UI provide a possibility to create input WFPDB-formatted files after the loading of an archive into DB.

The completion of the most part of archive data loading in junction with SP DBGPA V2.0 UI and EI have permitted the next step of DB creation, namely massive data verification. Data verification partly was implemented on the step of data loading and included data formats control and parse of string data in order to eliminate misprints, Cyrillic coding, shifts of symbols in data string and other variants of data punching. To reveal the factual errors in DB in total the supplemental software has been developed which permits to compare log data with DB and to find such inconsistency as alternative versions in dates and time, number of expositions, duration of expositions, missing coordinates, uncertainties in coordinates and so on. The another form of concealed verification is a part of all the scripts selecting, inserting or updating the data in DB when data are checking for duplicates, acceptable value range compliance, data type compliance (numeric or alphabetic), appropriateness of presence or absence of specific data, coordination of bound attributes and so on.

Currently the process of plates digitization and inclusion of digitized preview images into DBGPA is under way.

AUTOMATION OF TELESCOPE TIME SCHEDULING

A.V. Pomazan, A.V. Ivantsov, L.A. Gudkova

Research Institute "Nikolaev Astronomical Observatory", Mykolaiv, Ukraine; anton@mao.nikolaev.ua.

A software for efficient scheduling of observations of asteroids at a given time moment has been developed to optimize the observational process at the telescope AZT-8 (Evpatoria) operating in automatic mode.

The schedule of observations is calculated with the specific conditions of visibility of objects for the given telescope. The next conditions which correspond to astrometric observations of asteroids have been chosen to constrain scheduling at the given time moment:

1) observations of objects should be made as close as possible to the meridian;
2) observations should be made for the maximum number of objects.

The software uses technical characteristics of the telescope and camera, ephemerides, calculated with the HORIZONS system, and a given SNR for each object for scheduling of observations. The theoretical extinction value, phase and position of the Moon relatively to the observational objects and horizon are also used for the calculation of exposure time. The algorithm schedules observations of photometric calibration fields. The result of algorithm depends on a ratio number of the objects planned for observation to the maximum number of objects which can be observed at night, i.e. the algorithm will provide changes to the list of objects in dependence of the previous run (it is necessary to avoid a situation, when the algorithm systematically skips a certain class of objects all the time).

HOW MANY SATELLITES ARE DISCOVERED IN THE SOLAR SYSTEM AFTER GALILEO

Zh. Pozhalova[1], D. Lupishko[2]

[1] Research Institute "Nikolaev Astronomical Observatory", Nikolaev, Ukraine; zhanna@mao.nikolaev.ua.

[2] Institute of Astronomy of Kharkiv V.N. Karazin National University, Kharkiv, Ukraine; lupishko@astron.kharkov.ua.

The Moon as a natural satellite of the Earth was "discovered" by Nicolaus Copernicus in his heliocentric system and it was the only known satellite in the Solar System before Galileo Galilei (1564-1642).

Early in 1610 Galileo discovered four satellites orbiting Jupiter, that are satellites of another planet than the Earth. They are well known as Galilean moons (or satellites) Io, Europa, Ganymede and Callisto. It was not until 45 years later that the next satellite in the Solar System was discovered (13 years after Galileo's death). It was the biggest Saturn's moon Titan, discovered by Christian Huygens. After that the discoveries of satellites happened more frequently and by the end of the 17th century the total number of discovered moons was ten.

From 1684 till 1787 (more than one century!) no satellites were discovered and the next 18th century added only four satellites (two of Saturn and two of Uranus). They were discovered by William Herschel, the most famous astronomer of 18th century (1738-1822), who also discovered the 7th planet Uranus in 1781. It should be stressed that during that century there were no more discoveries of either planets or satellites. Thus, we can conclude that while G. Galilei was the greatest discoverer of the 17th century, W. Herschel was the greatest discoverer of the 18th century.

In the 19th century the 8th planet Neptune and its moon Triton, two Uranus' and two Saturn's moons, one of Jupiter and both of Mars' moons (Phobos and Deimos) were discovered. However, the next 20th century and the beginning of 21st one turned out to be much more abundant in satellite discoveries due to both ground-based observations and space missions (Voyager-1, Voyager-2, Cassini-Huygens, Galileo). In 1992 the first satellite (Dactyl) orbiting main-belt asteroid 243 Ida was discovered by space mission "Galileo". It was the beginning of abundant discoveries of asteroid satellites by photometric and radar observations and then of satellites of Kuiper-belt and transneptunian objects.

By the beginning of 2010 the total number of natural satellites in the Solar System was equal to 350, including 168 satellites of large planets, 119 multiple asteroids (including main-belt and near-Earth asteroids, Mars-crossers and Jupiter Trojan asteroids) and 63 multiple transneptunian and Kuiper-belt objects. Meanwhile, we cannot count precisely how many moons in total are discovered to date due to the deficiency of accepted definitions.

FIRST OBSERVATIONS OF ARTIFICIAL SATELLITES AND SPACE DEVICES AT THE SCIENCE RESEARCH INSNITUTE "CRIMEAN ASTROPHYSICAL OBSERVATORY"

V.V. Prokofjeva-Mikhailovskaja, L.M. Sharipova

Scientific Research Institute "Crimean Astrophysical Observatory", Nauchny, Crimea, Ukraine; prok@crao.crimea.ua.

During 40 years the Scientific Research Institute "Crimean Astrophysical Observatory" has been taking active part in working out a technique for observations and observation of artificial space objects. The organization of the first visual observations has allowed to register the image of the first artificial satellite of the Earth.

In the early 60s before CrAO there was a task of tracking the motion and determination of spherical coordinates of space objects going at distances from the Earth. Observations were carried out with the 2.6-metre Shain reflector. Cascade electron-optical converters were used. They have been tested at the half-meter telescope MTM-500 in 1957.

Using TV apparatus for observations of artificial satellite has begun since summer 1964, when the first experiences in observations of artificial satellites have been gained together with V.M. Mozhzherin, V.B. Nikonov, engineers E.S. Agapov, V.F. Anisimov and V.I. Pergament. The observations have shown that the high-sensitivity television equipment allows to register 100 times weaker images of artificial satellites, as compared to the photo register. The received results have been reported at the XY International Congress on Astronautics in Warsaw in 1964.

The following step was observation of the artificial satellite "Kosmos-41", which was at the distance of about 40000 km. The observations were carried out at the half-meter telescope MTM-500 in September 1964. The automatic station "Luna-7" was launched on October 4, 1965. The distance to it was about 100000 km. A huge number of photo pictures of the station were received within several hours. The result of the first television observations of the artificial space objects leaving at the far distances from the Earth, have shown that the TV essentially facilitates the task of their finding and detection. The further observations have been transferred to the 2.6 Shain reflector. In the mid-sixties, by means of television system the good results were obtained in determinations of coordinates of space objects - Luna-11, Luna-12, Luna-13, Luna-14, Zond-4, Zond-6, Kosmos-159, Molnija-1. The group of engineers who have created television equipment, V.F. Anisimov, S.M. Sinenok, E.S. Agapov and V.B. Nikonov, P.P. Dobronravin and V.K. Prokofiev from CrAO, as a part of the big group of scientists have been awarded by the state award of the USSR.

An interest in getting photometric information about geostationary artificial satellites of the Earth has raised in the 80s. It was necessary to solve the problem of their identification and to establish a correlation between photometric and constructive characteristics of the objects with a solution of the inverse problem of the photometry – restorations of the form of object from the photometric lightcurves.

V.V. Prokofieva-Mikhailovskaja, A.N. Abramenko, E.P. Pavlenko and L.M. Sharipova took part in a projects. S.A. Severniy from Astrocouncil has headed the works, A.V. Bagrov and M.A. Smirnov. M.V. Bratijchuk, M.I. Demchik, and V.P. Epishev from Uzhgorod took part in observations, and N.N. Nosova, A.K. Murtazov from Russia participated in the works also. For colour observations, the A.N. Abramenko's technique of simultaneous BVR observations was used, for spectral ones – the slitless spectrograph, which had been invented by V.I. Pronik and L.M. Sharipova, was used. For a short term about 300 thousands of photometric estimations of 8 satellites have been made and over 100 spectra of 9 satellites have been taken. The high resolution spectra of satellites allowed to detect the lines of titanium and chromium.

The digital high-sensitivity television complex is being used now for scientific research of small bodies of the Solar system.

DEVELOPMENT OF THE TELEVISION METHOD OF ASTRONOMICAL OBSERVATIONS IN THE CRIMEAN ASTROPHYSICAL OBSERVATORY

V.V. Prokofjeva-Mikhailovskaja, A.N. Rublevsky

Scientific Research Institute "Crimean Astrophysical Observatory", Nauchny, Crimea, Ukraine; prok@crao.crimea.ua; anr@crao.crimea.ua.

Development of television astronomy was going in several directions: new techniques of television apparatus have been created; methods of photometric measurements of television pictures of stars and planets have been developed, the method of simultaneous photometric observations of stars in several spectral bands and pulsars in different phases of their light curves has been created. Tests of new television tubes were done, their quantum efficiency was measured, accuracy of the photometric measurements and field error were determined. On the basis of the tests the recommendations were elaborated to engineers-manufacturers, who considered them with developing new types of television tubes. An essential step forward was the development and application of a new television tube superisocon in 1977. The tube LI-804 allowed to register images in wide light range, possessed high absolute ($5x10^{-7}$ lx) and contrast sensitivity, provided signal/noise ratio up to 200 at reading out of one television frame. The linear range of a calibration curve used for the stellar photometry has increased up to 6^m.

In the beginning of 80th years digital registration of video signal of a part of the television staff has been maid by engineers of the "ORION" (Moscow). The photometry accuracy increase up to 0.003 at the high light luminosity and summarize in the computer of 2000 TV frames.

For a long time it was not clear why stellar photometry made with foreign television tubes gave rather low accuracy. Now it is known, that the reason was in the unequal sensitivity over the field, caused by polycrystalline structure of films, used for manufacturing of the targets in the TV tubes. The head of the laboratory on manufacturing tubes in Leningrad, Dr. N.D. Galinskiy, has applied to this purpose a usual homogeneous glass and has received excellent results in the uniformity of the sensitivity over the field.

High results in application of the new photoelectronic equipment were based on close creative cooperation of astrophysicists, physicists and engineers. Astrophysics obtained further insight into principles of work of devices, physics and engineers – in a technique of astronomical observations. The people working in different institutes and cities were joined operatively, which provided fast success.

So, from the beginning of 60^{th} of the last century and to the present time the television equipment working with vacuum television tubes, allows astronomers to carry out the newest research. The group of engineers under direction of A.N. Abramenko continues their works on improvement of stabilization of the feeding voltage of different units of the television equipment. The TV equipment has an advantage in comparison with solid-state detectors of light widely used now (matrices), as it allows to operate with a bunch electron in vacuum and to receive simultaneous observations of astronomical objects in three spectral pass-bands, in color system BVR.

ANALYSIS OF STELLAR PROPER MOTIONS OBTAINED WITH NORMAL ASTROGRAPH

V. Ryl'kov

Main (Pulkovo) Astronomical Observatory of RAS, St. Petersburg, Russia; vrylk1145@yandex.ru.

Getting the positions and proper motions of stars with the highest precision is one of principal tasks of astrometry. Up to space-based observations this task was solved by direct method of determinations of star coordinates using meridian astrometric observations and mass determinations using photographic observations, which provided high enough accuracy for coordinates and proper motions of stars with sufficient difference of the first and second epochs of observations.

After publication of Hipparcos и Tycho space catalogues it became evident that at present no ground observations can give the position precision as the space observation provides. The non-stability of the Earth atmosphere does not allow to resolve the close binary stars for the components, and these stars make the greatest part on the sky, how it is following from the space observations of Hipparcos. The influence of atmospheric dispersion is always considerable also, especially on the selection of reference stars for reduction. In this case, it does not matter whether a catalogue has the highest precision: the images of celestial objects are obtained from the Earth ground, and stellar positions are distorted by atmospheric effects. Besides, the ground observations should have a great enough interval from the first to second epochs of the observations to get significant proper motions of stars fainter than 9^m, while using space observations the astrometric positions can be obtained within a smaller interval of time with considerably greater precision for a large number of stars.

In this report the accuracy of obtained astrometric parameters of stars from ground-based observations at the small telescopes is considered on the example of photographic observations of Pleiades cluster, which were made at the Pulkovo's Normal astrograph (33/346) during the nearly 100 years from 1895 till 1993. The plates before 1970 year were taken for measurements from Pulkovo's photographic library. The plates after 1980 year were obtained by the author mainly for the research of precision characteristics of the obtained results. There were measured 2, 3, 5 and more plates of 1895, 1910, 1930, 1949, 1956, 1979, 1986, 1989, 1993. The observation intervals were practically arbitrary, however the performed calculations for positions with intervals of 10, 20, 30 and more years showed, what and how one can get using these intervals for calculation of proper motions in astrometric sense.

For all the plates within 1895-1993 years there were calculated coordinates and proper motions of 60 common stars. The calculations were carried out in the ICRF system, J2000.0 using the reference stars from the Tycho-2 and UCAC3 catalogues. A number of reference stars was chosen from 12 to 22, reduction errors varied from 0.1" to 0.3". The best reduction precision appeared for the measurements of stellar images for all types of astronomical plates obtained before 1941. Besides the calculations using the classical schemes for astrometric reduction, positions and proper motions of stars were calculated with taking into account atmospheric dispersion according to the author's method. The coordinates and proper motions were obtained for more than 80 stars from 7 to 11 magnitude on the mean epochs using:

- different time intervals of observations;
- different selections of stars according to brightness and spectrum;
- different catalogues (Tycho-2 and UCAC3).

The results were compared between themselves and also with coordinates and proper motions from the space catalogues Hipparcos and Tycho-2. There were analyzed the results of transition from one type of photographic plates to others during the last 50 years of photographic observations. All results are presented in the form of a catalogue, and figures of (O–C).

A COMPILED CATALOGUE OF THE REFERENCE STARS FOR OPTICAL OBSERVATIONS OF EXTRAGALACTICAL RADIO SOURCES NEW INCLUSIONS

V.P. Ryl'kov[1], N.V. Narizhnaya[1], A.A. Dement'eva[1]
G.I. Pinigin[2], N.V. Maigurova[2]

[1]Main (Pulkovo) Astronomical Observatory of RAS, St. Petersburg, Russia; vryl@gao.spb.ru.
[2]Nikolaev Astronomical Observatory, Mykolaiv, Ukraine.

Ground-based astrometry was based mainly on optical observations, and up to XX century the fundamental catalogues, as FK3 – FK6, were the basis of this astrometry. When space mission HIPPARCOS have been finished, Hipparcos Celestial Reference Frame

(HCRF) was adopted as the main coordinate system. Hipparcos Celestial Reference Frame realizes ICRF system, based on the VLBI observations of the ERS (extragalactic radio sources). HCRF system is linked to the ICRF through the system of stars, radio stars and visually observational ERS. However, the estimates of the system stability show that errors of the stellar proper motions and positions of the Hipparcos catalogue have to be a reason of the system rotation about 0,25 mas yr^{-1}.

For establishing a link between optical and radio astrometrical coordinate systems, observations of the same objects in both radio and optical wavelength are considered as a priority problem in ground-based astrometry. The problems will be solved with telescopes using CCD-detectors because most of ERS are very faint ($18\text{-}20^m$). A magnitude equation adds errors to the system stability. High precise system of reference stars around ERS is needed. The reference system is needed to improve fundamental systems FK4-FK6 for obtaining high accurate coordinates of ERS.

We earlier compiled a catalogue of reference stars of $11\text{–}17^m$ for 235 fields around ERS to make a link with VLBI-observations. The catalogue includes 3 photographic catalogues (from Pulkovo – Pul-ERS , from Bucarest - Buch (188), from Kiev - Kiev (115)) and a catalogue obtained with AMC in Nikolaev Observatory, using CCD-detector (208 fields around ERS). A catalogue obtained with the telescope with the CCD detector have been included (192 – KMAC1) for several fields. Moreover, Chinese and Turkish observations (Shanghai, 1.2 m with a CCD-detector and Antalya, 1.0 m with a CCD-detector) have also been included.

Since the link of the reference systems is a problem of primary importance, many catalogues with stellar positions around ERS appear in the last years. We include new observations of the stars around ERS into our compiled catalogue. At the present stage we include several other catalogues into the compiled catalogue. Samples from these catalogues allow increasing a number of stars around ERS for 25-30% within the same sizes of our fields. So, we included catalogues CMC-9 and CMC-14 from observations with Carlsberg Meridian Circle. We made samples from Lazorenko catalogue (KMAC1) for all the fields with ERS. This catalogue was made with Kiev Meridian Axial Circle using a CCD-matrix 1040 x 1060.

Also we have used the XC1 catalogue from Kharkov. This enormous catalogue contains stellar positions up to 19^m for the Northern sky in 255 fields of 1 degree radius around ERS (856421 stars). It is based on the measurements of the photo plates ROSS-I и ROSS-II made with the PMM measuring machine of USNOFS. We plan to use proper motions for calculation of stellar positions to the mean epoch of observation for stars from other constituent catalogues without proper motions and identification with XC1. We use UCAC3 for the same task, but we have not include it into the compiled catalogue. Individual star coordinate errors will be decreased and the number of the stars with proper motions in the compiled catalogue will be increased. Moreover, we included the photographic catalogue ERLCat – USNO. The observations have been made with two small telescopes in the Northern and Southern hemispheres from 1976 till 1991. This catalogue contains 89422 stellar positions from 12^m to 14^m for 398 fields around ERS; but it has not proper motions. Moreover, we included new observations with Pulkovo Normal Astrograph using a CCD-detector. These observations allow increasing the number of stars around ICRF ERS.

Several tens of thousands of observations are being using. Compilation and classification were made. Systematic analysis of the star coordinate accuracy has begun. We use the total version of UCAC3 for analyzing precision. Currently we have 11 catalogues for this project. We shall obtain a compiled catalogue from for 241 fields of 40 x 40 minutes.

POSITIONS OF PLUTO CALCULATED AT PULKOVO FOR 1930 – 1996

V. Ryl'kov

Main (Pulkovo) Astronomical Observatory of RAS, St. Petersburg, Russia; vrylk1145@yandex.ru.

More than 300 positions of Pluto were obtained and calculated in the astronomical fundamental system ICRF (J2000.0). They were photographed from 1930 till 1994 with an exception of 1942-1949, the War and the after the War years. The basic series of observations were carried out with Pulkovo Normal Astrograph (33/346) beginning from the discovery of Pluto in 1930 up to it going to the Southern hemisphere. Exposure of plates should have reached one hour for the faint magnitude of Pluto and the great zenith distances made impossible taking images of the planet on the Normal Astrograph in Pulkovo. By this time at Pulkovo there were obtained 230 plates in 1930-1941 and

1949-1994. A considerable number of plates were obtained by the author in the last period of observation, when it was found a great difference in right ascension for the observation positions of Pluto relatively its ephemeris.

The author organized positional observations of Pluto with two telescopes in order to check this differences in RA. During 6 years from 1991 till 1996 there were obtained 74 plates with Pluto images with the Schmidt telescope (80/120/240) in Baldone (Latvia). The images were measured and postions were calculated. The author used the Zeiss-400 telescope (40/200) of Kazan Astronomical Observatory near BTA on the Pastukhov mount and obtained 9 plates with Pluto images in 1994. Several plates of 1985, 1988 and 1991 Kazan astronomers handed to Pulkovo in order to get Pluto positions.

All the plates were measured, and there were obtained equatorial geocentric coordinates of Pluto in fundamental system FK5 using the reference stars of different photographical catalogues.

In this paper the author presents more than 300 positions of Pluto, which were recalculated with the reference stars from the space Tycho-2 catalogue in fundamental system ICRF, J2000.0.

It is necessary to include these homogeneous series of Pluto positions to the international base of planet observations of astronomical data in Strasbourg (France) for improvement the theory of Pluto and planet motions.

AUTOMATIC DETECTION OF FAINT CELESTIAL OBJECTS BY MEANS OF LOW APERTURE TELESCOPES

V.E. Savanevich[1], A.B. Bryukhovetskiy[2], A.M. Kozhukhov[2]

[1]Kharkov National University of Radio and Electronics, Kharkov, Ukraine; domsv1@rambler.ru.

[2]National Space Facilities Control and Test Center, Evpatoria, Ukraine; izumsasha@rambler.ru.

Development of science and technics in the last twentieth years of XX – beginning of XXI centuries has made an extremely serious impact on optical observational astronomy. Occurrence of high-sensitivity astronomical CCD-cameras, new optical schemes and “the fast” automated mountings of telescopes have seriously raised an efficiency of the work of the observers. However, one side of work of the astronomer-observer remained practically away from the given rapid development. Search of moving objects on the image is the case. Actually, much depends on the experience of the observer here, especially in a case of search of star-shaped objects with small proper motion such as asteroids. The situation has begun to change for better only recently, with the advent of the first programs of automatic searching (for example, LINEAR, Spacewatch).

The development of the similar program for telescopes with small apertures in Ukraine is under go at present. In the report the first results of application of the program are presented at processing of observations from various telescopes. Further development of the universal software product allowing to make qualitative detection in different modes of moving objects as in the near-Earth space and far behind the orbit of our planet is planned.

COMPLEX OF ROBOTIC TELESCOPES FOR OBSERVATION OF THE EARTH ARTIFICIAL SATELLITES AND NEAR-EARTH OBJECTS

A.V. Shulga[1], E.S. Kozyrev[1], A.N. Kovalchuk[1], V.M. Chernozub[1], E.S. Sibiryakova[1], A.B. Bochkarev[1], V.V. Lopachenko[2], V.V. Ryhalsky[2]

[1.] Research Institute "Nikolaev Astronomical Observatory", Mykolaiv, Ukraine; shulga@mao.nikolaev.ua.

[2.] National Space Facilities Control and Test Center, Evpatoria, Ukraine.

Modern tasks for orbit control of the Earth artificial satellites and objects approaching the Earth define high requirements to ground-based telescopes, which have to be equipped with fast objectives, CCD cameras with a chip size not less than two inches. The CCD camera has to work in different modes. The telescopes must be fully robotized, and have a control system with remote operation and alert mode.

In cooperation between RI NAO and NSFCTC, the upgrade of the AZT-8 classical telescope, belonging to NSFCTC, was made. Two telescopes of original design, namely the Fast Robotic Telescope (FRT) and the Mobile Telescope (MobiTel) were made in RI NAO.

The telescopes are equipped with absolute angle encoders, CCD cameras with Kodak KAF-09000 chips, GPS time service, robotic drives and an automatic control system. The telescope features, such as a telescope name, f-number, chip name and operating modes, pixel numbers, field of view, pixel sizes, pixel scale, limiting magnitude, the standard deviation are given in the following list:

1) AZT-8 *(NSFCTC),* 0.7/2.8 m, FLI PL09000 stare, 3056 × 3056, 45′× 45′, 12 × 12 μm, 0.9″/pix, 20^m, 0.05″ ÷ 0.15″;
2) FRT *(NAO),* 0.3/1.5 m, Alta U9000 stare and drift-scan, 3056 × 3056, 1°24′× 1°24′, 12 × 12 μm, 1.6″/pix, 18^m, 0.15″ ÷ 0.40″;
3) MobiTel-0.5 *(NAO),* 0.5/3.0 m, Alta U9000 stare and drift-scan, 3056 × 3056, 42′× 42′, 12 × 12 μm, 0.8″/pix, 19^m, 0."05″ ÷ 0".15″;
4) MobiTel-0.3 *(NAO),* 0.3/0.75 m, Alta U9000 stare and drift-scan, 3056 × 3056, 2°48′× 2°48′, 12 × 12 μm, 3.2″/pix, 18^m, 0.20″ ÷ 0.45″.

The telescopes are actively used for control of the near-Earth space as well as for the solution of problems connected with the potentially hazardous asteroids and comets approaching the Earth.

Combination of classical and original methods of observations allows us to carry out virtually any observing programme.

Considering objects at geostationary orbits and at highly elliptical orbits, we are able to carry out the following types of observations: massive – survey, boundary – search, high accuracy – single object.

To solve the problems connected with the potentially hazardous asteroids and comets approaching the Earth, we are able to observe faint objects located in the asteroid belt as well as objects approaching the Earth at the distance less than 0.1 a.u. and with elongation angle up to 130º.

FIRST RESULTS OF FUNCTIONING OF THE UKRAINE-CHINA TELESCOPE NETWORK ON SPACE DEBRIS OBSERVATIONS

A.V. Shulga[1], E.S. Kozyrev[1], E.S. Sibiryakova[1], N.I. Koshkin[2], Ya. Blagodyr[3], V.P. Epishev[4], Yi. Mao[5], Y. Li[5], Zh. Chen[5], Zh. Tang[5]

[1] Research Institute "Nikolaev Astronomical Observatory", Mykolaiv, Ukraine; shulga@mao.nikolaev.ua.

[2] Research Institute "Astronomical Observatory" of Odessa National University named after I.I. Mechnikov, Odessa, Ukraine.

[3] Astronomical Observatory of Ivan Franko National University of Lviv, Lviv, Ukraine.

[4] Laboratory for Space Research of Uzhgorod National University, Uzhgorod, Ukraine.

[5] Shanghai Astronomical Observatory (ShAO), Shanghai, China.

Substantial growth of space debris (SD) on the near-Earth orbits is caused by increasing launch number of the Earth artificial satellites

(EAS). Leading space countries assign considerable efforts and contributions for creation, maintenance and development of space control systems (SCS). Effective work of SCS is achieved by usage of radio and optical means based both on the ground and space.

Control system of space environment (CSSE) developed by National Space Agency is working in Ukraine. CSSE provides space tracking of up to 300 objects and supplies information about them to customers. Usage of optical telescopes belonging to Ukrainian research institutes and universities of Ministry of Education and Science (MES) is a prospective way to enlarge number of information sources about the SD at low orbits (less than 2500 km) for CSSE. The network of the MES telescopes has a perspective in international cooperation in particular with People's Republic of China. Ukraine and China are members of the Interagency Coordinating Committee on Space Debris; and in accordance with the resolution of the United Nations General Assembly #61/11, they are responsible for collection and distribution of data on SD.

This project is directed towards creation of the first Ukrainian-Chinese network of optical telescopes for observations of the SD on the low orbits. The telescopes are equipped with the short focus objectives and sensitive TV CCD Watec cameras. A list of telescope features, such as an institution name, telescope abbreviation, focal length, f-number, field of view are given below:

1) RI NAO, FRT, 85 mm, 1.8, $4.2^o \times 3.2^o$;
2) RI AOONU, KT-50, 250 mm, 2.5, $1.5^o \times 1.1^o$;
3) AOLNU, TPL1M, 250 mm, 2.5, $1.5^o \times 1.1^o$;
4) LSRUNU, TPL1M, 85 mm, 1.5, $4.2^o \times 3.2^o$;
5) ShAO, TV, 85 mm, 1.8, $4.2^o \times 3.2^o$.

An original method of TV observations of the low orbit objects with a static telescope was tested at all the telescopes. This method was developed and successfully used in RI NAO in the last years. The observations have shown that used equipment allows us to observe objects with reflective square of 0.1 m^2 and mass of 50 kg. Orbit modelling of the EAS taken from the USSTRATCOM catalogue in observation zone of the network has shown that up to 1000 from 10500 objects may be tracked with a period of data update not more than 10 days. It allows us to obtain a forecast accuracy that is not worth than in the USSTRATCOM catalogue.

During the first observational campaign, measurements were carried out by two methods: along all visible orbit arc, in the limited sky zone with the largest density of objects. The first method is aimed at obtaining of maximum data volume to estimate the highest possible accuracy of orbit determination. The second method is designated to estimate a possibility of catalogue maintenance and enlargement for observations with several static telescopes. A quality of measurements for orbit improvement and a forecast accuracy were estimated for each method.

CATALOGUE OF POSITIONS AND ORBITAL ELEMENTS OF EARTH'S ARTIFICIAL SATELLITES AS A PART OF VIRTUAL OBSERVATORY

A.V. Shulga, E.S. Kozyryev, E.S. Sibiryakova

Research Institute "Nikolaev Astronomical Observatory",
Mykolaiv, Ukraine; shulga@mao.nikolaev.ua.

Regularly updated catalogue of positions and orbital elements of Earth's artificial satellites (EAS) are presented at the RI NAO website since 2005. The orbital elements are freely available. Information about the positions is provided on request by e-mail.

The catalogue contains data for the following orbit types of the EAS:

- geosynchronous and geotransitional orbits;
- low orbits;
- highly elliptical orbit.

Catalogue data is arranged by observation date and numbers of the EAS. The numbers correspond to the numbers of the NORAD catalogue. The catalogue is compiled using observations made in RI NAO. The observations are carried out by a combined method with the Fast Robotic Telescope. The orbital elements are calculated using Adams method of fifth order and data obtained during two or more nights. 105 geosynchronous and geotransitional satellites, 48 low orbit satellites, 1 highly elliptical orbit satellite are included in the catalogue now. Moreover, the internal accuracy of observations for reference stars and the EAS are given in the catalogue in a graphical format.

OBSERVATIONS AND THEORETICAL ANALYSIS OF LIGHT CURVES OF MUTUAL PHENOMENA IN THE SATELLITE SYSTEMS OF MAJOR PLANETS

E.N. Sokov, D.L. Gorshanov, A.V. Devyatkin

Main (Pulkovo) Astronomical Observatory of RAS,
St. Petersburg, Russia; jenias06@gmail.com.

The photometric observations of mutual phenomena, such as occultations and eclipses in the system of the satellites of major planets, such as Jupiter, Saturn have been carried out. They are effective means for obtaining high-precision astrometric data, which is necessary for improvement and constructing the theories of the motion of satellites. Accuracy of astrometric data, obtained by the analysis of the light curves of these phenomena is higher than that obtained in the ground position observations. The photometric observations of occultations and eclipses have been obtained by the automatic telescopes ZA-320M, located in the Pulkovo Observatory and MTM-500M, located in the Pulkovo Mount Astronomy Station. The part of the observations has been carried out with a planetary “coronograph”. It has enabled to decrease the influence of gating from the central planet. The satellites of Jupiter and Saturn have photometric inhomogeneities of their reflecting surfaces. It leads to the distortion of light curves and introduces systematic errors to their interpretation. With the interpretation of photometric curves of such

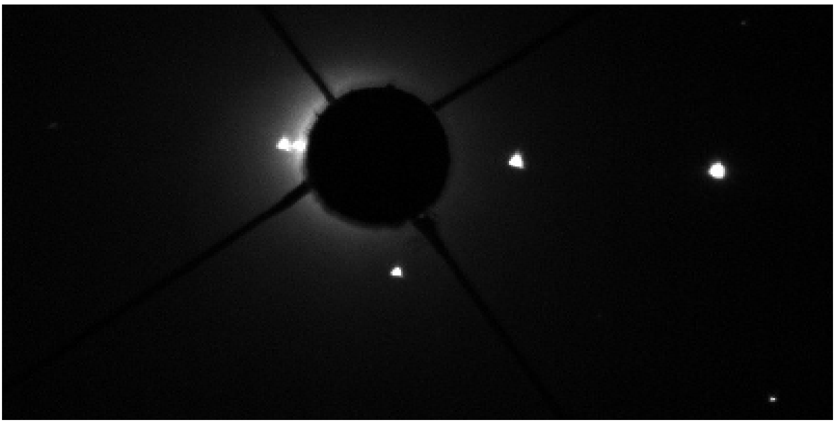

Fig 1. Mutual phenomenon in the system of the Saturn obtained by MTM-500M with a planetary “coronograph”.

phenomena, it has been considered the law of reflection of light by the surface of satellite, the influence of the effect of phase and the distribution of illumination in the penumbra. Corresponding moment of time of such phenomena has been also determined.

OBSERVATIONAL RESULTS OF SOME SPACE DEBRIS WITH ROTATING-DRIFT-SCAN CCD

Zh. Tang, Yi. Mao, Y. Li,
Y. Yu, X. Zhang

Shanghai Astronomical Observatory, Shanghai, China; zhtang@shao.ac.cn.

Normal drift-scan CCD is often used to survey the sky and to get images of stars in the time-delay and integrate (TDI) mode at the apparent sidereal rate. With drift-scan CCD, the track of stars can be realized even when the telescope keeps idle state. The orbits of middle and low orbit space debris are in different directions. To observe these objects for a long exposure, a drift-scan CCD camera needs to be rotated to make the direction of a pixel line parallel to the orbit of the object. Since the drift-scan mode can track objects for some time, the small telescopes with rotating drift-scan CCD can catch small and faint space debris. A prototype telescope with rotating drift-scan CCD has been developed and some preliminary observational results are given.

ACTIVITIES OF THE VO PARIS DATA CENTER

W. Thuillot[1], D. Hestroffer[1], J. Berthier[1],
J. Aboudarham[2], P. Le Sidaner[3], F. Le Petit[4]

[1]IMCCE, Paris Observatory, Paris, France; thuillot@imcce.fr,
thuillot@imcce.fr, hestroffer@imcce.fr, hestroffer@imcce.fr.
[2]LESIA, Paris Observatory, Paris, France.
[3]SIO, Paris Observatory, Paris, France.
[4]LUTH, Paris Observatory, Paris, France.

The Virtual Observatory is a relevant framework for massive processing of data and share of information and tools. Due to this ability, since several years all the laboratories of Paris Observatory have been involved in several national or international collaborations and several developments in this domain. We will describe this general context where, due to the wide spectrum of activities of Paris Observatory, many astronomical areas are concerned. The IMCCE, one of the Paris Observatory laboratories, is much involved in the VO activities. Web services have been developed there and some of them can now be applied to scientific studies. This is a case of the SkyBoT tool for the research of small Solar System Bodies, for example. More recently ephemerides of position and physical ephemerides have been developed under the form of a web services system labeled Miriade. We will particularly emphasize these recent developments.

NATIONAL UKRAINIAN VIRTUAL OBSERVATORY (UKRVO): CONCEPTION

I.B. Vavilova

Main Astronomical Observatory of NAS of Ukraine,
Kyiv, Ukraine; irivav@mao.kiev.ua.

The Ukrainian Astronomical Association adopted a decision to support the project aimed for originating National Astronomical Virtual Observatory of Ukraine (UkrVO) at its meeting on June 26, 2009. The UkrVO development allows us to open the wide on-line access to the joint database of digitized astronomic negatives and spectra obtained at the different Ukrainian astronomical institutions for the national/foreign scientific community. Besides the Ukrainian astronomical heritage preservation and an arrangement of the online access to it for the world astronomical community, it allows us to create the technical and structural preconditions for joining the UkrVO to IVOA in 2010-2011.

The UkrVO conception includes the following scientific components as the resources:

- photographic astronomical glass archives;
- astronomical archives of spectral observations;
- catalogues of celestial bodies;
- radio astronomical archives (positional, radio metrical and spectral observations);
- high-energy research laboratory VIRGO as a part of the European virtual laboratory;
- development of Information Technologies in the IVOA standards.

We shall note briefly the following for the UkrVO institution's participants and characterization of their recourses.

Information stored on many thousands of glass photographic plates obtained in the different astronomical institutions of Ukraine during more than 100 years from 1890th up to now within the various observational projects is the most valuable for the astronomers in Ukraine and over the world. These institutions are Astronomical Observatory of Taras Shevchenko National University of Kyiv (since 1890th), Main Astronomical Observatory of NAS of Ukraine (since 1940th), Astronomical Observatory of I. Franko National University of Lviv (since the end of 1930th), Institute of Astronomy of the V.N. Karazin Kharkiv National University (since the beginning of 1900th), Institute of Radio Astronomy of the NAS of Ukraine (Kharkiv, since 1950th), Astronomical Observatory of Odessa National University named after I.I. Mechnikov (since the end of 19th century), Nikolaev Astronomical Observatory (since the beginning of 20th century), Crimean Astrophysical Observatory (since 1945), Space Research Laboratory of Uzhgorod National University (since 1957), ICAMER (since 1970-ies) and some others. The database of stellar spectra, including the Sun, galaxies and other space objects in different diapasons of the electromagnetic waveband (optical, radio and gamma ones uppermost) were obtained mostly in the second half of 20th century. These archives contain observational material (glass plates, catalogues, spectra, databases), which is processed/non processed or processed partly depending on tasks of the observational projects. The content of these archives being retrieved is of great importance for research in the fields of physics of Solar system bodies, discoveries of asteroids and their orbits improving including potentially hazardous ones; researches of variables, nova and supernova stars, double and multiple star systems, researches of the Sun, kinematics and dynamics of galaxies, physics of active galactic nuclei, searching for optical counterparts of gamma burst sources, tasks of numerical simulations of space objects evolution as well.

In particular, the core of MAO NASU database includes long-term observational archives which contain about 55 thousands of astronomical plates, comprised more than 2.5 millions of stars and 10 millions of galaxies and the data about positions and other properties of the Solar System bodies such as the planets, satellites and potentially hazardous asteroids as well. The part of the MAO NASU archive is included into global WFPDB and now this work is going on. In IRA NASU about 50 thousands of spectra obtained in the decameter waveband using the UTR-2 telescope and URAN VLBI system are collected in the unique database, which is listed at the institution web-site.

The virtual observatory of Nikolaev Astronomical Observatory is finalized. So, a database of observations with access via Aladin is following: it contains textual information about 7437 plates and 933 preview images. Plate scale is 100"/mm. Observational campaigns were made in 1929-1931 and 1961-1999. Limiting magnitude is $B=14^m$. The database contains textual information about 16660 CCD frames obtained with the AMC, the MCT and the FRT in 1996-2006. The database also gives links to 280 CCD frames obtained with the AMC in 2002-2003. Limiting magnitudes are $R=16^m$, 14^m, 18^m for the AMC, the MCT and the FRT, correspondingly. The astrometric catalogues of stars in VOTable format and other archives are available through the web-site of Nikolaev Astronomical Observatory.

The archive of Astronomical Observatory of Odessa National University named after I.I. Mechnikov contains more than 100 thousands of plates with observation date since 1909: 20 thousands of the oldest ones of Simeiz observatory collection are included and 80 thousands plates obtained in Mayaky village station, Odessa since 1957. The general part of the latest collection as well as the collection of SRL of Uzhgorod National University consists of direct plates obtained in photographic waveband.

In the database of Crimean Astrophysical Observatory, the digitized plate archive is stored in “dBASE III+” formats and comprises the data of photographic observations of stars down to 12^m –14^m in photo visual waveband and down to 16^m–18^m in photographic waveband. The time intervals of these observations cover 1938-1965, 1984 yrs. The Crimean archives are also included into global WFPDB.

The Ukrainian astronomers have taken part in the creation of stellar catalogues of different purposes such as FONAC (near 2 millions stars of the northern sky), the catalogue of stars with large proper motions, the catalogue of triplets of galaxies, the catalogue of galaxies apparent from the edge, etc. Since 1989 the annual (global) determinations of the Earth rotation parameters have been conducted along with variations in positions of the observational stations and velocities of their variations, and orbital parameters of the observed satellites, as well in the centre of analysis of laser location observations of MAO NASU. The results were sent regularly to Strasbourg, France, where information about all the created catalogues is stored. We intend to provide a direct access to this and other astronomical data from the resources of UkrVO with identification of the Ukrainian content in this global catalogue database.

UkrVO Structural institutional participation. All the mentioned Ukrainian astronomical institutions as the owners of their unique archives represent themselves in UkrVO:

NAS of Ukraine (3 institutions)

- Main Astronomical Observatory (Kyiv);
- Institute of Radio Astronomy (Kharkiv);
- ICAMER (Kyiv, Ukraine – Terskol, Kabardino-Balkaria, Russia);

MES of Ukraine (7 institutions)

- Crimean Astrophysical Observatory;
- Nikolaev Astronomical Observatory;
- Astronomical observatory of Taras Shevchenko National University of Kyiv;
- Astronomical Observatory of I. Franko National University of Lviv;
- Institute of Astronomy of the V.N. Karazin Kharkiv National University;
- Astronomical Observatory of Odessa National University named after I.I. Mechnikov;
- Space Research Laboratory of Uzhgorod National University.

The next important steps are envisaged for UkrVO foundation because of the different developments of VO archives in these institutions:

- to make a complex analysis of the current status of the glass collections of all the astronomical institutions of Ukraine and their complete certification; search for the archives non-registered in WFPDB database and analysis of possibilities of their inclusion to the joint database of Ukraine; classification of the UkrVO astroinformation resources, working-out of recommendations for the institutions – owners of these archives;
- to develop and implement the digitizing methodology of the vast glass plate archives, including a software development for arrangement of the digitization of the vast glass plate archives on the basis of the software package DBGPA V2.0 earlier developed in MAO NASU and VO of Nikolev AO for other institutions;
- to create interactive online services for the data mining in the joint archive of digitized images; the arrangement of the online access to the image archive for remote users;
- to create the homogeneous electronic archives of astro informatics resources instead of heterogeneous store places by standardization of the data on astronomic glass plates and spectra;

- to assign online access to these resources, to develop search engines, visualization and verification instruments and data analysis tools with state-of-the-art technologies of data mining and international standards of data exchange and interoperability for scientific and educational purposes;
- to develop interactive online service for the spectral data archives of MAO NASU, IRA NASU, CrAO;
- to adopt the existing electronic archives structures to GRID-technologies implemented in MAO NASU and IRA NASU in order to provide the distributed IT queries mechanism to databases, composed the backbone of the virtual observatory;
- to provide the UkrVO primarily scientific polygon at the basis of the established VO resources of the MAO NASU and Nikolaev AO as a UkrVO prototype;
- to join IVOA in 2010-2011.

The development of the available resources (IT cluster and GRID technologies) and the state-of-the-art UkrVO IT support provide appropriate conditions for the executives to create the UkrVO core on the basis of MAO NASU for its further enhancement with other Ukrainian observational data archives and results of astronomical projects in the wide spectral range. All these steps allow us an effective usage of the resources by the Ukrainian and world astronomical communities as well as to develop and implement appropriate methods of the data verification and certification, which compose the VO informatics base, and to develop appropriate interfaces based on the data standards and the protocols of data exchange proposed by IVOA.

INFLUENCE OF APPARATUS FACTOR OF VISIBILITY ON THE DENSITY OF METEOROIDS STREAMS TAKING INTO ACCOUNT CONDITIONS OF CROSSING OF MIDDLE ORBITS OF METEOR SWARMS WITH THE ORBIT OF THE EARTH

Yu.I. Voloshchuk

Kharkov National University of Radio and Electronics, Kharkov, Ukraine; ort@kture.kharkov.ua.

Differences of the visible distribution of parameters of meteoroids in the atmosphere of the Earth from the veritable distribution in circumterrestrial and moreover in interplanetary space are determined by three factors: astronomical, geometrical and physical. These differences cause distortion in the density of meteors streams. The astronomical factor is a probability of meeting meteor bodies with the Earth calculated from the parameters of orbits on which they move. The geometrical factor characterizes visibility of meteors with different coordinates of radiants, at the calculation of which geometry of reflection of radio waves from meteor tracks and diagram of orientation of the antenna system is taken into account. The physical factor characterizes visibility of meteors with different speeds, at the calculation of which dependence of coefficient of ionization, height of evaporation and distributing of ionization along track of meteor, dependence of coefficient of ambipolar diffusion on a height, and also dependence of initial radius of track on speed and height are taken into consideration.

In addition to the above factors, the distortions in distribution of parameters of meteoroids are brought in by an apparatus factor. It depends on the chosen method of measuring of necessary parameters of meteors and the parameters of apparatus. When using diffraction method with pulse radar, the apparatus factor determines probability of

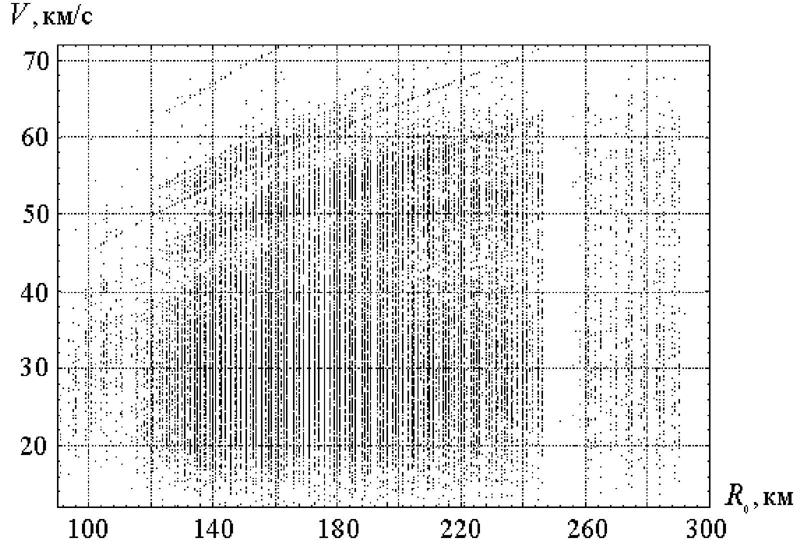

Fig 1. Distribution of meteors observed in Kharkov in 1973.

registration of meteors with different velocities and distances to the point of mirror reflection on the meteor track. The Fig 1. shows distribution (V, R_0) of about 56000 Kharkov meteors recorded in 1973. Due to the apparatus factor we cannot register meteors in top left and bottom right corners of this distribution. Knowing the influence of the apparatus factor allows us to correct distributions of meteor parameters and determine density of meteor streams more correctly. Estimations of density of meteor streams for perihelion of their average orbits are given.

ONCE MORE ABOUT SPACE DEBRIS

Ye. Vovchyk, A. Bilinsky, Ya. Blagodyr,
K. Martynyuk-Lototsky, N. Virun

Astronomical Observatory of Ivan Franko National University of Lviv,
Lviv, Ukraine; evavovchyk@ukr.net.

The scientists began to speak about the near-Earth space pollution in the 80^{th} of XX c. And than the term “space debris” was put into the science language. At present there are more than 10000 of satellites and space apparatus in the near-Earth space, but only 6% are operational. The total number of rotating around the Earth objects are 70–150 thousands with overall dimensions from 1 to 10 cm. The oldest piece of “space debris” is the U.S. satellite Vanguard I, launched in 1958 and it is still in orbit.

Space debris are dangerous in the first place for the cosmic satellites and stations, but they could be also dangerous for the mankind on the Earth. Debris grow, first of all, during launching (the last stages of the rockets, screens and so on; that is nearly 85% of all debris), but they could originate from the collisions between satellites or satellite and some natural body. At present the space debris' weight is more than $3\cdot10^6$ kg. During 1995-2000 it was created nearly $4\cdot10^6$ kg of debris (in the atmosphere it is burning only $8\cdot10^6$ kg). If consider the main price of putting 1 kg cargo into space in $10000, than the costs for making debris are nearly $40 bil.

The most urgent question is still the next: What to do with space debris? At present space debris are only observed and the received information is collected in different databases. The most popular and the most numerous database is the USA NORAD because space debris are observed most of all in the USA (Space surveillance Network). Russia is at the second place (the networks PULKON and ISON), but in other countries including Ukraine the observations are carrying out also.

Considering the importance of the problem there was formed the Inter-Agency Space Debris Coordination Committee (IADC). IADC is an international governmental forum for the worldwide coordination of activities related to the issues of artificial and natural debris in space. The primary purposes of the IADC are to exchange information on space debris research activities between member space agencies, to facilitate opportunities for cooperation in space debris research, to review the progress of ongoing cooperative activities, and to identify debris mitigation options. Ukraine is also a member of this Committee and it has a charge to perform research on the topic of space debris. The Ukrainian astronomical observatory can make a contribution to the questions of observing space debris.

INTRODUCTION OF THE CHINESE SLR NETWORK

Zh. Zhang, F. Yang,
H. Zhang, N. Zhu

Shanghai Astronomical Observatory, Shanghai, China.

The Chinese SLR network, which consists of Shanghai, Wuhan and Changchun stations, was set up in 1989. The operation and data centers are located in the Shanghai Observatory. The Beijing station started tracking in 1992. The Kunming station first got the returns from LAGEOS in winter of 1998. The first Chinese mobile system (CTLRS-1) started ranging in 1996. The second (CTLRS-2) was completed in 2000. Under support of the Ministry of Science and Technology in China, the National Astronomical Observatories, cooperation with the San Juan Observatory in Argentina, a new fixed Chinese SLR station was set up at the San Juan Observatory at the end of 2001.The Chinese SLR network has seven fixed stations and one mobile system, in which CTLRS-1 will become a fixed station by the end of this year. With a state key project from 1997-2000 — the crustal Movement Observation Network of China (CMONOC), the performance of the stations of the Chinese SLR network has been obviously upgraded. Under the support of the second stage of a state key project during the years of 2008-2011, the Chinese SLR stations will be upgraded to capability of kHz ranging and routine daylight with better performance.

DESIGN OF OPTICAL TELESCOPE FOR OBSERVATIONS OF SATELLITES

N. Zhu

Shanghai Astronomical Observatory, Shanghai, China.

The two mirrors reflector which has an aperture about 1m in diameter is often used for observations of satellites. However there are different demands for the observations. For example, the large field of view is usually needed for satellite survey, but the orbit determination of the satellite should have the resolution as high as possible. As far as the size of the CCD chip is limited, these two functions are contradictory if one is only using Cassegrain focus. Using both primary focus with a set of correct lenses and Cassegrain focus in one telescope, such a problem could be solved although it is necessary to change the focus from one to another.

We have adopted an option to swing a secondary mirror by the arm which can be rotated on the truss of the telescope’s tube. The design is quite different with a transfer method of secondary mirror by moving the whole secondary top ring from the telescope completely or making the secondary top ring to rotate 180 ° on the telescope.

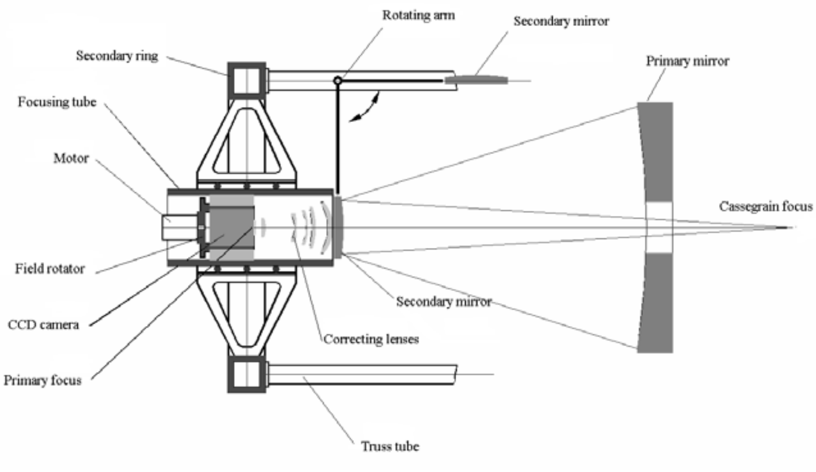

Fig 1. Telescope scheme.

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