

BOOK OF ABSTRACTS

Actual Questions of Ground-based Observational Astronomy



Mykolaiv, September 26-29, 2016

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

ACTUAL QUESTIONS OF GROUND-BASED OBSERVATIONAL ASTRONOMY

International Conference

ABSTRACT BOOK

September 26-29, 2016,
Mykolaiv, Ukraine

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Ministry of Education and Science of Ukraine
Research Institute “Mykolaiv Astronomical Observatory”
Ukrainian Astronomical Association

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- A 19 **Actual Questions of Ground-based Observational Astronomy.**
International Conference. Abstract Book. — Mykolaiv: 2016. — 40 p.

The Book of Abstracts contains abstracts of presentations to the International Conference “Actual Questions of Ground-based Observational Astronomy” to be held in Mykolaiv, Ukraine, on September 26-29, 2016. Methods and technical means of ground-based observations, IVOA role in modern research and actual problems of ground-based astronomy are presented.

GENERAL INFORMATION

The International Conference “Actual Questions of Ground-based Observational Astronomy” (MAO195) will be held in Research Institute “Mykolaiv Astronomical Observatory”, Mykolaiv, Ukraine on September 26-29, 2016.

The conference is organized to discuss methods and technical means of ground-based observations, IVOA role in modern research, actual problems of ground-based astronomy as well as history of astronomical research. Working languages are English, Ukrainian and Russian.

Main Topics of the Workshop:

- Methods, technical means and software for ground-based observations and data processing.
- Use of IVOA technologies for solution of modern astronomical problems.
- Results of data processing for ground-based observations.
- History of astronomical research.

Information about Participants:

- General number of registered participants – 48;
- General number of represented organizations – 22;
- Number of submitted papers – 38;
- Number of authors of submitted papers – 84.

MODERN METHOD OF CREATE AND RESEARCH THE LARGE ASTROMETRIC CATALOGS

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In this work we present some problems of creation new high-density astrometric catalog of more then one billion positions and absolute proper motions objects obtained from the SuperCOSMOS Science Archive. Removing the junk detections, cross-identification large dataset, astrometric reduction and star-galaxy classification are very important tasks in this work.

Some methods for astrometric and kinematics research of large catalogs have been describe. For analysis astrometric catalogs we present the method described by Roland Wielen. Using three or more independent catalogues, it is easy to estimate the external accuracy of each of them. The kinematics studies of the Galaxy we using classical Ogorodnikov-Milne model and mathematics method of Vector Spherical Harmonics.

For provide quick access to modern astronomical catalogs that contains data for celestial objects including stars, galaxies, quasars and others objects has been developed database.

THE ROLE AND THE PLACE OF MINOR ACADEMY OF SCIENCES IN THE FORMATION PROCESS OF SCIENTIFIC MANPOWER FOR ASTRONOMY

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The report highlights the role and the place of the educational system of Minor Academy of Sciences of Ukraine in the primary, precollege preparation of scientific manpower. It is shown by the example of Rivne Minor Academy of Sciences the work with youth in the research areas of “Astronomy” and “Aero Physics and Space Research” in cooperation with scientists of Research Institute “Mykolaiv Astronomical Observatory”.

STAR PHOTOMETRY ON DIGITIZED ASTRONEGATIVES

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O. Yizhakevych¹, Yu. Protsyuk², I. Eglitis³, M. Eglite³, L. Kazantseva⁴,
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This paper discusses the issues of characteristic curve restoration for astronegatives exposed in the wide range of expositions in U, B, V Johnson color bands using different telescopes. Photographic plates are digitized by Epson commercial scanners. Digitized images are processed in MIDAS/ROMAFOT software. Particular attention is paid to the reliability of extremely faint object photometry. The accuracy of characteristic curve restoration using photoelectric data is in the range 0.1-0.2^m.

THE AFR-2 SOLAR TELESCOPE MODERNIZATION

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I.Ya. Pidstryhach, M.I. Stodilka, Ye.B. Vovchyyk**

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The AFR-2 is an optical telescope for the detailed observations of Solar chromosphere and photosphere in the H-alpha narrowband spectral region. It is part of AO LNU ground based Solar observations service. The observations have been performed since 60s of the twentieth century. That's why the telescope needs modernization very much.

The main purpose of the upgrade was to change a film based receiver by CCD camera. Such modification led both to the rearrangement of the optical components in the telescope optical path and corresponding

adapter development and installation. However, the new thermostat (the accuracy of the temperature maintenance is 0,01 °C) for the interference-polarizing filter with the bandwidth 0.5 Å has been developed. The upgraded receiving system requires new software for format conversion and data processing. Test observations are held currently.

As a result of such modifications we have got a modern telescope which can give additional data to the available from external databases about the active processes on Sun. So, it can be used both in the space weather and solar physics research, and in education and astronomical practices.

MODIFICATION OF ‘GAUSS’ METHOD

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The method for determination of orbital elements of celestial bodies was developed by C.F.Gauss as early as at the beginning of the 19th century when the first asteroids were discovered. Up to the present time, this method has been successfully employed for preliminary orbit determination for both circumsolar and near-Earth orbital motion. However, the method presents some limitations in its usage. In particular, the orbital arc whose length is used for calculations should not be too long as in this case difficulties with solution of some equations may emerge. On the other hand, the orbital arc should not be too short as in this case uncertainties associated with observational errors may occur.

These and other limitations of Gauss' method can be overcome by exploiting capabilities of modern computers. At a two-body approximation the orbital plane always intersects the centre of gravity. With this fact the orbital plane position can be independently determined using the method of exhaustive enumeration of all possible values of inclination and longitude of the ascending node. All orbital elements can be derived for each pair of elements i and Ω using Gauss' method for determination of orbital elements from two position vectors and instants of time. Based on these orbital elements, it is possible to define a celestial body's position for the current i and Ω . Using the differences between the observed and calculated in such a manner positions (O-C), it is possible to select the inclination and longitude of the ascending node which define the actual position of the orbital plane.

It is evident that it is the minimum difference (O-C) that corresponds to the actual position of the orbital plane.

Thus, to ultimately determine the orbital plane using a modified Gauss' method, a priori information on the pattern of the celestial body's motion is required, particularly, whether its motion is direct or retrograde. This requirement is similar to that one for the application of Gauss' method for determination of orbital elements from two position vectors and instants of time.

ASTROMETRICAL STUDY OF THE SELECTED WDS STARS

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We present the results of double stars observations, which were carried out at the Research Institute NAO during the 2013-2016 years. For the observational program preparation we used by the Washington catalog of double stars (WDS). The observations were made by the two telescopes of the observatory (Mobitel, AMC), equipped with CCD cameras. Astrometric reduction of the received frames until the equatorial coordinates of binary and multiple systems components at the time of observation was made. The combination of the CCD received data with other Strasbourg base catalogs allowed to determine the new values of the observed stars proper motions. Parameters of mutual component configuration (position angle and separation) were measured for the 214 double stars. The analysis of the measurement results was carried out. The measurement results were published in the Journal of Double Star Observations (JDSO), and added to the WDS directory database.

SPACE RESEARCH IN BALDONE OBSERVATORY

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At the Baldone observatory were carried out the U, B, V, R, I photometry and low resolution spectroscopy of carbon stars, the monitoring of small bodies of Solar system, the digitizing and

processing of the Baldone Schmidt telescope wide field 24300 plate archive. Astronomers make popularization of astronomy.

Carbon star photometry revealed that some of carbon stars have the first and second period of variability and new type of variability – DY Per. The spectroscopy of carbon stars give the fundamental parameters of their atmospheres - $T(\text{eff})$, $m(\text{bol})$ and distances to these stars.

From 2008 the monitoring of small bodies of Solar system are carried out. 49 new asteroids are discovered. 3511 astrometric positions of 826 asteroids are calculated in cooperation with Institute of Theoretical Physics and Astronomy, Vilnius University. Orb-Fit v.4.0 program, which take into accounts planets and Ceres, Pallas, Vesta perturbations, is used in ephemerides calculations in case of asteroids of Main belt, but Orb-Fit v.4.2, which take into accounts 25 objects perturbation, in cases of Trojan and Centaurus asteroids.

The archive contain the astrophotos of Schmidt telescope of the Institute of Astronomy of the University of Latvia in the period 1967-2006. The archive contains more than 22000 direct and 2300 spectral photos of various sky regions. Information on the types of photo materials and color filters used as well as on most frequently photographed sky fields or objects are given. The images were digitized by the scanners EPSON EXPRESSION 11000XL. Standard image processing was performed in the environment of LINUX/MIDAS/ROMAFOT with an advanced set of original programs, which were developed in the Main Astronomical Observatory of National Academy of Sciences and Research Institute “Mykolaiv Astronomical Observatory”. The equatorial coordinates and magnitudes of all objects on the plates were obtained. Additional studies were conducted of the carriage mechanics and optical distortion.

CORRECTIONS OF THE ABSOLUTE PROPER MOTIONS OF THE XPM CATALOGUE

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The results of the work on correcting proper motions of stars of the XPM catalogue are presented. We applied two primary procedures to correct proper motions. The first of them allow us to create in the each field of the XPM catalogue the sample of galaxies cleaned from

stars of our Galaxy. Wherein to divide all objects to galactic and extragalactic sources we used colour-colour diagrams (B - I) - (J - W1) which are constructed based on photometric data in the J and W1 bands taken from 2MASS and WISE catalogues respectively as well as in B and I bands taken from the Super COSMOS catalogue.

The second procedure aims to eliminating errors connected with determination of zero-points of the proper motions as well as to exclusion of the magnitude equation in the each field of the XPM catalogue. As a result the system of proper motions of the stars of the derived XPMc catalogue is linked to extragalactic sources from 2MASS rather than to positions of extended sources of the XSC catalogue like before.

Also the results of the comparison of derived proper motions of stars with ones of other catalogues are presented.

THE THERMAL DESORPTION OF THE DUST PARTICLES SUBSTANCE NEAR THE SUN

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The work is devoted to the study of the physical and kinematic properties of the dust particles which approach to a distance less than 0.1 AU to the Sun. The statistical and quantitative analysis of a database of the meteor video observations (<http://sonotaco.jp/doc/SNM/> , SonotaCo catalog, Japan) revealed the following regularities:

- 1) Some of the sporadic meteor particles have the orbit elements which are similar to the orbits of the sungrazing comets;
- 2) The distribution of meteor particles on the perihelion distance shows a sharp decrease in the number of observed meteoroids with $q < 0.08$ AU.;
- 3) The inflow into the earth's atmosphere the sungrazing dust particles fixed after the perihelion passage is about 20 times weaker then before the perihelion passage;
- 4) The distribution of the mass revealed a maximum displacement (toward to the lower masses) for the sungrazing dust particles, which were fixed after the perihelion passage;
- 5) The comet observations make it possible to establish the temperature (T) dependence of the dust particles as a function of the heliocentric distance (r): $T = 326r^{-0.55}$;

6) It has been revealed a new groups of meteor radiants associated with the particles of the sungrazing sporadic dust background. Each group of the radiant belong to the comet families: Marsden, Kracht and Kreutz.

The methods of ground-based observations of meteoroids is proposed for the studying the effect of thermal desorption of the meteor matter near the Sun.

EXPLORING THE RELATIONSHIP BETWEEN METEOR PARAMETERS BASED ON TV OBSERVATIONS

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Observational material obtained during the meteor patrolling in 2003-2016 at the Kryzhanovka station based on TV method was reduced.

The meteor patrol observations are carried out at the different weather conditions and on the different horizontal altitudes. The undoubted value of observations is their regularity and homogeneity.

As a results of meteor patrolling we get the TV record with a certain space and time resolution. To resolve specific tasks of the meteor astronomy as a rule one needs to use observational material collected on the large time interval. At the same time the sky quality changes not only from night to night, but also during the night.

To estimate the sky quality which could be acceptable for TV observations we developed the method which is based on the star image flickering. This method enables one to get the numerical characteristics of the sky quality.

Using our long term meteor observations we discuss the dependence between the meteor particle entry angel with respect to the Earth's atmosphere and a time on an example of the Geminides meteor shower. We make a comparison with the results of other observers and give some interpretation of the obtained results.

THE BOOTES OF WORLD – WIDE NETWORK OF ROBOTIC TELESCOPES

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BOOTES the **B**urst **O**bserver and **O**ptical **T**ransient **E**xploring **S**ystem, is a network of astronomical observatories with sites in Southern Spain, New Zealand, China and Mexico (mostly 0.6m diameter telescope with EMCCD camera at the Cassegrain focus and a g'r'i'ZY filterset. The main goal of the network is to quickly observe transient events within few seconds/minutes of being detected by scientific satellites.

BOOTES provides an automated real time observing response to the detection of Gamma Ray Bursts GRBs. Error box size depending, it uses wide field cameras (WFC), ultra wide field cameras (UWFC) and narrow field cameras (NFC) attached to small robotic telescopes or the telescopes themselves. To study GRBs it is of the utmost importance to perform prompt optical follow up observations, to detect longer wavelength transient emission associated to them. BOOTES can perform such follow ups. Its scientific objectives include:

- Simultaneous and quasi simultaneous observations of GRB error boxes.
- Detection of optical flashes of cosmic origin.
- All-Sky monitoring with the CASANDRA cameras down to 10th mag every 60 s.
- Monitoring of different types of variable objects (galactic or extragalactic) down to 20th mag in order to search for optical variability.
- Discovery of comets, meteors, asteroids, variable stars, novae and supernovae.

BOOTES is part, within the framework of an international collaboration led by Spain, which started in order to support the ESA's satellite INTEGRAL with ground-based observations.

STUDY OF THE SOLAR ECLIPSE PHENOMENA OF DWARF PLANET PLUTO

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Pluto was discovered in 1930. In 2006, by the International Astronomical Union's decision it was referred to the class of dwarf planets.

The largest satellite of Pluto was discovered in 1978 as a dwarf planet was approaching perihelion at a distance of 29.7 AU. Another 4 satellites was opened to the summer of 2012.

This distant system is not available for qualitative observations from Earth. In July 2015 the spacecraft "New Horizons" approached Pluto at a minimum distance of 12.5 thousand km away from its surface. Because of this, quantitative description of the eclipse in the Pluto system becomes possible.

Pluto satellites are positioned so that the eclipse is only possible near perihelion and aphelion of the dwarf planet. A series of eclipses in the Pluto-Charon system lasted from February 1985 to October 1990, the following series of eclipses will take place from 2108 to 2112.

We have found the angular diameters of celestial bodies that may be involved in eclipses both near perihelion and aphelion of the orbit of Pluto. We have identified the possibility of occurrence of repeated multiple eclipses, those involving more than three celestial bodies. Using the results of the mission "New Horizons", we have determined resonances for Hydra and Cerberus 19:16, Charon, and Hydra 6:1. We have established the duration of the central eclipse of the Charon 1 hour 42 minutes on 11 February 2110, Nix - 6 minutes, 10 March 2110. Eclipses that involve remaining satellites will not be observed. We have also examined the eclipse of satellites by Pluto. Pluto shadows long enough for eclipsing satellites. The beginning of eclipse era and duration of satellites eclipse are found. Also consider various mutual configurations of the satellites in the shadow of Pluto.

SOME CHARACTERISTICS OF BINARY NEAR EARTH ASTEROIDS

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We present some results of a study of double asteroids, near-Earth objects (NEA). During the summer of 2014, we completed three double coordinate surveillance NEA (88710) 2001 SL9, (137170) 1999 HF1, (162483) 2000 PJ5 to clarify the elements of their orbits. In addition, we used the parameters of double NEA. We chose the asteroid systems for which parameters are known with the smallest error. We have identified the biggest tidal acceleration by Venus, Mars, Earth and Jupiter. All of them were negligible in order to cause their destruction.

Search for commensurability of asteroidal systems with planets was performed, as a result, it was found that the asteroid (363599) 2004 FG11 moves in resonance with the Earth at a ratio of 1: 2 and the error is 0.041159 days. For a more strict definition of sustainability movement asteroidal systems, we used the three-body problem. We determine the radius of the Hill sphere for each system near perihelion points. The calculation results showed that all of the satellites in the asteroidal system are deep in Hill areas. For example, in a satellite system Heracles (5143) moves in an orbit semi-major axis with respect to 4 km main component, while Hill sphere radius is 348 km.

Next, we examined the motion of satellites in binary systems, for which the period of axial rotation is well known. Comparison of centrifugal and gravitational acceleration on the surface of these satellites, assuming a spherical shape showed that for most of its surface loose bodies cannot hold . We performed a numerical simulation of trajectories for particles leaving the surface of the satellite in the double asteroid system.

MONITORING OF THE ORBITAL POSITION OF A GEOSTATIONARY SATELLITE BY THE SPATIALLY SEPARATED RECEPTION OF SIGNALS OF DIGITAL SATELLITE TELEVISION

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The report presents results of the determination of the orbital position of geostationary satellite «Eutelsat-13B», obtained during 2015-2016 years by the results of operation of European network of stations of reception of

DVB-S signals, incoming from the satellite. The network consists of 5 stations located in Ukraine and Latvia. The distances between the stations along latitude and longitude are about 1000 km. The stations are equipped with a radio engineering complex developed by the RI “MAO”. The measured parameter is a time difference of arrival (TDOA) of the DVB-S signals to the stations of the network. The measurements of TDOA are synchronized by GPS time marks. The determination errors of TDOA and satellite coordinates, obtained by the measured values of TDOA and using the method of multilateration and a numerical model of satellite motion, are equal 2.6 m, 1500 m and 100 m respectively. The method of multilateration is used to calculate Cartesian coordinates of the satellite in the WGS84 coordinate system. The numerical model is used to determine radial, tangential and normal coordinates of the satellite in a local orbital frame. Software implementation of the model is taken from the free space dynamics library OREKIT.

A NON-GRAVITATIONAL EFFECT AND SPIN ORIENTATION OF KILOMETRE-SIZED MAIN BELT ASTEROIDS

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Determining spin directions of asteroids - a rather difficult task. Today, only about 200 asteroids have identified spin orientations. For some asteroids it can determine the spin directions by precise calculations of the evolution of the orbits.

Numerical calculations of the orbital evolution of the MBA asteroids from 2005 to 2016 were carried out. The calculation results analysis leads to the conclusion that in our days an influence of non-gravitational effects (NGE) of cometary nature becomes apparent in motion of a significant portion (at least 5%) of the main belt asteroids up to 40 km. Such NGE causes the increase of the semi-major axes of orbits of the low-albedo asteroids with respect to the semi-major axes of orbits of bodies with the large albedos.

Change an asteroid semi-major axis should depend on the spin direction. Therefore the calculations may indicate on the spin direction (prograde or retrograde) for several tens of asteroids.

PROBLEMS BY ASSESSMENT OF ACCURACY AT PROCESSING JOINT ROWS OF DIGITIZED ASTRONOMICAL IMAGES OBTAINED WITH DIFFERENT INSTRUMENTS

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Current methods for determining the astrometry positions of digitized photographic plates have difficulty for correctly using data from different telescopes. Factors such as scale of a plate, exposure duration, size of the plate and its quality, affect the accuracy of the results. Scanner options add their mistakes. Often, it is important to get results in prolonged time period.

In such cases, we use observational data that were obtained using different telescopes. Then there is the need to balance the various data accuracy. The report provides a methodical approach. The method has been tested for some standard star fields.

ASTRONOMICAL OBSERVATION AS THE KEY FACTOR OF THE MODERN ASTRONOMY TEACHER TRAINING

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It is hardly possible to train a qualified astronomy teacher for secondary general educational institutions unless the teacher is familiarized with the modern recording methods of cosmic-emitted electromagnetic emissions as well as the practice of the observations.

In order to solve the above-mentioned tasks V.O.Sukhomlynskyi Mykolayiv National University the course called «Astronomical observations» which is comprised of two parts has been worked out. The first part, theoretical one, called «Modern Facilities of Astronomical Observations» fairly descriptively presents three branches of astronomical observations: ground optical, radio-astronomical and orbital exoatmospheric investigations. The second - practical part is a laboratory course which includes six laboratory researches mainly

aiming to familiarize with the modern amateur equipment for carrying out of astronomical observations.

Thus, evident pedagogical orientation is discernible, i.e. orientation aiming to train qualified astronomy teachers as well leaders of astronomy classes of out-of-school educational institutions.

As for the professional observations they are carried out during the astronomy and astrophysics courses as well as during the special practical training on astronomy by means of the University astronomical observatory equipment, most notably Cassegrain system reflecting telescope of 702-mm and Ritchey-Chretien system reflecting telescope of 400-mm.

THE USE OF MAVO'S LARGE ASTRONOMICAL IMAGES DATABASES FOR TODAY'S TASKS SOLUTIONS

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In recent years, noticeably increased volumes of astronomical images databases, access to which is organized in the framework of MAVO. The consequence of this process, there is a more effective solution to many tasks of astrometry. For the organization of access to astronomical images of MAVO we developed software that allows to set parameters for the search and download images to local computers. Multithreaded software allows to quickly download massive amounts of images, the speed limit only on the data server side and Internet bandwidth.

To automate the processing of large volumes of images was created complex of virtual computers with the installed program Astrometrica and other necessary software. Thus, on a single physical computers, you can run multiple streams of data reduction. The process of stars identification and reduction is fully automated, which allows you to handle arrays of hundreds of thousands or even millions of image files in a fairly short period of time.

ASTEROIDS OBSERVATIONS WITH NCSFCT'S AZT-8 TELESCOPE

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The asteroid observations of the small Solar System bodies were carried out at the telescope AZT-8 (D = 0.7 m, f/4) of the National Center of the Space Facilities Control and Test (NCSFCT), SSAU during 2010 – 2013. The telescope is located near Yevpatoria (Crimea), the observatory code according IAU is B17. The observational program was included perturbed main belt asteroids and alert observations of NEO in frame of GAIA FUN-SSO Company. The MPC database contains more than 4500 asteroids positions and magnitudes obtained during this period at AZT-8 telescope. The report presents an analysis of the positional accuracy of B17 observations obtained from the comparison from the comparison with the JPL HORIZONS ephemeris, and data from AstDyS-2 and NEODyS-2 web services.

DOUBLE STATION OBSERVATION OF FAINT METEORS IN MYKOLAIV

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Meteor research using TV CCD unintensified techniques was started in 2011 in Mykolaiv astronomical observatory (RI NAO). The method of meteor registration is based on combined observation method developed at RI NAO. The main accent of the research is made on precise astrometry and meteoroid orbits calculation. In 2013 first double station meteors with low baseline were observed. The accuracy of visible radiant estimation is 0.7° with baseline 5 km, and less 0.5° with baseline 11.8 km. The accuracy of velocity and height estimation is 0.5 km/s and 1-2 km.

DIRECT MEASUREMENT OF LASER COMMUNICATION POINT-AHEAD ANGLES FROM THE ARTEMIS GEOSTATIONARY SATELLITE THROUGH CLOUDS

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During several years we developed a ground telescope system for laser communication experiments with the geostationary satellite ARTEMIS of ESA. The orbital plane of ARTEMIS has an inclination angle of >10 degrees to the Earth's equatorial plane and precise tracking of the satellite is necessary. This was realized by calculating time resolved coordinates and tracking the satellite during the laser communication experiments, some of which were performed in cloudy conditions. During those a splitting of some images of the laser spot was observed when the laser beacon from the satellite was received through thin clouds. The splitting appeared in declination and right ascension. The splitting along declination may be interpreted as laser scattering and refraction in the atmosphere. The splitting in some images in right ascension was found to be equivalent to the calculated point-ahead angles required for space to ground laser communication (approximately $2''$). A small part of laser beam point ahead angle was observed in the direction of the velocity vector, where the satellite would be after the propagation time of the laser light to the telescope. These results are in accordance with the theory of relativity for aberration of light during the transition from a static to a moving coordinate systems. The condition of atmosphere in ahead points important to know for laser ranging, communication from ground stations to satellites and deep space missions. The observed results open ways for investigations and the development of systems for the turbulent of atmosphere compensation in ahead angle during from ground to space laser communications through atmosphere.

EFFECT OF THE REFERENCE CATALOG SYSTEM TO THE ASTEROID POSITIONS OF MPC DATA BASE

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The results of analysis MPC asteroid positions are presented. The database contains asteroid positions were obtained with about 50 reference catalogues by different observers. The problems of star systematic errors and astrometric weighting are discussed with using observations of the 12 selected asteroids. The observational series for these asteroids include 30-year period obtained with Zone Astrograph in Mykolaiv during 1960-1990. The residuals $(O - C)_{\alpha, \delta}$ of the selected asteroids has shown significant linear trends that change with using catalog bias corrections.

ASTRONOMICAL WEB SERVICES OF UKRVO

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Ukraine Virtual Observatory (UkrVO) has been a member of the International Virtual Observatory Alliance (IVOA) since 2011. The virtual observatory (VO) is not a magic solution to all problems of data storing and processing, but it provides us standards for building infrastructure of astronomical data centre. Astronomical databases facilitate data mining and provide users an easy access to observation metadata, images within celestial sphere and results of image processing. Astronomical web services (AWS) of UkrVO provide users handy data selection from a large astronomical catalogues for a relatively small region of interest in the sky. Examples of the AWS usage are given.

Ground-based and space telescopes have produced large volume of data over entire electromagnetic spectrum. In 2010, the Executive Committee of IVOA formally endorsed a note describing technical architecture to deal with all accumulated data resources. Interoperability of computer systems is one of the main concepts behind the technical

architecture to share and use astronomical data and metadata. The IVOA technical architecture consists of three main layers, namely user layer, VO core layer, resource layer. The VO core as the middle layer provides quick and easy access to the resources wherever they are located. The AWS allow users to obtain access to the resources, distributed across five continents, thanks to the interoperability between different astronomical archives and data centers. Simple cone search is one of many data access protocols, which provides the interoperability.

The AWS of UkrVO have successfully passed 30 regular checks out of 36 since November 2012. Most failures were caused by communication errors between servers in Ukraine and the USA.

The UkrVO image servers in Mykolaiv and Kyiv allow the user to get access to databases of observations, conducted with photo plates and CCD, via a web browser or a desktop application by using different graphical user interfaces.

PHOTOMETRIC OBSERVATIONS OF SELECTED ASTEROIDS ON TELESCOPE KT-50 OF MOBITEC COMPLEX OF RI NAO

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The results of asteroid observations performed on the telescope KT-50 (Mobitec, RI NAO) during 2014-2016 were presented. Asteroids were selected from the infrared survey NEOWISE, moving objects catalog SDSS MOC-3 and MPC database. Selected asteroids have a relatively high albedo ($pV > 0.2$) and are located in the outer part of the Main Belt (semi-major axis $a > 0.28$). The moments of opposition of the selected asteroids were obtained from HORIZONS service. The program of observations evenly covers the entire range of possible phase angles. The observations were made with filter close to the R standard band of Johnson-Cousins system. More than 1000 images were received. The instrumental magnitude of the selected asteroids and reference stars were computed. The standard deviations (RMS) of the measurements of instrumental magnitude for a 12-15.5^m reference stars are in range of 0.01-0.03^m. The lightcurves and phase dependencies were obtained for some asteroids.

RESULTS OF MODERN PROCESSING OF THE PHOTOGRAPHIC OBSERVATION OF URANUS AND NEPTUNE FROM ARCHIVES OF UKRVO

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We continue work, started in 2014, to use accumulated resources of UkrVO digital archive, containing images of Uranus and Neptune. Main part of used archives are from Research Institute - Nikolaev Astronomical Observatory (NAO) and Main Astronomical Observatory of National Academy of Science (MAO). Also some plates from Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences (AI UAS) were used. Numbers of plates containing images of Uranus and Neptune are, respectively, the following: 220 and 218 plates in NAO, 64 and 35 plates in MAO, 15 and 3 plates in AI UAS. Most of plates have 3 exposures per plate. The epoch of observation for most plates is 1960 to 1998.

All plates were scanned with the resolution not less than 1200 dpi. Each plate of NAO was scanned 5 to 6 times. Plates containing images of Uranus and Neptune were, respectively, scanned more than 1200 and 1100 times in NAO. All plates of other observatories were scanned only once. Raw image processing was conducted for all scans obtained in observatories.

Star identification for scans was conducted for more than 2300 scans in NAO and for 75 scans in MAO and 18 scans in AI UAS. Coordinates of all objects were obtained. Positional accuracy of reference stars has value of 0.04"-0.20". Standart deviation of planet's position is in ranges 0.10-0.12 pixel in main part of archive, that corresponds depending on the scale from 0."08 to 0."26. The comparison of the new topocentric positions of planets with Horizons ephemeris was made for calculation (O - C) residuals and their RMS.

CATALOGUE OF POSITION AND PROPER MOTIONS OF STARS IN THE VICINITY OF OPEN CLUSTERS

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In the Research Institute - Nikolaev Astronomical Observatory (NAO) catalogue of position and proper motions of stars in the areas around the Galactic open clusters was created by using photographic and CCD observations obtained with different telescopes in the 20-21 century.

Near 290 plates (20x20cm, 5ex5e) obtained with the Zonal Astrograph of NAO (D = 116 mm, F = 2040 mm, scale = 101"/mm) in 1962-1993. More than 20 thousands CCD frames obtained with KT-50 telescope (D = 500 mm, F = 3000 mm, 43rx43r, scale = 0.8"/pix) in 2011-2015. Also we downloaded more than 270 thousands FITS files from MAVO image archives with observational epoch from 1953 to 2010.

Catalogue of position and proper motions of about 2.7 million stars (7-16)^m in Tycho-2 system (NAO2015pm) was obtained. The accuracy of positions on both coordinates is ranged from 0.02-0.04" for the stars of (7-12)^m to 0.08-0.11" for the stars of (14-16)^m. Inner accuracy of proper motions is near 0.04"/year. Systematic difference between common stars of NAO2015pm and XPM catalogues less than 0.005"/year on both coordinates.

AUTOMATION OF OBSERVATIONS ON UTR-2 AND GURT RADIO TELESCOPES

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Ukraine is one of the leading radio astronomical countries due to developing and exploitation of the world largest and most efficient radio telescopes UTR-2 and URAN operating at decameter wavelengths. For more than 40 years they have been the main tools for exploration of cosmic radio emission at the lowest frequency range of below 33 MHz.

These radio telescopes enabled obtaining of a great number of top priority astrophysical results recognized by the international radio astronomical community. In the recent years, this is stimulated by the integrated research program of NAS of Ukraine "Modernization of the UTR-2 radio telescope and prospective development of decameter radio astronomy in Ukraine", which besides modernization of existing instruments take place a creation of additional new-generation radio telescope GURT.

In 2013-2015, a new software and hardware controlling complexes developed and installed on the UTR-2 and GURT radio telescopes. They designed for planning observations of discrete cosmic radio sources and areas of the celestial sphere, for programming control of directional patterns of radio telescopes, for control and monitoring of other systems.

Automation of observations made on the basis of distributed means, operating in the local network of the observatory. Local computer network also received further development. We created Grid cluster to store large volumes of radio astronomy data. The structure of automation and their basic functionality are shown in the report. It significantly automates the process of radio astronomy observations.

STAGES OF DEVELOPMENT OF THE MYKOLAIV ASTRONOMICAL OBSERVATORY

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Mykolaiv Astronomical Observatory, one of the oldest observatories in the south-east of Europe, was founded in 1821 by Admiral Greig. Our observatory passed three main stages in her history: 1821 - 1912, Naval Observatory (Russian Empire); 1913 - 1991, Nikolaev branch of Pulkovo Observatory (Russian Empire and USSR); 1992 - Present, Mykolaiv Astronomical Observatory (Ukraine). The observatory received the status of Research Institute in 2002. On March 2007, MAO was included into the tentative list of UNESCO of the World Heritage Sites from Ukraine under the number 5116. 5 full doctors and 28 PhD were prepared in the observatory since 1913. Mykolaiv astronomers used 16 telescopes for observations of the celestial bodies, one of which was inscribed in a list of scientific objects that represents the National Heritage of Ukraine.

THE ARTIFICIAL SATELLITES OBSERVATION USING THE COMPLEX OF TELESCOPES OF RESEARCH INSTITUTE “MYKOLAIV ASTRONOMICAL OBSERVATORY”

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The special methods are needs for observation of artificial objects (AO) due to the fast apparent motion relative to the stars especially for Low Earth Orbit. The special methods, telescopes and software were developed in RI MAO for AO observation. The combined method of observation consists in separated accumulation of images of reference stars and artificial objects and using for observation of artificial objects on all orbits type. The TDI mode and camera rotator using for full-frame camera and allows to obtain the point-like images of artificial object at all type of orbits. The method of accumulation frames with shift are using for TV CCD cameras and allows to obtain the point-like images of artificial objects with apparent motion up to $0.5^{\circ}/s$. The three telescopes of MOBTEL complex using for observation of artificial satellites in RI MAO: the KT-50 ($D=0.5m$, $F=3.0m$), the telescope equipped of full-frame CCD-camera ($3k \times 3k$), field of view $0.7^{\circ} \times 0.7^{\circ}$, limiting magnitude 18.5 (for exposure 120s). Mezon ($D=0.23 m$, $F=0.8 m$), the telescope equipped of full-frame CCD-camera ($3k \times 3k$), field of view $2.7^{\circ} \times 2.7^{\circ}$, limiting magnitude 16 (for exposure 120s). TV-telescope ($D=0.05 m$, $F=0.14 m$), the telescope equipped of TV CCD-camera Watec 902 h, field of view $2.8^{\circ} \times 2.1^{\circ}$, limiting magnitude 11.

NUMERICAL SIMULATION OF BINARY AND MULTIPLE ASTEROIDS SYSTEM DYNAMICS

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The paper shows a method of constructing the asteroid-centric coordinate system for the study of the evolution of the asteroids orbit satellites. The model includes a central asteroid, its satellite(s), Sun,

Moon and eight major planets. Also taken into account the nonsphericity of the attracting body and the pressure of sunlight on the asteroid's satellite based shadow function. The model takes into account the mutual attraction between all objects.

To calculate the distance modulus to large objects from the asteroid system, you need to know the coordinates of the asteroid-centric coordinates of the Sun, the Moon and the eight major planets. Initially we borrow heliocentric coordinates of the above objects and DE431 numerical theory. Further, the Kepler orbital elements are counting heliocentric coordinates of the asteroid, and then go to the asteroid-centric reference system.

With the help of the constructed model, the evolution of the orbits of satellites next asteroid systems were considered: the (45) Eugenia, (87) Sylvia, (10199) Chariklo, (66391) 1999 KW₄, (134340) Pluto, (136108) Haumea, (136617) 1994 CC, (153591) 2001 SN₂₆₃.

THE SIMULATION OF THE ORBITAL EVOLUTION OF A PASSIVE HIGH-ORBIT FRAGMENT WITH LARGE SURFACE AREA

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Today there are tens of thousands of artificial celestial bodies in the near-Earth space. Most of them belong to the space debris as such worn-out artificial satellites or their fragments. Such celestial bodies can remain in high orbits essentially indefinitely. Their motion is subjected to the perturbations by the Moon and Sun, as well as by the asymmetry of the Earth's gravitational field. The high-orbit objects are monitored using optical telescopes. This paper describes a new method for de-orbiting of worn-out artificial satellites from the geostationary orbits in the near-Earth space to lower altitudes.

For the first time such a considerable amount of data over long time intervals was gathered for the objects with high area-to-mass ratios that enabled us to determine and estimate their observation and orbital characteristics. The method of the celestial body orbit changing in the near-Earth space which is described in this paper can be useful in solution of the near-space ecology problem, particularly in the cleaning up the near-Earth space from the artificial space debris using the solar radiation pressure only.

OBSERVATIONS OF CEPHEIDS WITH SALT FOR THE ANALYSIS OF METALLICITY GRADIENT AND LOCAL CHEMICAL COMPOSITION HETEROGENEITY IN THE MILKY WAY DISK

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The problem of radial abundance gradients in spiral galaxies is central in the field of galaxies evolution. For the Galaxy, abundance gradients as observational characteristics of the galactic disk are among the most important input parameters in any theory of galactic chemical evolution. In recent years, great progress has been made on the distribution of abundances across the disk of the Galaxy, but many questions concerning the present-day abundance distribution in the galactic disk, its spatial properties, and evolution with time, remain to be answered.

We started to use the High Resolution Spectrograph (HRS) of the Southern African Large Telescope (SALT) to obtain the high-resolution spectroscopic observations of a sample of Cepheids which we are going to use:

(1) To derive the shape of the abundance gradients in the inner parts of the Milky Way,

(2) To strongly constraint the galactic chemo-dynamical models,

(3) To extract the possible objects belonging to the Population II.

We will present first observations, data reduction procedure and results.

POLARIS: HISTORY OF PULSATONAL ACTIVITY SINCE DISCOVERY

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We have analyzed the pulsation activity of small-amplitude Cepheid Alpha UMi (Polaris) during the period of its radial velocity

observations. As know during XX century Polaris demonstrated the decreasing of the radial velocity amplitude to the minima at 80th. After that amplitude have increased.

Our observations during September-December 2015 (21 spectra) obtained by 81cm telescope TCO with Spectrograph show the radial velocity amplitude comes to 4.16 km/, and it pproximately twice the one found in 2007, and the pulsation period increase up to 8.6 min.

LOW-FREQUENCY RADIO RECOMBINATION LINES: OBSERVATIONS AND DATA PROCESSING

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Investigations of radio recombination lines at extremely low frequencies provide new opportunities for the interstellar medium studying. However, the low intensities of the lines and high level of interferences makes such investigations very difficult and impose high requirements to both the equipment and observational methods, and to the data processing procedure. In this report observations of radio recombination lines, which are carried out with radio telescope UTR-2 using a 4096-channel autocorelometer and 16-bit digital spectral analyzer are described. The correct processing and interpretation of observational results provide new information about the basic parameters of the interstellar medium – electron temperature, density, element abundances, distribution of ionized gas. Radio recombination lines provide new opportunities non only for astrophysics but also for physical science as a whole.

KINEMATIC PARAMETERS OF THE GALAXY USING THE XPMC CATALOGUE DATA

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We present our results of kinematic investigations of our Galaxy using the XPMc catalogue data. XPMc is the corrected version of the high-density XPM catalogue covering the whole celestial sphere in the range of magnitudes from 10 to 20.

We derived kinematic parameters of the Galaxy using two different methods.

The first (traditional) method is based on estimating the parameters of the standard physical Ogorodnikov-Milne model while the second approach is mathematical and it allows to find all significant harmonics which are presented in the stellar velocity field.

Solving the system of the Ogorodnikov-Milne equations by the least-square method we derived 11 kinematic parameters of the Galaxy but applying the mathematical decomposition in vector spherical harmonics (VHS) we found out-of-model harmonics reaffirming conclusions of other authors (e. g. Vityazev, Tsvetkov, Shuksto). One more conclusion is that not all parameters of the Ogorodnikov-Milne model are statistically significant, and the set of parameters depends on the stellar sample.

Kinematic parameters derived using both methods are consistent within the error limits but the first method gives larger error bars. Also we found the dependence of parameters and decomposition coefficients on magnitude.

For comparison, we calculated kinematic parameters using data of several other modern catalogues. Taken results are consistent for faint magnitudes.

METHODS FOR DETERMINING THE FREQUENCY DRIFT RATE OF SOLAR RADIO BURSTS

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In this report we consider solar radio bursts as a probe signal for monitoring physical properties of the solar corona. One of the most important characteristics of solar bursts of different types is their frequency drift rate. It indicates that fast electrons ejected from the solar active regions and moving through the corona generate such bursts from plasma waves near the local electron plasma frequency and/or near its harmonic. As a result, solar bursts drift on dynamic spectra with frequency. Often the evolution of intensity humps of solar bursts in frequency and in time can be fitted to a power-law model. This provides strong evidence that the electron density in solar corona decreases as a power function of the radial distance above the solar photosphere. To interpret properly the observed rate of frequency drift for solar bursts, we discuss advantages and disadvantages of several methods helpful for conducting the study. Our results allow us to obtain the efficiency estimation for determining the frequency drift of solar bursts by different approaches.

LOW-TECHNOLOGY HIGH-EFFICIENCY RADIO- TECHNICAL SOLUTIONS FOR METEORS AND SATELLITE OBSERVATIONS

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The Solar system is inhabited with large number of celestial bodies. Some of them are well studied, such as planets and vast majority of big asteroids and comets. There is one group of objects which has received little attention. That is meteoroids and related to them meteors. Nowadays enough low-technology high-efficiency radio-technical solutions are appeared which allow to observe meteors round-the-clock. At RI “MAO” three methodologies for meteor observation are developed: single-station method using FM-receiver, correlation method using FM-receiver and Internet resources, and single-station method using low-cost SDR-receiver. Also SDR-receivers are well suitable for observation active artificial Earth's satellites on solar-synchronous orbits by measuring Doppler shift of the frequency of the signals they radiate. Two weeks of regular observational data were obtained for satellite 27844 (CUTE-1). The standard deviation of (O-C) of the satellite radial velocity is 4 m/s.

MULTICOLOR PHOTOMETRY OF GEOSYNCHRONOUS SATELLITES AND APPLICATION ON FEATURE RECOGNITION

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Multicolor photometric observations of Geosynchronous Earth Orbit (GEO) cluster have been performed experimentally using the Schmidt telescope at Xing-long Observatory of National Astronomical Observatories, Chinese Academy of Sciences. The data are reduced and the results are analyzed. Compared the 4 satellites, it is concluded that there are significant differences between the intensity curves

(color indices) of satellites with different bus types. And the curves of each satellite observed during 2 nights are extremely similar. The correlation coefficients are also evaluated to quantify the differences. The results indicate that multicolor photometric characteristic of GEO satellites may be one possible method of feature recognition.

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