

STATE AGENCY ON SCIENCE, INNOVATION  
AND INFORMATION OF UKRAINE  
RESEARCH INSTITUTE “NIKOLAEV ASTRONOMICAL OBSERVATORY”

**ASTRONOMICAL RESEARCH:  
FROM NEAR-EARTH SPACE  
TO THE GALAXY**

International Conference

**ABSTRACT BOOK**

September 26-29, 2011,  
Mykolaiv, Ukraine

**Organizers:**

State Agency on Science, Innovation and Information of Ukraine  
Research Institute “Nikolaev Astronomical Observatory”  
Ukrainian Astronomical Association

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The Book of Abstracts contains abstracts of presentations to the International Conference “Astronomical research: from near-Earth space to the Galaxy” to be held in Mykolaiv, Ukraine, on September 26-29, 2011. Aspects of the positional and photometrical research of near-Earth objects, astrometry of stars and asteroids, the use of virtual technologies in astronomy, as well as historical journey of Nikolaev Observatory are given in it.

## GENERAL INFORMATION

The International Conference “Astronomical research: from near-Earth space to the Galaxy” (NAO190) will be held in Research Institute “Nikolaev Astronomical Observatory”, Mykolaiv, Ukraine on September 26-29, 2011. It is devoted to the celebration of 190 anniversary of Observatory. It is organized to discuss the cooperation in research of near-Earth objects, contemporary observations of stars and asteroids, the use of virtual technologies in astrometry. Some aspects of history of Nikolaev Observatory is also discussed.

### **The Conference Topics will be:**

- positional and photometrical research of near-Earth objects;
- astrometry of stars and asteroids: contemporary observations and virtual technologies;
- historical journey of Nikolaev Observatory.

### **Information about Participants:**

- general number of represented organizations – 29
- number of submitted papers – 62
- number of authors of submitted papers –

The Organizing Committee is grateful for financial support of the Conference to the State Agency on Science, Innovation and Information of Ukraine, the Ukrainian Astronomical Association, Mykolaiv State Region Administration and Mykolaiv City Administration.



**PHENOMENON OF ASTRONOMICAL DYNASTIES  
STRUVE-KNORRE FROM DORPAT UNIVERSITY  
AND LONG-LASTING COOPERATION  
BETWEEN PULKOVO AND NIKOLAEV**

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The state of astronomy and some peculiarities of 18-19 centuries, when Struve and Knorre dynasties appeared in Dorpat (Tartu) University, are shown. For the first time, authors try to explain the phenomenon of cooperation between two astronomical dynasties - from personal relationships between V. Struve and K. Knorre to a long-term cooperation between Pulkovo and Nikolaev observatories their foundation to the present days. The information about Struve dynasty (Wilhelm Struve, Otto Struve, Hermann Struve) and Knorre dynasty (Ernst Knorre, Karl Knorre, Victor Knorre) and brief summaries of joint scientific achievements and research collaboration between Pulkovo and Nikolaev observatories during nearly 200 years are presented.

**THE RUSSIAN-UKRAINIAN OBSERVATORIES  
NETWORK FOR THE EUROPEAN ASTRONOMICAL  
OBSERVATORY ROUTE PROJECT**

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In 2004, the Center of UNESCO World Heritage has announced a new initiative “Astronomy & World Heritage” directed for search and preserving of objects, referred to astronomy, its history in a global value, historical and cultural properties. There

were defined a strategy of thematic programme “Initiative” and general criteria for selecting of ancient astronomical objects and observatories. In particular, properties that are situated or have significance in relation to celestial objects or astronomical events; representations of sky and/or celestial bodies and astronomical events; observatories and instruments; properties closely connected with the history of astronomy. In 2005-2006, in accordance with the program “Initiative”, information about outstanding properties connected with astronomy have been collected. In Ukraine such work was organized by astronomical expert group in Nikolaev Astronomical Observatory. In 2007, Nikolaev observatory was included to the Tentative List of UNESCO under # 5116. Later, in 2008, the network of four astronomical observatories of Ukraine in Kiev, Crimea, Nikolaev and Odessa, considering their high authenticities and integrities, was included to the Tentative List of UNESCO under # 5267 “Astronomical Observatories of Ukraine”. In 2008-2009, a new project “Thematic Study” was opened as a successor of “Initiative”. It includes all fields of astronomical heritage from earlier prehistory to the Space astronomy (14 themes in total).

We present the Ukraine-Russian Observatories network for the “European astronomical observatory Route project”. From Russia two observatories are presented: Kazan Observatory and Pulkovo Observatory in the theme “Astronomy from the Renaissance to the mid-twentieth century”. The description of astronomical observatories of Ukraine is given in accordance with the project “Thematic study”; the theme “Astronomy from the Renaissance to the mid-twentieth century” - astronomical observatories in Kiev, Nikolaev and Odessa; the theme “Contemporary Astronomy” - Crimean Astrophysical Observatory. Also on the basis of collaboration between Ukraine and Russia the Russian-Ukrainian network of astronomical observatories was organized.

The participation in Paris conference, on September 20-22, will be a good opportunity to present and to discuss some questions of selection, protection and preparation of Russian-Ukrainian- network to the List of UNESCO within the topic of the Project “Route of European astronomical observatories ”.

## **REFINEMENT OF APOPHIS ORBIT DURING 2011-2014 PERIOD**

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Discovered in 2004, the potentially hazardous asteroid 99942 Apophis is a famous object for studying the collision threat. This PHA will pass close to Earth in 2029 and several times in the future. According to the properties of this close encounter and with respect to the orbital uncertainties, the orbit of this object could become a collisional orbit during the XXIth century. Therefore the orbit monitoring and the analysis of the error propagation are fundamental to get a better knowledge of the small non gravitational effects and to estimate the collisional risks. At the beginning of 2011, Apophis entered in a short favourable period of visibility. Actually such a period exists again in autumn this year and will run until 2014. That is why observations have been performed in the early 2011. Such new observations can help to refine the Apophis orbit and to study the probability of an impact. In the coming months, new observations must be done and, thanks to these data, it will be possible to refine again the orbit of Apophis. In this communication we present how the observations in early 2011 have improved our knowledge of the orbit of Apophis.

## **NEW REDUCTION OF MINOR PLANETS PHOTOGRAPHIC PLATES OBTAINED WITH PULKOVO NORMAL ASTROGRAPH**

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Currently the program of digitization and new reduction of photographic plates obtained with Pulkovo Normal Astrograph (D = 33 cm, F = 3.5 m, FOV = 2x2 deg) during second half of past century within the framework of studying selected minor planets of Solar system is performed. The digitization is carried out with flatbed scanner adopted for photographic plate's measurements. In contrast to the first

reductions performed in systems of various reference catalogs (Yale, SAO, AGK3 etc.), the reduction of digitized photographic plates allows us to obtain objects coordinates directly in system of modern reference catalog and to avoid errors of transformation between the reference systems. In addition, the new reduction yields a larger number of coordinates of reference stars, measured on photographic plates, as well as background objects that were not previously measured. The series of observations of small bodies resulting from such processing can be used in the future to study of the systematic errors between the reference systems for long time intervals, and also to refine the theories of motion.

This work presents the results of processing more than 400 photographic plates obtained from 1949 to 1964. Reduction procedure was performed and equatorial coordinates of asteroids were calculated with UCAC3 as reference catalog. Furthermore, corrections to the measuring coordinates were obtained. They are based on analysis of (O-C) residuals of the reference stars, thus it allows us to improve reduction accuracy of about 10 mas at average.

Besides an target objects (selected minor planets), coordinates of background objects (stars with large proper motions from LSPM catalog and also another small bodies accidentally being on plates frame) were obtained.

Presented investigations were performed with supporting of RFBR (project #09-02-00419-a).

## **DETERMINATION OF SHORT-TERM PROPER MOTIONS OF FAST STARS WITH PULKOVO NORMAL ASTROGRAPH**

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Structure of local stellar streams within solar vicinity ( $r < 50$  pc) contains information about Galactic formation history. Various dwarf stars are typical objects of stellar population of this part of the Galaxy. But analysis of the kinematics of these stars is complicated by several causes. One of them is that these stars are usually fainter than 12 mag and, therefore, their astrometric history is poor. Hence, an accuracy of proper motions of these stars is insufficient for modern investigations. One of the aims of Pulkovo program of astrometric observations of fast stars is determination of their accurate proper motions with respect to HCRF. Comparison of obtained short-term proper motions (epoch difference is

about 10 yr) with long-term ones (epoch difference is about 50 yr) allows us to detect delta-mu-binaries candidates and find interesting astrophysical pairs of stars. The equatorial coordinates of program stars in UCAC3/HCRF had been calculated on the first stage of project realization. The short-term proper motions of 413 stars had been computed using their positions from SDSS DR7, CMC14, 2MASS, M2000 as early epochs. These proper motions may be distorted by mutual positional systematic errors of the catalogues. That is why image-to-image astrometric reduction had been performed on the second stage. New proper motions have been calculated from combinations of positional data derived from raw CCD-images obtained with Pulkovo Normal Astrograph (D=33cm, F=3.5 m, FOV = 18x16 arcmin), SDSS and WISE.

Presented investigations were performed with supporting of RFBR (project #09-02-00419-a).

## **IMPROVEMENT AND MODERNIZATIONS OF THE INSTRUMENTS FOR OBSERVATIONS OF THE ARTIFICIAL SATELLITES**

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In Lviv Astronomical Observatory the improvement and modernization of the instruments for observation of the artificial satellites were carried out from the moment of the creation of the station for observations satellites in the 1957.

Now the works are underway on:

- positional observations. Particularly, the works on the installation and investigation of different objectives (Uran –9 -- 100/250, Yupiter-9 -- 56/85) with the CCD on the telescope TPL and LD-2; adaptation the software for positional observations with digital tracking (developed by RI “NAO”) on the mounting LD-2 are carried on;
- photometric observations of the low orbit satellite. Particularly, improvement and automation of the 4-axis telescope LD-2; working up the algorithm and software for the treatment of the photometry results of the artificial satellites on the automatic mounting TPL –1M with the objective Uran-9 and the CCTV are going on;
- photometric observations of geostationary objects. Particularly, adaptation of the small telescope (250/1250) on the equatorial mounting with CCD and filter V for observation of the GS satellites is carried out;

- laser-ranging. Particularly, developing and putting on a new system of cooling laser; improvement of the software for observation and processing the results due to demands of the ILRS; reconstruction of the laser set are going on.

## **CHANGE OF PHOTOCENTER OFFSET IN POSITIONAL OBSERVATIONS OF COMET 17 P/HOLMES AFTER ITS OUTBURST**

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The brightness of the comet 17P/Holmes was increased hundreds times on October 23, 2007. About two billion tons of gas and dust were ejected from surface of the comet nucleus at the moment of outburst. Determination of the comet's orbit from observations before and after the outburst shows a systematic deviation of the O-C for observations made after 23 October 2007. It has been suggested that this deviation is due to displacement of the center of brightness. We determined the comet's orbit from observations on the interval from 13.05.2007 to 05.01.2011 with parameters describing the offset between the center of brightness and center of mass of the comet nucleus. The offset has been approximated by polynomials of fourth degree with respect to time. It was assumed that the offset caused by the ejection of matter and its further motion. In this regard, the dynamic model of particles motion in the vicinity of the comet nucleus was developed. The following terms have been included in the equations of motion of particles in the comet head: the perturbing accelerations by the light pressure from the Sun, deceleration (or acceleration) from the flow of the sublimating gas, gravitational attraction from the comet's nucleus and the Sun. The expansion of the gas molecules was assumed to be spherically symmetric in the comet's head. It was also assumed that the particles were spherical and did not encounter with each other. The change of particle diameter due to sublimation of volatile matter contained in them has been taken into account. It was believed that the evaporation occurred isotropically from whole surface of the particle. The simplified model of the distribution of brightness was accepted when the brightness of the center coincided with the central particle in the ejected cloud. The dynamics of the central particle was investigated in the cometocentric coordinate system XYZ. The X-axis coincides with the direction of the Sun at the moment of the outburst; the Y axis lies in the orbital plane and Z axis (perpendicular to the

orbital plane) complements the system to right-handed. The velocity vector,  $V$ , and the particle radius,  $R$ , were calculated. Velocity vector was determined by its module,  $V$ , and by angles  $\lambda$  with the X axis and  $\beta$  with the Z axis. In addition, it was assumed that during some time interval  $\Delta t$  a particle splits into  $N$  parts. Parameters  $V$  and  $R$  were determined by the least squares. The values of  $\Delta t$  and  $N$  were determined by exhaustive search. The polynomials describing the displacement of the center of brightness obtaining from the positional observations have been used as observations. Because of the strong correlation between the angles  $\lambda$  and  $\beta$  the improvement of these variables was carried out by stages: in the beginning set of  $V$ ,  $\beta$ ,  $R$  was improved and then set of  $V$ ,  $\lambda$ ,  $R$  was improved. The results of the improvements and their errors are:  $V=1.18\pm 0.06$  m/sec;  $\lambda=-35^\circ.16\pm 0.01$ ;  $\beta=68^\circ.55\pm 0.41$ ;  $R=26.83\pm 0.48$  m. The values  $\Delta t$ ,  $N$  found by sorting were equal to 20 days and 10,000, correspondingly. It means that the initial particle breaks up into 10,000 pieces within 20 days. Dynamics of the particle with the given parameters allows change in the center of brightness at 90 day interval to be predicted with the mean square error  $\sigma=0."184$ .

Thus, the offset of photocenter of Comet Holmes, derived from the positional observations can be simulated by the motion of large sublimating fragment or a few fragments as large as 53 m in diameter, which during 20 days fly away from the nucleus at a distance 1,208 km (921 km in the radial, 646 km in the transverse and 441 km in the normal direction). Then they are divided into smaller particles as small as 5.3 mm. After that the displacement of photocenter is determined the center of cloud of these particles. 90 days after the explosion these small particles are found at a distance of 4,260 km (893 km in the radial, in the transverse -3637 and 2032 km in the normal direction) from the comet's nucleus.

## **AUTOMATED COMPLEX FOR ESTIMATION OF METEORS COORDINATES BY SCATTERING SIGNALS OF FM BROADCAST STATIONS**

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Frequency-modulated (FM) signal of a broadcasting transmitter, located in Kielce (Poland), is receiving for 24-hour in RI NAO. The Radiation frequency of the transmitter is equal to 88.2 MHz, and the

power is 120 kW. Output spectra of frequency demodulator are analyzed to detect a meteor reflection of radio waves. A method of restoring the analogue of amplitude-time characteristics of FM-signal (ATC-analog), which was developed earlier, is used. Characteristics of ATC-analogue are taken as a model of the signal reflected from the meteoroid trail.

As a result of visual data processing of experimental data the daily estimates of number of meteor signals from August 2010 to August 2011 were obtained. Meteor showers were detected. Time and duration of these showers coincide with the optical observations of IMO (International Meteor Organization).

Reception of FM-signal from Kielce's transmitter was carried out simultaneously at two receiver sites, located at the distance of about 145 km. Differences of noise conditions have been identified. They are caused by differences of temperature inversion on radio paths. The ability of estimations of path difference for radiowaves reflected from meteor was verified by signal convolution. Software for automated detection of meteor reflections of radio waves is developed.

## **RESEARCH OF SEISMIC WAVES CAUSED BY STRONG EARTHQUAKES, WHICH WERE REGISTERED BY FEDCHENKO ASTRONOMICAL CLOCK**

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Since September 2009, the simultaneous recording of readings of Fedchenko astronomical clock (FAC) and seismograph station is carried out in RI NAO. The purpose is to register seismic waves caused by earthquakes. In a few minutes before arrival of seismic wave the effect of an anomalous decrease of the background dispersion fluctuation of the FAC readings (predecessor) is detected. This effect is absent in seismograph station readings. This effect is presumably caused by super-low frequency electromagnetic radiation at the epicenter of the earthquake. The map of the epicenters of earthquakes with predecessors and without them is given. Signal/noise ratio of FAC and seismograph station is compared.

# USING SIGNALS OF SATELLITE TELEVISION TO DETERMINE THE DISTANCE TO TELECOMMUNICATIONS GEOSTATIONARY SATELLITES

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In the RI NAO an experimental hardware and software complex have been designed to determine the difference of the slant range of a geostationary satellite (GSS). The complex consists of two spaced receivers and the processing centre of the received data. Each receiver has an identical set of hardware and software. A standard antenna-feeder system and a TV-tuner card SkyStar-1 are used for receiving DVB-S signals. The TV-tuner card has been modified in part of outputting the in-phase and the quadrature (IQ) signals of the quadrature detector. Temporary realizations of these signals are input data to determine the difference between the slant ranges of the GSS. The signals are recorded on the hard disk of a personal computer (PC) using digital USB-oscilloscopes with a bandwidth of 40 and 200 MHz and with 8 and 9 bit ADC respectively. The moment of the beginning of IQ signals sampling is set by the 1PPS (pulse per second) signal of a GPS receiver Resolution-T and for this reason the 1PPS signal is sent to the external start clamp of an oscilloscope. Reading the temporary realizations of IQ signals from the oscilloscope's memory and recording them on the PC hard disk are made at the moment when the packet with time information arrives from the GPS receiver. The DVB-S transport stream with a symbol rate 27.5 Msym/s is digitized with a sampling rate equal to 102.4 Msample/s. Recording rate – once per second or less.

In the processing centre the cross-correlation functions of temporary realizations of IQ signals obtained by the two receivers at the same moments of time are computed. At the same time the realization of one receiver is used in full (the first sample) and the second one – only the middle part which has the duration of about 10% (the second sample). The time shift of the maximum of correlation function is determined from the beginning of the first sample. A zero-crossing of the Hilbert transform of the correlation function is used to specify this time shift more carefully. The difference between the resulting shift of

the maximum of the correlation function and a given shift of the second sample is calculated. This difference is equal to the relative delay of TV-signal received by the two receivers and it is proportional to the difference between the GSS ranges to these receivers.

Tests of the complex were carried out in condition when the receiver sites were placed in the same position (the distance between the antennas was about 10 m) and the same 1PPS signal was used to run the oscilloscopes. During the tests an additional coaxial cable of around 6.94 m physical length was connected into one of the tracts and a changing of the relative delay of TV-signal due to the cable was determined. The mean delay caused by the cable was 0.025  $\mu\text{s}$  for the standard deviation equal 0.007  $\mu\text{s}$ .

Diurnal variations of the GSS ranges difference were defined in condition when the receiver sites were placed at a distance of about 145 km from one another. The measured standard deviation of the difference equal to 6.0 m or 0.02  $\mu\text{s}$  and it corresponds to the accuracy of the 1PPS signal of the Resolution-T.

Thus, the complex has some worse accuracy than the similar system "DARTS" (Digital Advanced Ranging with Transport-stream Signals) [Harles et al., 2001]. The DARTS ranging system has been developed in cooperation between Fraunhofer Institute for Integrated Circuits and the ASTRA Satellite System. The main reason of the inferior accuracy is the imperfection of the synchronization system. The use of more accurate time and frequency reference at all stages of signal processing starting with the analog-to-digital conversion should improve the complex's accuracy to the level of the best world analogues. The considering complex could be a prototype of an orbit determination system of geostationary satellites. This system will be cheap to implement and fully independent, do not tied to uplink station as is in the case of the DARTS ranging system.

#### REFERENCE

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## **ANOMALIES EMI SYNCHRONOUS WITH THE PASSAGE OF SEISMIC WAVES FROM EARTHQUAKES**

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As a result of a joint analysis of sensor data of Electromagnetic Impulse (EMI), the Fedchenko clock and amplitude VLF transmitter DCF-77 it was determined that the bursts of electromagnetic field had been observed with the arrival of seismic waves from some distant earthquakes. It is possible that the micro-discharge processes during the passage of seismic waves can be the reason of EMI. Such processes may be the reason of methane explosions. The described phenomenon can be used, for example, to take necessary protective measures in the mountain industry.

## **STRUCTURE OF THE NEAR NUCLEUS REGION IN COMET 81P/WILD 2**

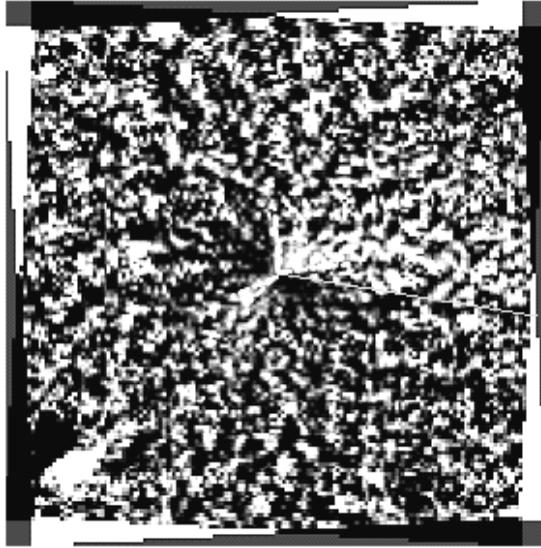
***K.I. Churyumov, V.V. Kleshchonok,  
O.R. Baransky, V.O. Ponomarenko***

*Taras Shevchenko National University of Kyiv, Ukraine*

Dust and gas jets were first detected in comet 1P/Halley (A'Hearn et al, Nature 324, 649, 1986). Then these structures were also observed in comet C/1996 B2 Hyakutake, C/1995 O1 Hale-Bopp, 109P/Swifta-Tuttle (were found in long-slit spectra), C/2004 Q2 (Machholz), 19P/Borelly and 81R/Vilda on board the spacecraft Deep Space in 2001 and Stardust in 2004, the comet C/2005 E2 (McNaught) in 2009 (Picazzio, Churyumov et al. Abstract book. IAU XXVII General Assembly. 3-14 Aug. 2009. p.62).

High-collimated jets observed in comet 81P/Wild 2 (20 jets) and in comets 103P/Hartley (dozens of thin jets), on both light and dark areas and even on the terminator. Jet comet Hartley consisted of carbon dioxide (CO<sub>2</sub>), the powerful flow of the sublimate pushed dust matter and different particles of frozen gases, including ice of H<sub>2</sub>O. This is the basic physical mechanism of formation of jets in the comets.

Space mission Stardust investigated short-period comet 81P/Wild 2 on January 2, 2004 and captured numerous samples of cometary and interstellar dust particles which were delivered to Earth on January 15,



*Fig. Comet 81P/Wild 2 on March 28, 2010 at 20.5567h UT (average time).*

2006. In the frame of the international program of ground support of space missions astronomers from the Department of Astrometry and Solar system small bodies (Baransky and Ponomarenko) observed 81P/Wild 2 comet on March 27 and 28, 2010 using the Zeiss-600 reflector with narrow band comet filters of the High-mountain astronomical station of Institute of Astronomy of Russian Academy of Sciences and Main Astronomical Observatory of National Academy of Sciences of Ukraine in Peak Terskol.

During March 28, 2010 from 19.7836<sup>h</sup> UT to 21.3543<sup>h</sup> UT 16 narrow-band images of comet 81P were obtained, using filters, centred on the spectral region of the continuum. After adding 10 sequential images we got the following image (Fig.). Line shows the direction from the Sun.

Detection jets in comet 81P shows the presence of a wide jet (it consists from multiple jets, which because of the small resolution merge in broad beam) directed upward (to north) and a narrow jet downward (to south). The main results are: 1. The axis of rotation of the comet nucleus at the time of observation on March 27-28, 2010 had the small positional angle in the picture plane  $\varepsilon \approx 127 \pm 5^\circ$ . 2. Major releases of dust structure generated by two active regions: the near pole jet by width of  $20 \pm 5^\circ$  and the opposite one by width  $77 \pm 15^\circ$ . 3. Active areas of the nucleus of comet 81P/Wild 2 may exist within more than 10 years.

# VERIFICATION OF THE MODEL OF THE ARTIFICIAL EXPLOSIVE CRATER ON THE COMET 9P/TEMPEL NUCLEUS

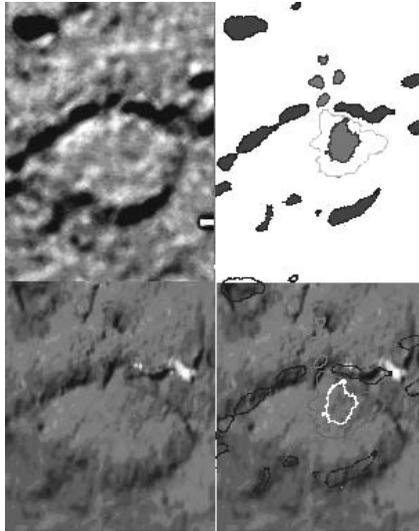
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As one of results of collision of the copper impactor of the spacecraft Deep Impact, which had mass of 372 kg, with the 6-km icy nucleus of short-periodic comet 9P/Tempel 1 at velocity of 10.2 km/s on July 4, 2005 an artificial impact crater was formed on the surface of the comet Tempel 1 nucleus. Using theoretical model of collision of the copper impactor with the cometary nucleus, we got the possible crater diameter on the nucleus of comet Tempel 1, formed by the impactor, must be equal from 40 to 80 m and its depth must be equal from 5-6 m. On February 14, 2011 spacecraft Stardust-Next reached comet 81P/Wild and passed to Earth 72 pictures of the comet nucleus at a distance of 181 km. These photos showed the artificial crater on the surface of a comet nucleus 9P, formed by the Deep Impact impactor in 2005.



*Fig. Identification of the true place of falling of the Deep impact copper impactor on the comet 9P nucleus surface*

Using the image-processing program, proposed by O.P. Kuchеров, on the new nucleus images of comet Tempel 1 we detected an artificial impact crater (shown in the lower right region of the picture) within the old crater on the comet nucleus. The position and sizes of the crater detected by us differs from those, which experts determined in [<http://stardustnext.jpl.nasa.gov/>].

In the picture we see a dark spot - impact hole, which is the own artificial shock crater. It has the diameter close to 60 m. Now, when we see that the true diameter of the crater is about 60 m, which practically coincides with our forecast, it is possible to determine the strength of materials surface layers comet nucleus. On the basis of the model [K. I. Churyumov, V. G. Kruchynenko and L. S. Chubko. The Size of the Artificial Explosive Crater on the Nucleus of Comet 9P/Tempel 1 //Deep Impact as a World Observatory Event: Synergies in Space, Time, and Wavelength. ESO Astrophysics Symposia. 2009, 191-196], the dependence of strength  $\sigma_p$  surface layers of the comet nucleus on the diameter of the crater formed by:  $\sigma_p = 5.2 \times 10^{20} D_c^{-4.286}$ . Here are the size of the crater diameter  $D_c$  in cm and the strength  $\sigma_p$  in  $\text{dyn/cm}^2$ . Taking  $D_c = 55 \text{ m}$ ,  $60 \text{ m}$ ,  $65 \text{ m}$ , respectively we receive  $\sigma_p = 4.8 \times 10^4 \text{ dyn/cm}^2$ ,  $3.3 \times 10^4 \text{ dyn/cm}^2$ ,  $2.4 \times 10^4 \text{ dyn/cm}^2$ . As we got in our previous works, the strength of material surface layers comet nucleus approximately identical strength dust balls (dustball)  $\sim 10^4 \text{ dyn/cm}^2$  that exist in interplanetary space and there are probably at the disintegration of comet nuclei and which were discovered by a meteor observations.

## **EXPLORATION OF COMET 67P/CHURYUMOV-GERASIMENKO – THE MAIN TARGET OF THE “ROSETTA” SPACE MISSION**

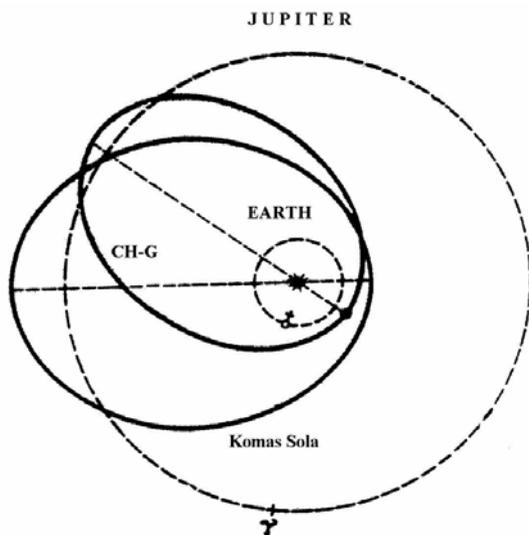
*K.I. Churyumov, O.K. Melnik*

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Short-period comet 67P/Churyumov-Gerasimenko was discovered in 1969 by Klim Churyumov and Svitlana Gerasimenko on the five plates got in Alma-Ata on Sept. 9, 11 and 21, 1969 at 50-cm f/2.4 Maksutov telescope. Some physical parameters of the magnetic field of comet plasma tail (coefficients of diffusion  $D_{\text{par}}$ ,  $D_{\text{per}}$  and induction of magnetic field  $B$ ) were determined on the basis of photometric processing of two photographic images of comet 67P obtained in

Nizhny Arkhyz on Jan. 12-13, 1983 at the 6-m BTA reflector of SAO RAS. Detailed light curve of comet 67P was built on the basis of the visual observations of its integral magnitudes during 1982-83. It was allowed to compare changes of comet brightness with the changes of some indices of the solar activity and to find a good correlation between comet and solar activities. The nucleus of comet 67P/Churyumov-Gerasimenko emerges as an irregular body with an effective radius (that of the sphere having the same volume) of 1.72 km and moderate axial ratios  $a/b$  of 1.26 and  $a/c$  from 1.5 to 1.6. The overall dimensions measured along the principal axis for the two solutions are 4.49–4.75 km, 3.54–3.77 km and 2.94–2.92 km. The nucleus is found to be in principal axis rotation with a period  $\sim 12.4$ – $12.7$  h.

Comet 67P/Churyumov-Gerasimenko has an unusual history. Before 1840 the comet had an orbit that kept it pretty far from the Sun. In 1840 it got close to Jupiter. The strong gravity of Jupiter changed the comet's orbit, moving it closer to the Sun. Its perihelion distance decreased from  $q \sim 4$  AU after an encounter with Jupiter and the orbit shifted inwards to a perihelion distance of  $q \sim 3$  AU. From there it slowly decreased further to 2.77 AU, from which a further Jupiter encounter in 1959 moved it into the recent orbit with a



*Fig. Orbits of comets 67P/Churyumov-Gerasimenko and 32P/Comas Sola in 1969*

perihelion distance of  $q = 1.28$  AU. Since the comet was far from the Sun until recent times, it hasn't melted very much. That means it hasn't changed very much since it was "born", when our Solar System was young. Scientists are interested in studying of such comets because they may help to learn about the early times in the history of our Solar System. In 2003, short-period comet 67P was selected for the main target of the "Rosetta" space mission from more than 200 known short-period comets. On March 2, 2004 Rosetta space mission successfully started from the Kourou cosmodrom to comet 67P/Churyumov-Gerasimenko nucleus. Rosetta will be the first spacecraft on the orbit of a comet's nucleus. It will be the first spacecraft to fly alongside a comet as it heads towards the inner Solar System. Rosetta will be the first spacecraft to examine from close proximity how a frozen comet is transformed by the warmth of the Sun. A lander, named Philae, will be deployed and attempt to make the first ever controlled landing on a comet.

The best estimate of the bulk density of comet 67P/Churyumov-Gerasimenko is  $370 \text{ kg m}^{-3}$  and a comet nucleus mass is  $\sim 8 \times 10^{12} \text{ kg}$ , which should ease the landing of Philae and insure the overall success of the Rosetta mission.

## **STATISTICS AND ANALYSIS OF THE UNCERTAINTY OF ASTEROID ORBIT**

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In April 2011, the number of discovered asteroids reaches 550 000. This large number of asteroids allows a statistical analysis especially for their orbital uncertainty. For Near-Earth Asteroids, the estimation of the uncertainty is particularly important in order to estimate their close approach from Earth and eventually their risk of collision. We analyse uncertainty parameters (CEU, U) of the two main databases ASTORB and MPCORB, in relation to their orbital characteristics (orbital arc, absolute magnitude,...). A review of the different measurements is also done and the impact of these measures on the accuracy of the orbit is also estimated.

## **IMPROVEMENT OF ASTROMETRY AND DYNAMICAL MODEL OF PHOEBE**

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We have developed a new dynamical model of Saturn satellite Phoebe by taking into account perturbations of the main planets, the main satellites and the flatness of Saturn. The dynamical model can be fitted to a large set of observations from 1904 to 2011. An important improvement of this set can be realized by applying different techniques. In particular, some old observations can be reduced by using an accurate stellar catalogue and the treatment of star catalogue biases can be applied for almost 75% of the set of observations.

## **BEHAVIOR MODEL OF SATELLITE "PAGEOS" IN ORBIT BEFORE AND AFTER ITS DESTRUCTION**

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A well-known geodetic satellite "Pageos" - an object with a diameter of 30 m and weight of 56 kg, was at an altitude of near 4000 km about 10 years. It was an excellent indicator of the impact on the own rotation of the spacecraft of various disturbing factors in near space than has attracted attention of specialists in the field of satellite control. The satellite was destroyed after 9 years. Two big holes and several smaller ones were formed on its surface. It was observed almost a year in this state.

The Laboratory for Space Researches UzhNU has accumulated a large observational photometric material over the years. After several years of treatment and comprehensive analysis, it would create the model of the quite complex rotation of the object under the influence of other celestial bodies. The uniqueness of this case is that we were able to trace the behaviour of the satellite before the "disaster" and after. The values of the perturbations of the object by

the gravitational fields of Earth and Moon, as well as solar radiation, were defined. The reasons for the precessional satellite's rotation, secular precession and seasonal changes in its own period of rotation were detected. The law of conservation of angular momentum in the event of "catastrophic" events with a satellite in orbit has been confirmed experimentally.

## **INVESTIGATION OF OWN ROTATION OF "MIDAS" SATELLITES AT THE MINIMUM SOLAR ACTIVITY**

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Satellite systems "Midas" (especially the "Midas-4") were quite good indicators of the slightest changes in solar radiation on the boundary of Earth's upper atmosphere. An indicator of such changes is the period of own rotation of satellites, which correlates with solar activity over all solar cycle.

The Laboratory for Space Research UzhNU attempted to assess the relative changes in the "solar constant" during the cycle of solar activity on results of observations of these satellites. The conducted results show that it is necessary to exclude other disturbing factors affecting the proper rotation of chosen objects, although they are smaller in value. Hence, it is very important to know the behavior of objects "Midas" during a deep minimum of solar activity. Such opportunity was presented during last 3-4 years. The results confirmed that during the last "quiet" of the Sun surface, these objects were rotated about their axis faster than for all the years of their orbit life.

So, the satellite "Midas-3" in 2008-2011 years has period of own rotation varied in the range 104 - 108 seconds, the "Midas-4" - 88.2 - 92.5, the "Midas-6" - 70.1 - 74.3, the "Midas-7" - 127 - 148 seconds. Small changes in their rotation caused by other, not solar, disturbances, the magnitude of which can already be measured reliably.

Thus, we set the "zero-point" for further data investigation of these objects for monitoring of solar activity and its influence the Earth's atmosphere.

# EFFECT OF LIGHT RADIATION ON GEOSYNCHRONOUS SATELLITES MOVEMENT

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The Lagrange equations in the Gauss form use to determine the perturbations of orbital elements due to solar and terrestrial radiation, as well as the satellite passes the Earth's shadow. It allows us to compute derivatives of the orbital elements of the geosynchronous object (GO) under any of the disturbing force by a known vector of the GO acceleration and orbit elements. The gravitation of the Moon and heterogeneity of Earth's gravitational field taken into account in calculation the orbit elements. The formula for acceleration vector allows us to calculate the acceleration from the direct solar radiation, radiation from the Earth and as a result of the GO passage through Earth's shadow. Numerical integration or special method of harmonics where used to decide the Lagrange equations. The calculations were performed on the interval 10 - 15 years with an increments of 0.001 days for 16 satellites selected from the GO catalog.

It is shown, that the direct solar radiation leads to short periodic changes in all elements of the orbits of geosynchronous satellites. Periods of change for semi-major axis  $a$ , inclination  $i$  and longitude of the ascending node  $\Omega$  are of one day. Eccentricity  $e$ , argument of perigee  $\omega$  and mean anomaly  $M$  vary with a period of 0.5 days. Direct solar radiation also leads to long-period changes of  $e$ ,  $\omega$ ,  $M$  with a period of one year.

When the satellite passes through Earth's shadow the minor secular changes of  $a$ ,  $i$ ,  $\Omega$  happen. Periodic changes are not harmonious. All the elements are harmonic with a period of one day. Period of their long-term changes is a year ( $a$ ,  $e$ ) or 0.5 years ( $\omega$ ,  $i$ ,  $\Omega$ ,  $M$ ).

Reflected sunlight from the Earth's surface leads to a very small secular changes of the semi-major axis only. All orbital elements have daily inharmonic and annual harmonious changes of small amplitude. Diurnal harmonic vibrations of orbital elements occur under the influence of Earth's infrared radiation. Long-period changes are absent. Slight secular changes of  $a$ ,  $e$  and  $M$  were found. Inclination  $i$  and longitude  $\Omega$  virtually unchanged by the radiation from the Earth (own and reflected).

# RESIDUAL ROTATION OF THE HIPPARCOS/TYCHO-2 SYSTEM DETERMINED FROM THE DATA OF THE XPM CATALOGUE

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From a comparison of absolute proper motions of stars from XPM catalogue with those of the same stars from PPMXL, UCAC3, Tycho-2 and XC1 catalogues, the equatorial components of the rotation vector of these coordinate systems were determined with respect to the coordinate system spaced by positions and proper motions of XPM. These parameters are calculated with the use of about 90 million stars from the UCAC3 catalogue and about 300 million stars from the PPMXL catalogue. It was shown that HCRF, represented by Tycho-2, PPMXL, UCAC3 and XC1 catalogues, have a significant rotation component  $\omega_z = (-1.8 \pm 0.16)$  mas/yr about the equatorial axis directed to the celestial pole. The result is confirmed by the analysis of the formal proper motions of the extragalactic sources from catalogues under consideration.

## BASIS OBSERVATIONS OF METEORS USING TV REGISTRATIONS

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An overview of the results of basis observations of meteors, conducted by Odessa and Nikolaev Astronomical Observatories (in 2010-2011) is presented. Observations were carried out on the bases: Nikolaev - Odessa (Kryzhanovka), distance - 100 km; Odessa (Kryzhanovka) - Snake Island, distance - 150 km. Description of telescopes for basis television meteor patrolling is presented. The original method of observations with a TV camera is described. Software for observation, identification, and automatic measurement of stellar images coordinates for positional linking is created.

Statistics of fixed meteor phenomena in basis observations is presented. Estimation for the accuracy of kinematic characteristics of meteor phenomena, determined on the different basis distances, is made. Advantages and disadvantages of different methods of observations and

processing are discussed. The database structure of the meteor patrolling and opportunities for immediate processing of observational data are described.

Questions of modernization of basis meteor patrolling with the use of new technical possibilities of receiver equipment and management systems are discussed. Prospects of basis television observations in meteor studies are presented.

## **PERSPECTIVES OF SPECTRAL OBSERVATIONS OF NEAS AT THE RTT150 TELESCOPE COMPLEX**

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New option, tracking on given trajectory, has been realized in an observational complex of 1.5m telescope RTT150. This makes it possible to get long exposure with minimal signal loss of the objects with high proper motions, in particularly, Near Earth Asteroids (NEAs). The reflecting spectra of NEAs – 433 (Eros), 1036 (Ganymed), 1917 (Cuyo) and 8567, with magnitudes range from 10.5 to 16.5 and the proper motion range from 20 to 160 arcsec per hour were obtained. The spectra are covered visible range from 3500 to 9000 Angstrom with the resolution  $R \sim 600$ . To compare the quality of spectra of asteroids with known classes (433, 1036 and 1917) the spectral classification in SMASS system were performed. The spectral class of NEA 8567 was estimated for the first time as a class Q. Due to “tracking on given trajectory” are carrying out without feedback, the exposure time of highly movement asteroids is limited by 600 seconds. For this duration the reflecting spectra of 16 mag asteroids with signal-to-noise ratio from 8 to 25 at whole visible range are obtained.

## **CLOSE ENCOUNTERS BETWEEN ASTEROIDS FOR DETERMINING ASTEROID MASSES IN THE TIME BEFORE GAIA**

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One of the possible scientific outcomes of the future Gaia mission in the field of Solar system research will be masses of large asteroids.

The perturbing effect of these asteroids onto orbits of asteroids of small masses is expected to be measured with reasonable errors during Gaia mission. For the cases of maximum perturbation for asteroids of small masses being occurred before or just after Gaia mission, the ground-based astrometric observations of high accuracy can be helpful in getting better solution.

The population of discovered asteroids is constantly growing, so the previous calculations made earlier (Kuzmanoski & Knezevic 1993, Hilton et al. 1996, Galad 2001, Galad & Gray 2002, and Fienga et al. 2003, Mouret et al. 2007) were not able to consider asteroids as perturbed candidates discovered later.

The details of method used (Hilton et al. 1996), the results of calculations made useful for planning astrometric activities at the ground-based telescopes will be described.

## **ASTROMETRY AND PHOTOMETRY OBSERVATIONS OF SELECTED ASTEROIDS WITHIN THE INTERNATIONAL JOINT PROJECT**

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The participating institutions of France, Ukraine, Russia and Turkey are engaged in the joint project complementary to one of the Gaia outputs for research of Solar system objects, namely determination of masses for large asteroids. The idea consists in observing and thus providing astrometry observations for the selected asteroids, which are already or will be perturbed before the launch of Gaia mission in 2013. Such observations will have high added value for those asteroids perturbed just before or after the mission window, and for which the Gaia data alone are insufficient. These observations will provide the orbit at the time of maximum deflection angle or perturbation useful for the later mass determination together with the Gaia data.

The paper presents statistics of observations made at the Russian-Turkish telescope RTT150 under the international joint project in 2008-2011. Besides, the standard errors of astrometric and photometric measurements are given and discussed. Current status of the project, problems and possibilities are also discussed.

## **THE COLLABORATION BETWEEN SHAO AND NAO — CELEBRATION OF THE 190TH ANNIVERSARY OF NAO**

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The long histories of SHAO and NAO are briefly described. The process of collaboration between SHAO and NAO, which has been implemented near 15 years since October 1996, is reviewed. The scientific results, such as link between optical and radio reference frame, Sino-Ukrainian network of optical telescopes for observations of the Space Debris on the low orbits, manufacture of rotating CCD camera etc., are attained and introduced. Finally, the further collaboration in the near future is suggested.

## **OBSERVATIONS WITH KYIV MERIDIAN AXIAL CIRCLE**

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The Kyiv meridian axial circle (MAC) is a meridian refractor (D=180 mm, F=2.3 m). This instrument was used for observations of star fields in the direction of ICRF objects and, currently, for the equatorial zone astrometric survey. Since March 2001 we have started the program of observations of star fields with extragalactic radio-sources, which is now completed. The purpose of the astrometric survey program is to determine positions, proper motions, magnitudes and V-R colours of faint stars in the equatorial zones.

# **SOME PROBLEMS IN ARTIFICIAL CORRECTION OF ORBITS OF POTENTIALLY DANGEROUS ASTEROIDS**

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Modern calculations of orbit evolution of the Solar system bodies can predict precisely the time and the circumstances of asteroid approaches with the Earth. If a possibility of the asteroid falling on the Earth's surface appears, an effective method to prevent such falling may be artificial correction of the asteroid orbit. One of the correction methods, which are now considered, is bombardment of the asteroid surface by massive bodies or exploding charges.

To realize such space experiment it is necessary:

- a) to calculate precisely the asteroid orbits evolution;
- b) to know exactly the asteroid physical characteristics (size, mass, surface density);
- c) to calculate precisely the additional momentum to asteroid from the explosion of the its surface.

It is known that in 2029 asteroid Apophis will have a close approach with the Earth. After that, a possibility of its falling to the Earth's surface may appear in 2036 – 2037.

A possibility of artificial correction of Apophis orbit was considered to eliminate of such falling. The convenient time for the asteroid bombardment may be on January, 2013. Thus, the launch of the spacecraft should be planned on the end of December, 2012. Additional heliocentric velocity for the asteroid of 5 mm/sec will be sufficient. The necessary correction can be realize if a body with weight about 5 tons will fall on the asteroid surface or if the charge capacity of at least 100 tons of TNT will explode. There were estimate the influences of the above paragraphs. a) – c) on errors at the calculations and realization of the space experiment. The calculations accuracy of the asteroid orbit evolution (a) can introduce an error of a few percent, the accuracy of the presently known physical characteristics of the asteroid (b) - 50 - 100 percent, the calculation accuracy of additional momentum from the explosion (c) - 200 - 400 percent. To substantially reduce of these errors it is necessary to obtain accurate data on the size and mass of the asteroid. Just such space experiments can increase the calculation accuracy of additional momentum from the explosion.

# **INTERNATIONAL ASTRONOMICAL-CULTURAL INITIATIVES AND UKRAINIAN ASTRONOMICAL HERITAGE IN THE CONTEXT OF WORLD HERITAGE**

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Astronomy as science of world view has left its mark in many areas of human culture. Astronomical movable and immovable monuments as cultural and scientific content recently started to be studied carefully, and finally receive their recognition for their further preservation. Various international organizations have initiated a diverse case studies of these monuments, produced some recommendations for their organization, typology, division into periods. In joint programs, experts of IAU, UNESCO, ICOMOS elaborate criteria for selection of monuments of global significance. Complete study of astronomical sights will allow to consider the history of scientific knowledge dissemination in time and in space.

Ukraine has also carefully examined their stored astronomical monuments scattered in astronomical observatories, libraries, archives, museums, university collections, architectural ensembles, archaeological parks and cemeteries. In conditions of instability and crises it is important to establish uniqueness or typicality of certain historical sites, to study their characteristics and identity, relationship with global trends that will enable their successful promotion and protection. Part of these research works are conducted in our observatories, but not as intensively as in other countries. They have not engaged in related industries and professionals authorized state institutions. Not having used an active effort in this case, we can stay behind the big international project for study the intellectual and cultural heritage.

## **REPROCESSING RESULTS OF PHOTOGRAPHIC OBSERVATIONS OF AO KNU: STAGE OF ORGANIZING, CATALOGING AND EVALUATION OF ACCURACY**

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The collection of photographic images of Kiev University Observatory covers a period of almost a hundred years and it is interesting from scientific and historical point of view. The study of contemporary

techniques of such observations, processing of negatives, creating of copies of them, a photometric standards using various photographic emulsions and photographic materials in combination with preserved photographic techniques and astronomical instruments (from telescopes unique homemade photometer to cassettes) - reflect the age-old history of photographic field of astronomy. For the first, celestial objects, astronomical events, star fields, recorded on such a long time interval have a valuable information. For the second, complete restoration of information causes many difficulties. Even with well-preserved emulsion for a hundred years, the standarts for description of photographs repeatedly were changing; not all magazines of observations are preserved; sometimes it is not possible to install a toll, which held up. Therefore phase of systematization and cataloging the collection is very important and quite difficult. Conduction of observations in expedition conditions with various instruments requires a comparative assessment of their accuracy. This division performed on a series of collections, identified photos, and selected certain standards, scanned images of each series by the standard method compared with catalogue information. In the future such work will enable a quick search and use images in conjunction with other than the object coordinates, date, method of observation, and for astrometry and photometric accuracy.

## **THE RESULTS OF NEW REDUCTION OF PULKOVO PHOTOGRAPHIC PLATES WITH SELECTED ASTEROIDS AND PLUTO USING THE DAMIAN DIGITIZER.**

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For the present times, there are a lot of photographic plates with observations obtained in XIX - XX centuries. They include plates with the observations of Solar system bodies in the astronomical institutes all over the world. Digitization and new reduction of old photographic plates and modern CCD observations of Solar system bodies are important for solving many actual problems of modern astrometry and celestial mechanics, in particular, for improved ephemerides of the Solar system

bodies. Special attention deserves the observations of Pluto in connection with planned space mission "New Horizons" to this object in 2015.

The glass plate archive of Pulkovo observatory contains more than 50000 photographic plates with observations of astronomical objects. Among them, more than 5000 plates with images of planets, planetary satellites and asteroids. 47 Pulkovo photographic plates with selected asteroids and 50 plates with Pluto were measured using DAMIAN digitizer at Royal Observatory of Belgium (ROB) in September 2009 and January 2010.

The results of new astrometric reduction of these plates are given. Random and systematic errors of the measuring device have been analyzed. The random error of measurement objects for one plate is in the range 0.06-0.1 microns. Plates with selected asteroids (NN 1,2,3,4,6,7,11,18,39,40,532) contain the observations during the period of 1954-1983, plates with Pluto contain the observations during the period of 1930 – 1960. The six-constant method with UCAC3 catalogue was used for the astrometric reduction. There were from 20 to 200 reference stars per plate depending on the galactic latitude. The average value of the measurement error of coordinates of reference stars on a plate is 15-20 mas. The error of reduction (error unit of weight) is 95-110 mas.

The internal positional accuracy of the PLUTO during 1930-1960 is 170 mas for RA and 140 mas for DECL. The results of comparison of the observed equatorial coordinates of the PLUTO with ephemerides DE200, DE405, INPOP08, INPOP10, EPM2008 were analyzed.

The completed processing of digitized plates has confirmed the high precision of the ROB digitizer and the possibilities of its use for the processing of astronegatives. This work was supported by grant from the Department of Science at the French Embassy in Russian Federation.

## **COMETARY SOURCES OF THE METEORITE-DROPPING METEOROIDS**

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The existence of possibility of cometary sources of the meteorite-dropping bodies is considered. The literature discussing possible relationship between meteorite-dropping bodies and cometary sources is

rare and quite limited in extent. The collection of terrestrial meteorites consist of 4% nickel-iron meteorites, ordinary chondrites (OC) forming 85% from fallen and discovered meteorites. Carbonaceous chondrites (CI, CII), forming 9% from the whole available mass in collection meteorites and, probably, it is not enough to be presented because of their fragility and low density. It has been estimated that about 24000 meteorites with masses from 100 to 10 kg fall to Earth each year and among them there are few meteorites that would have been a cometary origin. For the present day, there are nine well known orbits for meteorite-dropping fireballs and seven of them are producing meteorites H4-H6 type chondrite that has an asteroidal orbit. Other two meteorites Tagish Lake and Orgueil have low density of  $1.6 \text{ g/sm}^3$  and fragile nature. It was the first clue that Tagish Lake might be a primitive type of chondrite.

Tagish Lake meteorite is related to the known  $\mu$ -Orionid fireball stream. Moreover, the 60-Orionid meteor stream and asteroid (4183) Cuno can be connected with the  $\mu$ -Orionid fireball stream and the Tagish Lake meteorite.

Meteorite Orgueil is carbonaceous chondrite that has an orbit similar to that of Jupiter-family comets (JFCs), although a Halley-type comet cannot be excluded.

The established associations of some known meteoroid streams with asteroids, suggests that such asteroids can be dormant comets. Many cometary meteoroid streams were formed by the continuous sublimation of the ice-rich regions in cometary nuclei. Other important mechanism which forms the meteoroid stream connected with comet is the catastrophic disruption of cometary nuclei and generation of m-sized fragments. Formed large fragments are potential candidates to produce meteorite-dropping meteoroids which cross the Earth and can survive during interaction with the Earth's atmosphere. Among 56 MORP fireballs, there are 12 candidates to produce meteorite-dropping meteoroids which have objects with cometary orbit. We present here some physical properties of the likely meteorite-dropping superbolide 230708 recorded on July 23, 2008 (Tajikistan), which belongs to the cometary meteor shower June Bootids. Taking into account the fireball velocity and atmospheric density at the height of three bright flares (35 km, 28 km, 26.5 km), formed as a result of meteoroid fragmentation, the aerodynamic strength 1.5 MPa, 2.9 MPa and 3.1 MPa respectively was obtained. According to the obtaining aerodynamic strength, end height (19 km) for the luminous trail and computed terminal mass, fireball 230708 is a good candidate to produce meteorite.

As a result, we can conclude that both, the fireball and the meteor streams of cometary origin, can include large, m-sized meteorite-dropping bodies. The detailed study of physical and structural properties of this component of interplanetary bodies yields very important information about the sources of meteorites – comets and asteroids, from which they have been occurred.

**THE RESULTS OF THE JOINT PHOTOMETRIC  
OBSERVATIONS OF THE ARTIFICIAL SATELLITES  
IN ODESSA ASTRONOMICAL OBSERVATORY  
AND IN THE NATIONAL SPACE CENTRE**

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The photometric observations of the artificial Earth satellites (AES) give the opportunity to obtain information on the form, optical properties of the surface and the parameters of rotation, such as angular velocity and orientation of the satellite’s rotation axis in space. The basic observations and the synchronous ones all the more, are the most useful for interpretation. In the present study, we considered some results of the photometry of the geodesic satellite Ajisai, the first “sailer” in the atmosphere NanoSail-D2, etc.

318 reflecting flat mirrors are placed on outer surface of spherical satellite. Ajisai can be a convenient source of the time-calibrated optical signals, for instance, to synchronize the photometric observations, obtained at different sites. When being observed, the satellite demonstrates numerous short (~0.0014 sec) flashes of brightness with the period of reiteration of the flashes series of about ~2 sec. The light curve is quickly transformed due to alternation of the mirrors, reflecting the light towards the observer. Observing the repeated sequence of flashes, it becomes possible to determine the true orientation of the Ajisai rotation axis successfully and to determine with high precision the value of the sidereal period of its rotation. The goal is to determine the current real period and the space position of the Ajisai rotation axis and to use its mirrors as the reference source of the optical pulses on the one hand, and for exchange of the laser pulses between different stations of the ILRS network on the other hand.

Satellite NanoSail-D2 with the sail area of about 10m<sup>2</sup> has been independently flying since January 2011. This satellite is a prototype of the future mechanisms for the accelerated deorbit the space debris. In the present report, the character of the sail's drag in the Earth upper atmosphere, as well as the properties of its movement about the center of masses are considered. The satellite's dynamics is causing it to orbit the Earth in a flat spin as opposed to a random tumble, or facing into the direction of flight velocity. It is supposed to be the cause of the insufficiently quick braking of the sail. The photometric observations discover different changes of the satellite's brightness, including regular variability. In the latter case, the photometric period is about 5 sec in the end of April with 12 clearly visible variations within period. That confirms the opinion that in the result of interaction with the flux of particles of the upper atmosphere, the sail switched over to the mode of rotation about axis, which does not coincide with the axis of symmetry and, possibly, rapidly precesses in space. The results of modeling of the NanoSail-D2 rotation are presented.

## **CORRECTION OF DIGITIZED IMAGES OF PLATES USING A RULER WITH CALIBRATED LINES, METHODS AND FIRST RESULTS**

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Problems of the processing of scanned images of photographic plates in terms of getting the most accurate astrometric information are described. Method for refinement of coordinate information includes image pre-processing, namely, digital filtering, separation of useful information, identification of image part that contains a ruler with calibrated lines. Next steps are linear approximation of the lines, obtained from image, their identification with the reference measurements obtained with measuring machine Fantasia (GAO RAS, St. Petersburg), and correction of image grid.

Serious attention devoted to the stage of preliminary processing of images is caused by a fairly high level of noises of consumer scanners, which we use to produce images of photographic plates, as well as the heterogeneity of the background caused by optical effects, which essentially is a feature of instrument on which the plate was exposed.

These problems require a solution at this preprocessing stage, since their contribution to the final error is quite high and often difficult identification of ruler lines, as well as images of the observed objects.

At the current stage of work after the correction of plate grid, the image is saved in standard FITS format for calculating the object coordinates by existing programs. In the future, to get more precise coordinates of the objects, we are going to create an interface for transmitting the raw coordinate information of objects into other software developed in NAO.

The first tests of this method and software, produced using the plate with the Pleiades open clusters, showed positive results.

## **FORMATION OF CATALOGUE OF GEOSYNCHRONOUS OBJECTS IN RI NAO**

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The catalogue of the orbital elements of geosynchronous objects was generated from observation results obtained in the period of 2008-2010. Observations were carried out by the combined CCD observation method at Fast Robotic Telescope. The catalogue contains orbital elements of 67 objects. The orbital elements were used to calculate ephemerides on the interval from 2 to 200 days. The comparison of calculated ephemerides with new observation results was made. This made possible to estimate the calculation error of ephemerides and the necessary term of new observation.

The software for generation of geosynchronous objects observation list was developed, which consider the analysis of obtained results. The conception of Internet site for catalogue presentation was developed.

## **OBSERVATIONS OF NATURAL AND ARTIFICIAL OBJECTS IN NEAR-EARTH SPACE USING THE COMBINED OBSERVATION METHOD**

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Near-Earth objects, such as artificial satellites and potentially hazardous objects are difficult for optical astrometry observations. High

apparent motion makes difficult to use long exposure time and to determine coordinates relatively to reference stars at once. This problem is most serious for middle and low Earth orbits. A combined observation method (COM) is effective for astrometry observations of near-Earth objects. COM gives high accuracy for faint objects with high apparent motion. The idea of COM is to accumulate images of object and reference stars separately using different accumulation modes. First COM was used in 1960-s for photographic observations of artificial satellites.

A great experience of COM using with CCD cameras was gained in RI NAO since 2000 year. The implementations for full-frame CCD and TV CCD matrix were designed. In both implementations there is no mechanical movement during frame accumulation.

For full-frame CCD, COM uses time delay integration mode (TDI) and camera rotator which performs electronic level tracking during the object accumulation. Images of object and stars is obtained in separated frames with different accumulation modes. This observation method is effective for Earth artificial satellites on any orbit altitude (from 200 to 300'000 km) as well as for asteroids during close approach to the Earth (on distance less than 0.05 AU).

For TV CCD, COM uses track & stack technique which performs digital level tracking during object accumulation. Images of object and stars are stacked simultaneously with different tracking speed. This observation method allow to observed low Earth orbit satellites with mass more then 50kg using only photographic lens and TV CCD camera on stare telescope.

A video stream meteor detection method was designed in RI NAO and was used for basis meteor observations. This detection method can be also used for low Earth orbit satellites and become a base for developing of low Earth orbit satellites searching and surveillance for orbit determination.

## **RT-70 RADIO TELESCOPE IN “SPEKTR-R” AND “FOBOS-GRUNT” SPACE MISSIONS**

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The paper presents issues of preparation and upcoming use of Yevpatoria RT-70 radio telescope in “Spektr-R” and “Fobos-Grunt” space missions.

In “Spektr-R” project RT-70 radio telescope intend for radio astronomy observations in VLBI mode in conjunction with space radio telescope launched in July 2011. This project provides record angular resolution up to a few millionths of an arcsecond.

In “Fobos-Grunt” space mission RT-70 radio telescope intend for radio location measurements of distance to Mars with aim of trajectory correction of the space probe.

## **OBJECT DETECTION FROM IMAGES OF ROTATING-DRIFT-SCAN CCD**

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Under rotating-drift-scan CCD mode, images of space objects are among complicated stretched images of background stars. An effective object detection technology is introduced, which can detect objects with SNR>3 easily.

## **ASSESSMENT OF THE SC "EGYPTSAT-1" ACCORDING TO THE RESULTS OF OBSERVATIONS USING OPTICAL INSTRUMENTS OF THE UKRAINE**

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"EgyptSat-1" is a spacecraft (SC) designed in the Yuzhnoye Design Office which was put into orbit by the Dnepr carrier rocket on April 17, 2007. The control of the spacecraft was carried out by specialized units of the State Space Agency of the Ukraine (SSAU) and Republic of Egypt. On July 2010, during the routine management session, an attempt to establish radio

communication with the SC "EgyptSat-1" failed. Later, there were a brief appearance of the carrier frequency, but the communication with spacecraft was never restored. This situation led to inability to determine the current state of the spacecraft by telemetry data. To resolve the problem the optical instruments of the SSAU (NSCTC and CRPSI NFC) were involved as well as the instruments of the astronomical observatories (Odessa, Lviv) and the Laboratory for Space Research (Uzhgorod). As a result of coordinated observations in the optical band the data on the spatial position and visible brightness of the spacecraft were obtained. Operational analysis of the spacecraft was carried out by the specialists of the Uzhgorod Laboratory for Space Research and sent out to the Yuzhnoye Design Office.

Independent analysis of the photometric data was carried out. It based on the techniques, which developed in the group of optical systems of the Space Control and Test Center. Data processing consisted of:

- identification of moments of extreme brightness and calculation the current orientation of the normal vector of solar panels' surface;
- determination of the primary parameters of the spacecraft orientation and the rotation characteristics;
- construction of mathematical model of the spacecraft and calculation of the model brightness;
- comparison of the simulated and measured data.

It was found that on the interval of observations since 27 July to 14 September 2010 the SC "EgyptSat-1" revolved about axis which was tilted by about  $22^\circ$  from the precession axis. At the same time the precession axis itself is tilted by about  $32^\circ$  from the plane of the celestial equator. The period of rotation around the center of mass of the spacecraft is 87.2s. The angle between the long axis of the spacecraft and the rotation axis is  $30^\circ$ - $40^\circ$ . The received data indicate to significant breach of the standard (three-axis) orientation of the spacecraft.

## **INFLUENCE OF YORP-EFFECT ON THE AXIS ROTATION OF NEAR-EARTH ASTEROIDS**

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The distribution of near-Earth asteroid (NEA) rotation rates, obtained using all available data, differs considerably from the distribution of main-belt asteroids (MBAs). Among possible reasons

there can be influence of solar radiation on the axis rotation of small NEAs, the so-called “YORP-effect” [1], that appears due to reflection, absorption and re-emission of the sunlight as thermal radiation from an irregularly shaped asteroid. It is well known that the YORP-effect action strongly depends on the size of the body: the smaller body, the influence of the effect is more evident. At the same time, an increment of angular momentum may be both positive and negative. The YORP-effect action is insignificant but it may be accumulated on a  $10^7$ -year timescale to produce a noticeable change of the distribution of NEA rotation rates.

The obtained histograms of the rotation rate distribution for NEAs and MBAs of comparable sizes show the presence of excesses of both fast rotators and slow ones, which are not observed for MBAs. Exactly this type of distribution qualitatively conforms with the action of the YORP-effect which may spin up and spin down small asteroids. The study of the diameter distribution of NEAs depending on their spin rate showed that the mean diameter of NEAs decreases from the middle of distribution to edges, that is, the excesses of slow rotators ( $\omega \leq 2$  rev/day) and fast rotators ( $\omega \geq 8$  rev/day) are composed of smaller NEAs than in the middle of the distribution. Such diameter distribution agrees well with the YORP-effect.

It is clear that the influence of the YORP-effect has to depend also on the obtained solar energy (insolation), that is, on the asteroid heliocentric distance, which is determined by a semimajor axis and an eccentricity of orbit. More insolation, more effective the action of the effect is. The obtained dependence of NEA rotation rate on the relative insolation evidences that the NEAs of both excesses are in the orbits where they have about 8-10% more insolation than the NEAs at the middle of distribution. This result can be an independent conformation of the YORP-effect action.

As a result of this study we can conclude that the available data of observations confirm qualitatively an influence of the YORP-effect on axis rotation of the NEAs of  $D \sim 2$  km and less. It is the first attempt to detect the YORP-effect influence on the rotation of the whole population of near-Earth asteroids.

1. Rubincam D. P. 2000. Radiative spin-up and spin-down of small asteroids. *Icarus*, v. 148, No. 1, P. 2-11.

## **SOME PROBLEMS OF THE ERS ASTROMETRIC REDUCTIONS**

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The observations of 5 optical counterparts of the extragalactic radio sources from the ICRF2 list were made by using the 2m RCC telescope of Rozhen National Astronomical Observatory (Bulgarian Academy of Sciences). About 30 fields were observed by using CCD camera VersArray 1300B (1340x1300 pixels, the pixel size is 20x20 micrometers) at the end of March 2011. The optical positions of radio sources determined with respect to the reference stars of some modern astrometric catalogues. The mean optical positions were compared with ICRF2 radio positions. Significant discrepancies between values of mean optical positions with respect to different astrometric catalogues were found out.

## **THE NIKOLAEV MERIDIAN CIRCLES CATALOGUE OF STARS IN FIELDS**

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A catalog of astrometric positions and proper motions of stars (9 -16)<sup>m</sup> in fields of ecliptical zone and around higher proper motion stars were obtained by results of CCD-observations during 2008-2009 years. The mean square error for one catalogue position is about 30-90 mas in right ascension and 20-80 mas in declination for stars of (9 -15.5)<sup>m</sup> with proper motions -3-12 mas/year. The UCAC2 catalogue was used as reference for performing the astrometric reductions. Cross-correlation of obtained data with modern astrometric catalogues, such as TYCHO2, 2MASS, CMC14, PPMX, XPM and USNOA2.0, were made for investigation system errors and calculation of the proper motions. The external accuracy of one catalog position is about 120 mas. The catalog also contains photometric data (B, V, R, r', J, H, K).

## **NEW OBSERVATION RESULTS FROM ROTATING- DRIFT-SCAN CCD**

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After moved to a new site, the 300mm telescope with rotating-drift-scan CCD has observed many space objects. Statistic results of observation are given. The limited magnitude can be fainter than 14 magnitude with ~10 seconds exposure time under drift-scan mode.

## **INVESTIGATION OF SELECTED STARS WITH LARGE PROPER MOTIONS AND DETECTION OF $\Delta\mu$ -BINARY SYSTEMS**

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Astrometric investigation of stars with large proper motions yields new data on the nature of low-luminosity objects, searches for stars with invisible companions, analyzes the distribution and kinematics of stars in the solar neighborhood. A catalog of astrometric positions and proper motions of stars (9 -16)<sup>m</sup> in fields of ecliptic zone and around higher proper motion stars was obtained by results of CCD-observations during 2008-2009 years with Axial Meridian Circle (AMC) of RI NAO. Cross-correlation of obtained data with astrometric catalogues, such as TYCHO2, 2MASS, CMC11, CMC14, PPMX, XPM, LSPM and USNOA2.0, was made for investigation of irregular proper motions and detection of  $\Delta\mu$ -binaries with probable invisible companions. 147 stars may be considered as  $\Delta\mu$ -binaries candidates.

## **FROM CREATION OF DIGITAL ARCHIVES TO DATA PROCESSING BY USING VIRTUAL TECHNOLOGIES**

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We present background and current results in development of digital archives and astronomical databases obtained during 2008-2011

years at Nikolaev Astronomical Observatory. Creation of a digital archive should be considered as the first necessary step on the way to development of any database. In their turn, the databases should be considered as a basis for construction of a data centre, which provides data processing in accordance with the standards of virtual technologies.

A standalone database has been developed since 2008 to process initial textual data concerning photographic observations carried out in the 20th century. Using this database, we can prepare output textual data in any given format, for example in accordance with the format developed by the Institute of Astronomy (Bulgaria).

Online database of photographic and CCD observations has been developed since 2008 to provide wide access to textual data and processed images. Update of this database is regularly carried out using new textual data obtained with the standalone database. There are two possibilities to get access to the database via a browser and via a standalone application such as Aladin.

The digital archives also contain the whole bulk of raw and processed images of the celestial bodies as well as the results of data reduction in the form of scanned publications of astrometric stellar catalogues and positions of the solar system bodies. Obtained images of printed catalogues were processed using semiautomatic software for optical character recognition. Using obtained textual data, all astrometric stellar catalogues were compiled in the standard VOTable format using eXtensible Markup Language, and online database of the solar system bodies was created.

Using access to the given databases via a browser, it is possible to use various data selection options, such as, search by: equatorial coordinates, type of celestial object, time period of observations, telescope name, etc. Aladin as a standalone application also provides a wide range of data processing tools in accordance with the standards of virtual technologies.

## **THE PULKOVO CATALOGUE OF REFERENCE STARS FOR OBSERVATIONS OF GALACTIC RADIO SOURCES**

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Pulkovo catalogue of reference stars for 78 fields around galactic radio stars (Pul GRS) of northern sky from H.G.Walter's list was created. Coordinates of 12577 stars from the photographic plates, which were received during 1994-1999 at Pulkovo Normal Astrograph

(NA, 33/346), were obtained. The size of star fields with radius about 20 angular seconds was determined by available technical resources, in specifically modern size of CCD-matrix. High-precision astrometric coordinates of radiostars, which are obtained from optical CCD observations are intended to link ground-based reference coordinate system and the system of space astrometry.

The calculation of star coordinates with reference stars from catalogue Tycho-2 (ICRF, J2000.0) was realized. Errors of a unit of weight were about  $(0.12 - 0.27)''$  (number of reference stars is 12 - 50). Internal accuracy of catalogue position of star was from 0.02 to 0.20 arcseconds for the both coordinates. Distribution for number of catalogue stars with stellar magnitude was illustrated by histogram. Most of stars is in the magnitudes interval from  $13.5^m$  to  $15.5^m$ ; it is about half of the all catalogue stars (it is 44%). We obtained the new coordinates of 911 stars (about 7 %) which cannot be identified in the other catalogues (Tycho-2, UCAC3, USNO-B1.0, USNO-A2.0, CMAC).

## **"ADELAIDE" - FOR CREATION OF THE VIRTUAL OBSERVATORY SOFTWARE**

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In the modern era of the global informatization, the question of proper placement, storage, structurization and further usage of data, rises more than ever before. Simultaneously with those issues, it's most important to overview the question of efficient access to the data using set of modern computing facilities, including smartphones and tablet PCs.

Software complex "Adelaide" includes a set of service tools:

- creation kit for web-services, for development of the structure for individual virtual observatories;
- converter for common type of catalogues (Tycho2, USNO-B2.0, 2MASS, GSC2.3, PPMX, Hipparcos, etc) into preferred DBMS format;
- query builder for data, and query handling means;
- set of functions for processing astronomical data:
  - a) photometric data processing;
  - b) object's position calculation;
  - c) object's proper motion calculation;

d) calculations of the orbit and brightness for small objects using celestial mechanics algorithms;

- powerful data search engine;
- customizable format and logic control for linkage of the local virtual observatory with other similar data storages, as well as ingressed into IVOA Alliance, or independent astronomical data archives of selected observatories.
- 2D and 3D visualization of the objects.

Usage of .NET technologies is in the core of this software complex. Complex supports Oracle, Microsoft SQL Server, Sybase, PostgreSQL, FireBird, MySQL DBMSs. As an HTTP server for this complex could be used such servers like Apache, or Microsoft IIS. Complex "Adelaide" runs under OS Windows, Linux or Android. Also, software "Adelaide" can transform data storage for using it in cloud services.

## **NIKOLAEV OBSERVATORY IN THE FIRST HALF OF XX CENTURY**

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At the beginning of last century the tremendous changes expected Nikolaev Observatory, which was subordinated to Navy Ministry during 90 years. The main event of this period was its transformation in 1912 into one of the southern department of Pulkovo Observatory with the aim to create a base for astrometric researches in the South. There was the time of the greatest upheavals in our society: the First World War, the Revolution of 1917, the Civil War. A small respite, which was associated with the revival of the observatory in 20-30 years of XX century, was interrupted by new troubles - the Great Patriotic War. The Observatory have survived all these troubles, and have preserved as a scientific institution, and as a historical and architectural complex. Of course, the credit for this was due to the two directors of the observatory - Boris Pavlovich Ostaschenko-Kudryavtsev (1909-1923) and Leonid Ivanovich Semenov (1923-1950), who came from the Pulkovo Observatory. During those years, the observatory participated in the first major international project on developing of the sky maps. Absolute catalogs of stars, which were

compiled from observations with Freiberg-Kondratiev transit instrument and Repsold vertical circle, were included as a part in the fundamental catalogs FK. In 1931 the Time service, which was one of the best in the USSR, was organized in the Observatory. Another target of Nikolaev department was to determine the positions of the Sun and Solar system bodies.

Currently, we are working on a new book of the series of bibliographical books devoted to the directors of NAO - B.P. Ostaschenko-Kudryavtsev and L.I. Semenov. Materials in the archives of the NAO, Pulkovo Observatory and personal archives of B.P. Ostaschenko-Kudryavtseva are used to write it.

## **THE INFLUENCE OF YARKOVSKY AND YORP EFFECTS ON DYNAMICAL EVOLUTION OF ASTEROIDS**

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The two effects are produced by a weak non-gravitational acceleration of asteroids and meteoroids, which is caused by radiative recoil due to anisotropic thermal re-emission of energy. The first one produces secular changes in orbital semi-major axis of body and is called Yarkovsky effect. The second one produces changes in rotational state and is called YORP (Yarkovsky-O'Keefe-Radzievskiy-Paddack) effect. It is believed that these effects have significant influence on orbital and rotational dynamics of asteroids less than 100 km. The Yarkovsky and YORP effects were not investigated earlier due to insufficient precision of observations.

The Yarkovsky effect was predicted in 1900 and firstly confirmed in 2003 up to now only for one asteroid (6489) Golevka using radar ranging. At present, YORP effect was detected for 4 asteroids using photometric data. All of these asteroids are NEAs, and detection of YORP and Yarkovsky effects for main belt asteroids is forthcoming.

The review presents basic principles of the Yarkovsky and YORP effects, their possible influences on dynamical evolution of asteroids and recent results. The estimation and inclusion these effects to a model of motion among with other already used factors will improve our understanding of the dynamical evolution of small Solar system bodies.

**COMPARATIVE SPECTROPHOTOMETRY  
OF COMETS 22P/KOPFF, 81P/WILD,  
C/2006 W3 (CHRISTENSEN),  
C/2009 K5 (MCNAUGHT) AND 103P/HARTLEY 2**

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Preliminary results of observations and study of middle-resolution optical spectra ( $R=15000$  and  $R=1500$ ) of comets 81P/Wild, 22P/Kopff, C/2006 W3 (Christensen), C/2009 K5 (McNaught), 103P/Hartley 2 are presented. The spectra were obtained with the echelle spectrograph and with the slit spectrograph installed on the 2-m Zeiss reflector of the High-mountain astronomical station of Institute of Astronomy of Russian Academy of Sciences and Main Astronomical Observatory of National Academy of Sciences of Ukraine at Peak Terskol in 2009-2010 years. With resolution  $R=15000$ , there were obtained: for 22P/Kopff – 5 spectra, 81P/Wild – 2, C/2006 W3 (Christensen) – 14, C/2009 K5 (McNaught) – 2, 103P/Hartley 2 – 9. With resolution  $R=1500$ , there were obtained: for 81P/Wild – 5 spectra, C/2009 K5 (McNaught) – 4, 103P/Hartley 2 – 8.

The energy distributions in the spectra for the near nucleus regions of five comets are built and detailed identification of the spectral emission lines in the spectra was made. Fluorescent cometary continuum level in spectra of comets was searched. Physical parameters of the neutral comas of comets (velocities of gas expansion, lives times of molecules C<sub>2</sub>, C<sub>3</sub> and CN and other parameters) were calculated using the Shulman's and Haser's models. Comparative analysis of the spectra of five comets was made.

**NIKOLAEV DATA ARCHIVE AS A PART OF UKRVO**

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Nikolaev data archive has been built up for 15 years, and consists of about 6000 scanned images of photoplates obtained in 1929-1996 as well as more than 60,000 CCD frames obtained in 1996-2011. Data archive contains mainly information about observations of the northern

hemisphere sky from  $-20^\circ$  to  $+85^\circ$ . The observations were carried out to solve different scientific tasks using 4 instruments. The archive also contains all catalogs of NAO in the form of digital images and textual files. At the middle of 2011, the volume of accumulated data in the form of CCD images was more than 500 GB, and in form of scanned plate images was more than 600 GB. Archive data is regularly included in several NAO databases with user friendly interfaces. Nikolaev Virtual Observatory (NikVO) was created as the result of work in 2007-2009 on development of these astronomical databases. We have taken an active part in development of the Ukrainian Virtual Observatory (UkrVO) since 2010. Most part of Nikolaev data archive, including all astrometric catalogs and observational data, were integrated into UkrVO website <http://ukr-vo.org>.

## **USING DIGITIZED PHOTOGRAPHIC OBSERVATIONS FOR THE CREATION OF MODERN ASTROMETRIC CATALOGUES OF COORDINATES AND PROPER MOTIONS**

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We present a possibility of receiving new astrometric stellar catalogues of coordinates and proper motions with good accuracy by using digitized images of old photoplates scanned with existing consumer and prosumer scanners.

The plates for scanning and image processing were taken from an archive of the RI NAO, which contains more than 8400 plates obtained with the Zonal Astrograph (D=160 mm, F=2.04 m, FOV=  $5^\circ \times 5^\circ$ ). Selected plates obtained from 1972 to 1993 were scanned with two scanners: Epson Perfection V200 Photo (consumer) and Epson Perfection V750 Pro (prosumer); 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 analysis of results were carried out using our own software and the Tycho-2 reference catalogue.

Using both scanners with the same parameters for scanning plates in series of 5 scans, we made data reduction, and received two catalogues of star positions and proper motions in ecliptic zone and

galactic plane. Catalogues contain the coordinates of stars in the ICRS system from 7 to 14 magnitude, main part of them from 11 mag to 13 mag, with the mean epoch of observations about 1977. The sample standard deviation of position measurement is about 0."06 in RA and 0."07 in DEC. Root mean square error of (O-C) differences is about 0."09 for coordinates and 0."005/year for proper motions. Further work in this direction is being successfully continuing.

**COMPILED ASTROMETRIC CATALOGUE  
OF 196600 REFERENCE STARS  
FOR CCD-OBSERVATIONS  
OF 240 EXTRAGALACTIC RADIO SOURCES**

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Compiled Catalogue of Reference Stars up 17<sup>m</sup> (Pul-ERS) around Extragalactic Radio Sources is created to obtain the high precision coordinates of 240 Extragalactic Radiosources (ERS). Nine catalogues of stars observed by ground based telescopes and were used for compiling the Pul-ERS catalogue. Among them the photographic observations of the stellar fields were made with Pulkovo Normal astrograph, Zeiss telescope of in Observatory of Kiev University and 26" refractor of in Rumanian National Observatory in Bucharest. The Pul-ERS catalogue containing 208 fields around ERS was observed in Nikolaev observatory at telescope with CCD-camera (AMC). The Carlsberg catalogues CMC-9 and CMC-14 from CAMC in La Palma were also included. The catalogue ERL for stars near 398 ERS was used for the northern ERS. We included the coordinates of stars from the Kharkov catalogue XC1 up to 17<sup>m</sup> which, in our opinion, it is most reliable of what obtained by scanning the Shmidts plates. For 70% stars the proper motions from UCAC3 catalogue were used to convert the positions ofstars to the common epoch. For the rest of stars the proper motions were taken from the XC1.

The size of fields is 40 arcmin. It is enough to guarantee the high precision reduction of the ERS coordinates in optics to construct astrometric system for connection our system with the space and VLBI

observations of the ERS. The number of positions for each star varies from one to more than ten. The inner precision of positions in Pul-ERS is from 4 to 150 mas. For 240 fields of ERS we obtained more than 196600 positions of stars. The 157556 stars of our compiled catalogue were identified with the stars of the UCAC3. The average differences Pul-ERS - UCAC3 for common stars is 12 mas in Right Ascension and 7 mas in Declination. The positions of stars in the Pul-ERS catalogue are given in degree and integer forms. The number of positions to compile the coordinates is given too. Besides the positions, the Pul-ERS catalogue contains magnitudes, average epochs in RA, DE and proper motions.

## **PROGRAM OF AUTOMATIC ASTEROID SEARCH AND DETECTION COLITEC (CLT) – THE LAST RESULTS OF APPLICATION**

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Modern system of asteroids detection in one night takes images of considerable sky area. The areas of such size can't be sufficiently processed using "blinking technique", especially if we are talking about wide-field "fast" astrographs detecting dozens of faint asteroids simultaneously. One of the approaches dealing with this problem is implementation of automatic asteroids detection, visually controlling obtained information.

Program of automatic asteroid search and detection CoLiTec (CLT) was created by initiative group headed by Vadim Savanevich. Now program CoLiTec (CLT) has been successfully used in two observatories: Andrushivka Astronomical Observatory (near Kiev, Ukraine, MPC code A50) and Russian remotely observatory ISON-NM (Mayhill, New Mexico, USA, MPC code H15). The present report represents results of CoLiTec (CLT) software application since May 2010.

## **USING OF OPTICAL MEANS AND METHODS IN RI NAO FOR OBSERVATION OF NEAR-EARTH SPACE OBJECTS**

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Since 2000 year a new methods for Earth orbit object observations have been developed in RI NAO. They use combination of different operation modes of CCD camera. Several telescopes with diameters from 50 to 500 mm were made in RI NAO to implement the combined method. All telescopes equipped with the necessary units and mechanisms to provide operation in automatic mode with remote control.

The telescopes of RI NAO provide observations of artificial space objects in low (200 – 2'000 km), middle (2000 – 36'000 km), geosynchronous (36'000 km) and highly elliptical (apogee > 36'000 km) orbits, as well as NEO during the time of close approach to the Earth ( $r < 0.05$  AU) and meteors in optical band (~100 km).

RI NAO successfully participates in the functioning of the Space Situation Monitoring and Analysis System conducted by State Space Agency of Ukraine, as well as in international projects of asteroid and comet hazard and space debris monitoring.

## **DETERMINING THE COORDINATES OF METEOROID TRAIL BY TWO SEPARATED FM RECIEVERS**

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A system of two distant sites for observation of forward scattering of radio wave from meteor trail is considered. The method for determination the coordinates of the reflection signal point from the meteoroid trail is proposed. These coordinates are determined from the difference of time arrival of signal, scattering from meteor, to distant sites, and the bearing of both the azimuth and the elevation in one of the distant sites. The estimation of the control zone location for radio path Kielce (Poland) - Nikolaev is carried out. Earth's curve is taken into account to determine the reflection signal point.

## **DETERMINATION OF GEOMETRICAL PARAMETERS OF METEOR TRAILS AND RADIANT USING TV TRANSMITTER SIGNAL INFORMATION**

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Characteristics of one-site forward-scattering radar to estimate the radiant and meteoroid's velocity are considered. TV and FM stations of VHF range are assumed to be used as transmitters. The possibility of creating an antenna system to determine the elevation and azimuth to the point of specular scattering at the meteoroid trail with the required accuracy is described. The determination for time of signal propagation is technically feasible at the reception of TV-signal scattered on the ionized meteoroid's trail. If the distance between the transmitter and the receiver is known, those data are sufficient for estimation of radiant and meteoroid's velocity. Such radar is more profitable from organizational and financial points of view in comparison with multi-site radar.

## **THE SURVEILLANCE DYNAMIC STATE GSS “INTELSAT 10-02” ON BASE MULTICOLORED PHOTOMETRICAL DATA**

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Complex coordinate and multicolored photometric observations of active geostationary satellite (GSS) “Intelsat 10-02” (28358/2004022A, sub point GSS 359<sup>0</sup>.0E, with inclination to the equator  $i=0^0.05$ , the eccentricity  $e=0.00$ ) took place at the “Mayaki” station, located nearby Odessa, on October 6,7,12,13,14, 2010 and on March 4, 2011. On those dates the satellite was nearby the border of the Earth's shadow. On basis of multicolored photometric observations some of its optical and geometrical characteristics were calculated. The analysis of light variation of GSS in B,V,R spectral regions of Johnson's system and the color indexes variation show that during the dates of observation the systems of stabilization of the platform of the transceiver antenna and the solar panels worked in the normal operating mode. During the

observations the tracking panels of GSS "Intelsat 10.2" are well preserved relatively to the direction of Sun. The rotation of SB panels happens about axis, which is perpendicular to the equatorial plane. The orientation of the main axis of the platform, within calculation errors, remained unchanged in to the direction of the Earth's mass center. The analyses of the coordinate and photometric information for this GSS show how we can effectively control the dynamic state of the satellite and evaluate the optical characteristics of visible surface of spacecraft components and their behavior on its orbit using the photometric observations.

## **CONDITIONS OF THE ENTERING OF ACTIVE EQUATORIAL GSS IN TERRESTRIAL SHADOW**

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We describe the conditions of an active GSS enter-exit of the Earth's shadow relatively to the plane of the Earth's equator with a small inclination of the orbit to the equator. Calculations for three different models of Earth shadow (cone-shaped, cone-shaped + refraction and cylindrical) are presented. A cone-shaped + refraction model is more close to the observed moment of enter-exit from the shadow.

## **ON THE MEMORY OF ASTRONOMER V.P. SIBILEV**

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In this report the biography of V.P. Sibilev, the member of known astronomical circle in Baku Palace of Pioneers, is presented. V.P. Sibilev was a pupil of S.I. Sorin, known amateur astronomer & telescope maker. Hi had a difficult way of professional astronomer. His fate is in close relationship with Nikolaev astronomical observatory (Ukraine). Main topic of his scientific interests was research of refraction anomalies influence for observation of Solar system bodies and Sun. Methods for calculation of refraction anomalies elaborated by V.P. Sibilev permit to improve the accuracy of daily astrometry observations (in declination) and

to reprocess successfully the previous observation. At 1 August 2004 Vyacheslav Petrovich Sibilev was died but his colleagues keep the memory of a clever astronomer and good man.

## **DETERMINATION OF POSITION OF OBJECTS WITH ROTATING-DRIFT-SCAN CCD**

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With short exposures of stars under stare mode before and after drift-scan CCD mode, stars in stare mode can be used as reference to determine the position and magnitude of space objects with rotating-drift-scan CCD. The whole procedure of the method is given.

## **UKRAINIAN VIRTUAL OBSERVATORY IN THE NETWORK OF WORLD VIRTUAL OBSERVATORIES**

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The UkrVO (Ukrainian VO) database consists of about 200,000 astronegatives and 50,000 CCD-frames containing the unique astroinformation for formulation of important scientific tasks. This database is compiled from observations conducted in 1898-2011 years at observational sites of 8 Ukrainian observatories with about 50 instruments.

This paper deals with some principal UkrVO scientific projects, which are currently under development, namely the creation of the Joint Digitized Archive (JDA); compilation of new stellar catalogues; search for the optical GRB's counterparts, spectral study of the solar flares and solar active formations, software for the new Solar System small bodies searching.

Our near-term plan is to join the structure of International Virtual Observatory Alliance (IVOA). Current version of UkrVO site placed on <http://ukr-vo.org>.

**Key words:** virtual technologies, virtual observatory, astronomical databases

**UKRVO' RESOURSE OF CCD-OBSERVATION'S  
ARCHIVE OBTAINED BY THE KYIV  
MERIDIAN AXIAL CIRCLE IN 2001-2011**

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The MAC is a refractor (D=180 mm, F=2.3 m) which is used now for CCD astrometric survey of the equatorial zone. In 2001, it was equipped with ISD017AP CCD (1040x1160 pxs, 16 mkm pixel size and 1.394" per pixel scale).

The photometric system of the MAC reproduces standard V photometric system; the limiting magnitude is about V=17. Star pixel coordinates are measured with an accuracy of 0.02 pxs and star fluxes accuracy is equal to 0.02 mag.

The telescope is used for observations of equatorial stars with the aim of measuring their positions, proper motions and magnitudes.

We created the database of observations received on MAC. Also we developed the software for information management and accumulation of new data.

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Книга містить тези доповідей на міжнародній конференції «Астрономічні дослідження: від навколоземного космічного простору до Галактики», що буде проводитись у Миколаєві, Україна з 26 по 29 вересня 2011 року. В ній викладені питання позиційних і фотометричних досліджень навколоземних об'єктів, астрометрії зірок і астероїдів, використання віртуальних технологій в галузі астрономії, а також історичний шлях Миколаївської обсерваторії.

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"Астрономічні дослідження: від навколоземного  
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