BOOK OF ABSTRACTS

Actual Questions of Ground-based Observational Astronomy

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

ACTUAL QUESTIONS OF GROUND-BASED OBSERVATIONAL ASTRONOMY

International Conference

ABSTRACT BOOK

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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 27-30, 2021. Methods and technical means of ground-based observations, a role of the International Virtual Observatory Alliance (IVOA) in modern research and actual problems of ground-based astronomy are presented.

CONTENT

ANALYSIS OF MODERN ASTROMETRIC CATALOGUES IN THE GAIA ERA

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We investigate of the systems of proper motions of stars in the ground-based catalogues HSOY, UCAC5, GPS1 and PMA derived by combining with the Gaia DR1 space data. Assuming the systematic differences of stellar proper motions of two catalogues to be caused by the mutual solid-body rotation and glide of the coordinate systems produced by the data of the catalogues under comparison, we analyse the components of the mutual rotation vector and displacement of the origins of these systems. The equatorial components of the vector of mutual rotation velocity of the compared coordinate systems, as well as velocities of the mutual displacement of their origins, varying within the range from 0.2 to 2.9 mas yr−1, were derived from a comparison of proper motions of the sources that are common for Gaia EDR3 and the TGAS, UCAC5, HSOY, GPS1 and PMA catalogues, respectively. The systematic errors of proper motions of stars in the HSOY, GPS1, PMA and Gaia EDR3 catalogues in the range of faint stellar magnitudes were estimated by analysing the formal proper motions of extragalactic objects contained in these catalogues.

ASTROINFORMATICS: STATISTICAL PROPERTIES OF FUNCTIONS OF PARAMETERS OF THE STATISTICALLY OPTIMAL APPROXIMATIONS OF SIGNALS

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Correct error estimates are very important to estimate statistical significance of results and to prevent fake discoveries. Classical methods are to determine separate errors of separate coefficients. However, due to generally nonzero correlations between the deviations of the coefficients due to observational errors of the input data, the simplified version of the evaluation may cause drastic errors of the estimate of variance $\sigma^2[G(C_\alpha)]$ of the function G of m parameters of approximation C_α, $\alpha=1..m$. A correct expression is $\underline{\sigma^2[G(C_\alpha)]=\sigma_0^2 \cdot \Sigma_{\alpha\beta=1}^{m} A_{\alpha\beta}^{-1} (\partial G/\partial C_\alpha) \cdot (\partial G/\partial C_\beta)}$ where $A_{\alpha\beta}^{-1}$ is a matrix inverse to the matrix of normal equations $A_{\alpha\beta}$. A typical error is to use an abbreviated formula $\sigma^2[G(C_\alpha)]=\sigma_0^2 \cdot \Sigma_{\alpha=1}^{m} A_{\alpha\alpha}^{-1} (\partial G/\partial C_\alpha)^2$, what is equal to set nondiagonal elements of $A_{\alpha\beta}^{-1}$ to zero

This simplification is generally not correct (see 1994OAP.....7...49A, 2020kdbd.book..191A). Here the fit is $x_C(t)= \Sigma_{\alpha=1}^{m} C_\alpha \cdot f_\alpha(t)$, where $f_\alpha(t)$ are the basic functions, and σ_0 is the unit weight error.

Particularly, for the approximation and it's derivatives of power s, $\sigma_0^2[x_C^{(s)}(t)]= \sigma_0^2 \cdot \Sigma_{\alpha\beta=1}^{m} A_{\alpha\beta}^{-1} \cdot f_\alpha^{(s)}(t) \cdot f_\beta^{(s)}(t)$.

Other methods are based on artificial data sets based either on mixing deviations from the fit, or on generating (normally distributed) random "observational errors).

The "bootstrap" method is often used during recent decades.. It has systematically different error estimates.

For a large number of data, results are expected to converge asymptotically to that in the matrix. Examples are discussed.

THE RESULTS OF OBSERVATIONS OF BINARY AND MULTIPLE STAR SYSTEMS FROM THE WDS CATALOG AT THE RI "MAO"

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Double and multiple star systems are source of unique information for determining the parameters of star formation models and for testing stellar models evolution. Therefore observations and measuring of their mutual configuration parameters is still important. The history of observations of double and multiple stars at the Research Institute «MAO» (RI MAO) covers the period from 2013 to 2020. Two telescopes of the RI MAO equipped with CCD cameras were used for observations: AMC (D=180mm, F=2500mm) and KT-50 of the MobiTel complex (D=500mm, F=3000mm). Target objects for observational list were selected from Washington Visual Double Star Catalog (WDS) taking into account the conditions of visibility and technical capabilities of telescopes. All astrometric processing was performed by the Astrometrica software using UCAC4 and GAIA DR2 as reference catalogs. The measurement of the mutual configuration parameters (separations and positional angles) was performed by the software REDUC in manual mode till 2019.

Software for automatic search of the double and multiple stars from WDS catalog and measuring of their mutual configuration parameters was created at RI MAO in 2019. This made it possible to search for WDS systems in the CCD database of old observations, which were carried out according to the other programs of observations. In current work we presented such data from observation of fields around open clusters in the plane of the galactic equator from 2011 till 2020.

The statistics, analysis and processing results of the obtained observations for more than 2, 000 double and multiple systems are presented, as well as the results of comparison of the Mykolaiv data with the WDS catalog.

RELIABLE STANDARDS FOR POLARIMETRY: TECHNIQUE, CALIBRATION AND VARIABILITY

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Polarization is an important property of light. It is the subject of observation, interpretation and simulation for multiple decades. Correct polarimetric data processing require high polarization standards and zero-polarization stars.

The observations were obtained using single-channel aperture photometer-polarimeter on the 2.6-m Shajn mirror telescope (SMT) at the Crimean astrophysical observatory (Ukraine) in 2002 - 2017. Measurements of zero-polarization stars are used to compute the instrumental polarization. Classic approach implies usage of the measurements obtained each night before and or after the observations, in the same filter, similarly to flat field and dark frames in CCD photometry. We determined the instrumental polarization in the form of piecewise continuous functions from the observations of about 65 non-polarized stars for the whole data interval. Highly polarization standards were observed for calibration of position angle zero-point. taking into account statistically insignificant difference between many consecutive sets, we decided to determine the position angle for time intervals larger then one set of observations. We obtained the catalogue of Stokes parameters for 98 standard stars (both non-polarized and highly polarized). Our catalogue is not compilative, but obtained using the same instrument and technique. We analyzed time series of Stokes parameters of each standard using multiple well known scatter-based numerical parameters characterizing the degree of variability (so called variability indices). We detected some standard stars to show variability of at least one Stokes parameter, so they should not be used as polarized standard stars without further investigation.

The technique we used allows to increase the reliability of results, since incorrect accounting of even one standard may have significant impact on the results of polarimetric observations.

OBSERVATION OF GEO AND LEO SATELLITES BY RADIO-TECHNICAL MEANS IN THE RESEARCH INSTITUTE "MYKOLAIV ASTRONOMICAL OBSERVATORY"

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The RI "MAO" radio-technical means are fully passive. To track satellites they use radio signals emitted by the satellites themselves. Thus, the following were developed and put into operation: 1) Simple INTerferometer NETwork (SintNet) for monitoring the orbital position of geostationary (GEO) satellites; 2) Doppler station (DS) for clarifying the orbital elements of low Earth orbit (LEO) satellites. Two SintNet operate now: European and Chinese. The European SintNet consists of 10 stations and tracks 3 co-located satellites simultaneously. The Chinese SintNet consists of 4 stations and tracks one satellite. The error in determining the coordinates of the satellites is about 200 m.

The Doppler station operates in the frequency range 430-440 MHz. It uses signal spectrum analysis to determine the frequency F(t) of the radio signal emitted by LEO satellite and received by the station at time t. The SGP4/SDP4 analytical model of the satellite's motion is applied to the analysis F(t) and to clarify the satellite orbital elements. Errors in the measurement of the Doppler frequency shift and time are 4 sm/s and 30 ms respectively.

KINEMATIC ANALYSIS OF THE MILKY WAY BY GAIA EDR3 DATA

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In this work, the kinematic analysis of a sample of red giants with radial velocities from third release of the GAIA space mission we carried out. Twelve kinematics parameters of the Ogorodnikov-Miln model were determined for stellar systems with the radius of 1 kpc that are located along the direction from the galaxy center to the anticenter. The range of the samples is 0-14 kpc, with a step of 0.25 kpc, in the θ angles in the range of 135-235 degrees, where 180 is the direction of the galaxy center - the Sun - the anticenter. In this range, bases on the analysis and combinations of some model parameters the information characterizing the behavior of stellar velocity field in different parts of the studied galaxy region, as well as the rotation curve of the Galaxy at different θ angles were obtained. The determined kinematic parameters in the Solar vicinity with a radius of 1 kpc are in good agreement with the results of earlier studies of the solar neighborhood.

DYNAMYCS OF SOME NEO ASTEROIDS

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During 2018-2021 in the Baldone observatory, 49 new asteroids were discovered and more than 6000 astrometric positions for 1122 asteroids were published in MPC circulars. In this period in 221 observation nights were obtained 5544 CCD images, which covered 648 square degrees of sky. Of them, 3412 CCD images were devoted to studying the dynamics of 25 NEO-type asteroids. For asteroids, rotation periods and amplitude of brightness variation in the G(RP) passband were obtained. Photometric data reductions for the CCD images were done using the MPO Canopus, Lemur and MaxIM DL programs. Through 15 minutes steps using Fourier analysis were determined the best size of periods. The G(RP) photometric magnitudes for reference stars were taken from Gaia DR2 release.

This research is funded by the Latvian Council of Science, project Complex investigations of Solar System small bodies, project No. lzp-2018/1-0401.

THE RESULTS OF METEOR OBSERVATIONS OF THE TAURIDS SHOWER IN KHARKIV IN 2019-2020

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We present the kinematic, physical and chemical characteristics of the meteoroid of the Southern Taurids meteor shower associated with the comet 2P/Encke. It was observing on November 21, 2019. The observations were carried out using the automatic video and spectral meteor patrol (AVSMP) of the Institute of Astronomy of V.N. Karazin Kharkiv National University. The analysis of the identified emission lines was carried out. The material composition of the investigated meteor body has determined. The most intense lines in the meteor spectrum belong to FeI, MgI, NaI atoms which are characteristic of meteoroids of the Southern Taurids shower, and atmospheric NI, OI atoms and N_2 molecules. We used methods of the relative and absolute photometry of meteor spectra obtained by CMOS-sensors which are used in modern CCTV video cameras.

CURRENT STATE OF OBSERVATIONS OF STELLAR OCCULTATIONS BY SMALL SOLAR SYSTEM BODIES IN UKRAINE

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This paper presents a description of problems that can be solved using observations of stellar occultations by small Solar System bodies. In order to observe stellar occultations, a hardware and software complex system for operating long focal length telescopes has been created in the MAO of NASU in cooperation with Taras Shevchenko National University of Kyiv. This system employs a high performance cooled CCD camera Apogee Alta U47 in precision time delayed charge-integration (TDI) mode with provides high sensitivity. The system also includes a focus reducer with a colour filter kit. The system can be used in telescopes AZT-12 of the MAO of NASU and AZT-14 at the Lisnyky observing station. A mobile observation unit based on a Newtonian telescope (D = 203 mm, F = 1.200 mm) with a fully computerised assembly Sky-Watcher EQ-5.

The value of stellar occultation observations is enhanced greatly when multiple observation sites are involved. To this end, a new stellar occultation observers' group has been launched in Ukraine. This group includes observers from Odesa Astronomical Observatory, which use the Ritchey-Chrétien telescope OMT-800 (D = 800 mm, F = 2,134 mm) with a CCD camera QHY174M-GPS and a Schmidt telescope (D = 271.25 mm, F = 440 m) with a camera «Videoscan-415-2001» at the Mayaki and Kryzhanivka observing stations, respectively.

The group also includes several amateur observatories, such as the observing station.

We provide a comprehensive description of all instruments and equipment employed at the afore-mentioned observing stations and also several examples of successful observations of stellar occultations performed by this group.

STELLAR OCCULTATION BY THE ASTEROID (853) NANSENIA ON 8 APRIL 2021

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Observations of occultations of stars by asteroids provide useful information about the shape and size of asteroids. Ground-based multisite observations are especially valuable in that regard. To this end, on the joint initiative of the Main Astronomical Observatory of the National Academy of Sciences of Ukraine and Astronomical Observatory of Taras Shevchenko National University of Kyiv, the development of Ukrainian network of stellar occultation observing stations is currently underway.

This paper presents the results of observations of the star UCAC4 516-047388 occultation by the asteroid (853) Nansenia on 8 April 2021 performed at the Kryzhanovka observation station of Odessa I.I. Mechnikov National University. A Schmidt telescope (D = 271.25 mm, F = 440 mm) and Videoscan-415-2001 CCD camera were used to carry out observations. The ICX415AL chip (with the number of effective pixels 782 (H) x 582 (V) and unit cell size of 8.3 μm x 8.3 μm) serves as an interline image sensor for the specified CCD camera. The exposure duration for the occultation recording was chosen to be 5 seconds in order to acquire an image of the star adequate for photometric measurements, on the one hand, but to minimise the exposure time thus improving temporal resolution, on the other hand.

The star UCAC4 516-047388 has a low brightness of $14^{m}.2$ which provides another reason for a long exposure time of 5 seconds to be used. This exposure time exceeds the maximum duration of occultation of 2.8 sec. An approach that enables us to draw a conclusion that the occultation has taken place and also to estimate the duration of such a phenomenon is adopted to construe the photometric (light) curve. Our calculations yield the duration of occultation $\tau = 2.0 \pm 1.2$ sec, which corresponds to the predicted value within the error.

SOFTWARE FOR PROCESSING TV METEOR IMAGES

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Observational material comprises an archive of video footages collected during regular television observations performed by meteor watch (patrol) in 2003-2018.

We justified the need for creating unconventional software for processing meteor images in TV frames.

Three fundamental principles are laid down in the algorithm employed in photometric processing:

1. Before image processing starts, astrometric reference stars, imaged in the frame, shall be found. Cartesian co-ordinates of all measured stars are used to find centroid positions for individual stars, thus creating a mask which enables to improve the accuracy of measurements and avoid any errors due to radiation detector noise.

2. A circular aperture is used when calculating the intensity values of pixels throughout the star image. Intensity values of the imaged star pixels in the aperture are summed up proportionally to the area of each respective pixel in the aperture.

3. Adaptive optics techniques are used to choose the size of measuring aperture for each measured star.

Observational selection bias has been detected using television and telescopic observations, as well as observations conducted with astronomy cameras with short and long focal length objectives. In particular, we have studied such processes as quasi-continuous disintegration of meteors, breaking of meteors into fragments and asymmetry of meteor wakes.

A significant difference of images of disintegrating meteors shows a huge observational selectivity which fundamentally alters information about this process per se and the number of fragments of a meteor that undergoes disintegration. As a result, telescopic observations are favoured for studying the fine structure in meteor images.

The paper also discusses the prospects for implementation of the created software package to study different physical processes that occur during meteor events.

POLARIZATION IN ASTRONOMY AND ITS REGISTRATION. EDIPO PROJECT.

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The main idea and some detailes of EDIPO (Efficient & Dedicated wide-field Imaging POlarimeter) are presented. Widefield photometer-polarimeter designed for very early observations of gamma-ray bursts (afterglow), regular monitoring of the peculiar objects and polarimetric sky survey. Polarimetric observations will be simultaneously in four channels, to ensure, respectively, four Stokes parameters (0, 45, 90, 135 degrees). Some device parameters: field of view 30 to 30 minutes for each of the four channels, the wavelength from 4000 to 10000 AA, 4 CCD with a pixel size of 10 by 10 or 20 to 20 microns.

REVIEW OF WORKS OVER THE LAST DECADE ON THE PROCESSING OF DIGITIZED PHOTOGRAPHIC OBSERVATIONS

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The current state of research IVOA and UkrVO in the direction of digitization and processing of astroplates was analyzed.

We highlighted the main results and trends of the last decade, evaluated the availability of digitized material and metadata on different regional and local platforms, compared scanning equipment, software, and accuracy positions of celestial objects and their stellar magnitudes from processing of images. We also collected information about the catalogs obtained from the reprocessing of digitized results of photographic observations.

METHODS OF PROCESSING ASTRONOMICAL OBSERVATIONS OBTAINED AT THE OBSERVATORY AT TERSKOL PEAK

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Positional, photometric, spectral and polarimetric observations of galaxies , planets and their satellites, exoplanets, gamma-ray bursts, interstellar medium, small bodies of the solar system, space debris are carried out at the observation complexes of the Terskol Peak Observatory (Kabardino-Balkaria, Russia, altitude 3150 m above sea level, international code B18) as part of a number of International Programs "Astronomy in Elbrus".

Both standard software (MAXIM DL, ASTROMETRICA, DECH) and original programs (preparation and processing of high-resolution spectra, processing of space debris) are used to process the obtained observations.

The data of positional and astrophysical observations are given in the work and the methods of their processing are demonstrated.

PHOTOMETRIC VARIABILITY OF THE SELECTED BLAZARS IN THE OPTICAL RANGE BL LACERTAE AND ES 1426 + 428

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In our paper we present the results of photometric observations of two bright blazars of the northern hemisphere: BL Lacertae and 1ES 1426 + 428 in BVRI filters of the Johnson / Bessel system. For both objects, fluctuations of brightness in 2018-2020 up to 1 m were recorded in BVRI filters with a total error of ≈ 0,03 m – 0,1 m/ The intraday variability was revealed (IDV) for BL Lacertae 17/18.11.2018.

During calculations of the color indexes, we found the trend of bluish color with increasing brightness (BWB - bluer-when-brighter) for BL Lacertae in LTV was reliably revealed by using different pairs of filters. Also, the BWB trend with an average correlation (over 0.5) was recorded for 1ES 1426 + 428. The presence of such fluctuations in the color of blazars is due to the synchrotron radiation of the jet. The revealed partial correlation of variations in brightness with low time resolution (more than a week) between the photometric optical observations obtained by us and the data of the Fermi gamma-ray telescope in 2018-2020 requires additional research.

CIRCULAR POLARIZATION IN SOME SMALL BODIES OF THE SOLAR SYSTEM

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Using more accurate values of standard objects and the methodology presented in our work, see "Reliable Polarimetry Standards: Methodology, Calibration and Variability", we reanalyzed the Shine telescope we obtained on a 2.6-meter reflector in the mode of simultaneous measurements of circular and linear polarization of a number of objects in the solar system for 15 years. The previously obtained results of linear polarimetry are fully confirmed. In the case of circular polarimetry results, the situation is significantly different.

We found significant circular polarization at phase angles less than 0.2 degrees (i.e., during opposition) in Jupiter's moons with a high albedo: Io, Europa, Ganymede, with a positive sign and an amplitude of 0.2-0.4%. Polarization increases synchronously for different objects with decreasing phase angle. Also, nonzero values of circular polarization of opposite signs at large phase angles were found both for these objects and for asteroids and satellites of Saturn with a large albedo. Low circular polarization of opposite signs at different phase angles has also been determined for several comets measured over more than 10 years. In this case, no dependence of the circular polarization on the phase angle was found. And the only discovered dependence can be called the fact that in small bodies circular polarization is observed simultaneously with nonzero linear polarization.

In our opinion, the detected small circular polarization of opposite signs in comets and a group of small bodies can be explained by the superposition during observations from the Earth's surface of several media with different linear polarization and / or light scattering by nonspherical dust grains in a nonspherical form. dust cloud.

RESULTS OF NEO OBSERVATIONS IN NSFCTC IN 2020 – 2021

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In 2017, the Quantum Optical Station (QOS) (0.3 m, f/1.0 telescope) of the Center for Special Information Reception and Processing and Navigation Field Control of the National Space Facilities Control and Test Center (NSFCTC) received the MPC code L18. Since 2019, the QOS has begun to conduct more or less regular observations of Near-Earth Objects (NEOs).

Since June 2020, the new NSFCTC's 0.5 m, f/3.8 telescope, located next to the QOS, has been observing NEOs. It made it possible to significantly increase the number of observations. In total, more than 4,900 observations of more than 380 NEOs by the September 15, 2021, were received, and also this telescope took part in confirming the discovery of a significant number of new NEOs.

METHODOLOGY AND SOFTWARE FOR SEPARATION OF GSS CLUSTER OBSERVATIONS

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The method of separation of GSS in close cluster groups by their NORAD numbers is presented. The method can be used when direct identification using (O-C) residuals is impossible. Long series of GSS observations that were obtained at the SAC telescope of the Mykolaiv observatory during 2020-2021 were used to test this method. The software for automatic separation of GSS in close cluster groups by their NORAD numbers was created to further use this data to calculate sets of orbit elements in TLE format.

OPTICAL AND RADIO OBSERVATIONS OF METEORS AT RI "MAO"

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Observation of meteors using TV CCD unintensified technique was started at RI "MAO" in 2010. The method of meteor registration is based on combined observation method developed at RI "MAO". The research was focused on faint meteors and meteoroid orbits calculation. Results of more than 10 years of the research include catalogs of single station meteor parameters (>15000 meteors) and elements of heliocentric meteoroid orbits based on low and large baseline double station observations. Colorimetric observations of meteors were also started. Results of radio meteor observations campaign are also presented.

PECULIARITIES OF OBSERVATIONS OF SATELLITES ON HIGH ECCENTRICITY ORBITS

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Molniya-like orbits are typical highly elliptical orbit (HEO) orbit with inclination of about 65°, high eccentricity of about 0.7 and periods of one-half day. Most of the satellites on the HEO orbits are old rocket bodies and other space debris. Objects on as highly elliptical orbit are very danger for LEO satellites and for people in case of a fall because of increasing velocity near the perigee. The situation is complicated by the fact that the NORAD catalog does not contain the orbital elements for many of these objects.

This report is dedicated to observation of space debris on Molniya-like orbits with purpose of their reentry prediction. 8 Molniya-like satellites were successfully observed at RI MAO during May-September 2021. The orbital elements for some of these objects are not presented in NORAD catalog. The estimates of the accuracy of the obtained positional observations are given. The mean square errors of position were ±(1.0–3.0)″ in right ascension and declination for the objects in $(8–11)^{mag}$ range. Orbital elements of these satellites were calculated using FindOrb software and software developed in Astronomical observatory of Odessa National University. Orbital elements in TLE format were represented on Ukrainian Optical Station Network (UMOS) website.

RECENT NOVAE OBSERVATIONS AT ASTRONOMICAL OBSERVATORY ON KOLONICA SADDLE

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We are experiencing an increased rate of nova explosion on the northern hemisphere in recent 2 years. Starting from July 2020 with the strongly reddened nova V1391 Cas we are continuously observing some nova in outburst. At Astronomical Observatory on Kolonica Saddle we have the possibility to perform simultaneously photometric and spectroscopic observations. Here we report the observations of 5 classical novae. Nova Cas 2020 = V1391 Cas, Nova Per 2020 = V1112 Per, Nova Cas 2021 = V1405 Cas, Nova Her 2021 = V1674 Her and Nova Vul 2021 = V606 Vul. We want to highlight the fact that in the case of V1405 Cas we know the orbital period of the progenitor. The progenitor of V1674 Her is an intermediate polar with known white dwarf spin period. In both cases it will be very interesting to compare the values after the nova explosion. In the case of V1674 Her we have already measured both the orbital and the spin period.

ON RADIOMETEOR INFORMATION PROCESSING

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NURE has a catalog of parameters meteor orbits in electronic format of about 250,000 orbits obtained during the seven-year period of the 70s and measuring the number and speed of meteors for the 80s of the twentieth century. All these data are the result of radio meteor experiments near Balaklia by researchers of the Kharkiv Scientific School of Meteor Radar. At the same time, relevant unique knowledge about the observation and processing of radio meteors has been accumulated using the back-reflection probing method.

The report is devoted to some features of radio meteor data processing and experience of their processing at Kharkiv National University of Radio Electronics. The question of data comparison with the method of sounding with mapping backwards and the method of forward scattering is discussed.

Radio meteor information has a pronounced probable nature. Information about meteors depends on various selectivity factors and processing methods, in particular those that take into account selectivity factors. Some methods will be considered in the report.

In particular, the visualization of meteor data distributions for the period 1972-1978 according to certain parameters and under certain conditions is presented. Visualization was performed using a modern computer program Alladin.

RESULTS OF NEA OBSERVATIONS IN RI MAO

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The problem of asteroid-cometary hazard is one of the priority tasks all over the world. The near earth objects (NEO) can be a threat for both existing artificial space satellites and for the population of the Earth as a whole. Currently, many scientific projects are devoted to monitoring well-known and search for new NEOs. Since 2010 RI MAO carry out regular observations of the selected near earth asteroids (NEAs). The results of high-precision astrometric follow-up observations of the selected NEAs with usage the KT-50 telescope of Mobitel Complex are presented. Main feature of the NEAs during close approach to the Earth is the fast moving in the field of view. That circumstance makes impossible to get NEAs images as point sources and to obtain their precise coordinates for the next stage of performing astrometric reductions by the classical methods. The modified Rotating-drift-scan CCD mode for obtaining target objects images and classical mode – for obtaining fields with reference stars to carry out astrometric reductions were used in RI MAO. The combination of classical and modified observational modes allows us to recover objects up to 17.5 V^{mag} with high astrometric precision. For a now more than 10,000 positions for about 500 NEAs were obtained. The comparative statistics of Mykolaiv observations of NEOs and analysis of positional accuracy are presented.

INSTRUMENTS OF TERSKOL PEAK OBSERVATORY

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The Observatory of the International Center for Astronomical and Medical and Ecological Research (ICAMER) is located in the mountains of the North Caucasus on Terskol Peak (Kabardino-Balkaria Republic, Russia, altitude 3150 m, international code B18).

The observatory has the following observation complexes:

- Zeiss-2000;
- Zeiss-600;
- Celestron 11" and Meade 14" robot telescopes.

The Zeiss-2000 telescope is equipped with a position observation camera with BVRI filters, a Multi Mode Cassegrain Spectrometer (MMCS), a high-resolution MAESTRO spectrometer and a dual-channel polarimeter.

The technical characteristics of the instruments are given and the observational capabilities of the tools are shown.

KINEMATICS OF SELECTED OPEN CLUSTERS OBTAINED BY COMBINING LAMOST DR5 AND GAIA DR2

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Context. Open clusters (OCs) are very important objects to study many astrophysical topics, including kinematics of the Galactic disc. High-resolution spectroscopic measurements of radial velocities (RVs) for selected OCs are available from LAMOST DR5 ground-based survey, which contains more spectra than Gaia DR2 catalogue, 9.0 and 7.2 millions respectively.

Aim. The aims are to compare RVs of common OCs from different catalogues and study kinematics of selected OCs around the Sun at distances of not more than 8 kpc.

Methods. The most probable members of selected OCs were taken from published paper of previous investigation obtained by using Gaia DR2 catalogue. Cross-correlation of equatorial coordinates allowed us to determine members of selected OCs among stars of LAMOST DR5 ground-based spectroscopic survey. Data processing was conducted by using TOPCAT (Tool for Operations on Catalogues And Tables).

Results. 3470 members of 306 selected OCs in declination range of -7º to +62º have been identified among stars of LAMOST DR5 survey. The weighted mean RVs and galactic velocities (GVs) in Cartesian system of coordinates have been determined for 212 selected OCs, which contain three and more members. The RVs and GVs of 85 selected OCs have been determined for the first time. The mean values of GVs for 85 selected OCs are (-2.5 7.8 -17.7) km/s. The mean velocity towards the southern Galactic pole is W= -17.7 km/s. The mean velocity in direction of galaxy rotation is V= 7.8 km/s. The mean velocity towards the galaxy center is U= -2.5 km/s.

Key words. Open clusters, radial velocities, galactic velocities, spectroscopic survey.

PECULIARITIES OF ENRICHMENTS WITH CHEMICAL ELEMENTS OF METALS-POOR STARS

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Metal-poor stars allow us to establish the early history of the Milky Way (MW), the nucleosynthesis yields from early mergers of neutron stars (NSM) and massive supernovae (SN), and also the chemical evolution and structure of the MW in general. On the base of spectra obtained using echelle-spectrograph fibre-fed HRS by Southern African Large Telescope (SALT, 11 m) in 2018-2020, the atmospheric parameters and elemental abundances of four metal-poor star HD 6268, HD 121135, HD 195636 and TYC 5594-576-1 ([Fe/H] ~ -1.5 -- -3.0) have been studied. The abundances of C, O, Na, Mg, Al, Ca, Sr, Ba, Eu and Th, which are important in the analysis of enrichment sources of early Galaxy were calculated using the synthetic spectrum method, taken into account the hyperfine structure (HFS) for the Ba, Eu II lines. The iron abundance was determined based on the equivalent widths of lines. The carbon abundance was obtained by the molecular synthesis fitting for the region of CH (4300-4330 ÅÅ). For several elements the NLTE abundance corrections have been applied. The relationship between the chemical enrichment of stars and their belonging to the populations of the early Galaxy was considered.

CLASSIFICATION OF GALAXY CLUSTERS. ALGORITHMS FOR APPLYING NUMERICAL CRITERIA

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For detail studying of galaxy clusters taking into account numerical criteria we developed algorithms for detecting various kinds of regular substructures in this objects. The input data (the Catalogue of Galaxy Clusters and Groups, E. Panko & P. Flin, 2006, and list of galaxies of Münster Red Sky Survey, R. Ungruhe, W. C. Seitter, and H. W. Duerbeck, 2003) allow to create the 2D map with positions of galaxies in the cluster field and show for each cluster member it's shape and orientation as best-fit ellipse. Our algorithms allow the detect the standard cases, such as the degree of concentration to the cluster center as well as the degree of concentration to the straight axe. We also developed the algorithm for detection some other features, such as a crosses, a semi-crosses, and complex crosses. The numerical criteria for the significance of detecting the substructures are applied for all cases.

The results of detail morphological classification are used for study of evolution of galaxy clusters.

IMPROVING WORLD SPACE SITUATIONAL AWARENESS

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Improving the world's Space Situational Awareness (SSA) is a very high priority activity, but space tracking resources are limited. Observatories have great resources to contribute to this effort, but can observatories make a meaningful contribution without impacting their primary mission? Europe, the USA, and Russia have SSA efforts but are there gaps in, as an example, our knowledge of what satellites are in space?

The Ukraine Network of Optical Stations (UMOS) has, with their colleague from the United States, has found a way that uses their observing network to track critical satellites. UMOS has tracked at least three objects that do not appear in the world's (default official) satellite catalog – the US web site Space-Track.org or even in another large satellite catalog. There are several satellite catalogs, for instance the Mini_MegaTORTORA site, where some objects are left out. The same situation exists in Space-Track.org as well.

Five high inclination satellites and three lower inclination satellites were tracked from May to August of 2021. The five higher inclination objects appear in the US Space Force's Satellite Catalog but without orbital parameters being given. The three lower inclination satellites appear to not be in the Satellite Catalog. The estimates of the accuracy of the obtained positional observations are given. The mean square errors of position were $\pm(1.0–3.0)''$ in right ascension and declination for the objects in $(8–11)^{mag}$ range. Orbital elements of these satellites were calculated using software from the Odessa National University.

This presentation shows the work done to find unknown satellites, and how UMOS is prepared to make that information available. This begins a discussion of what is the best use of the observatory's resources? Where should this contribution to SSA reside?

FOLLOW-UP NEA OBSERVATIONS IN SHAO

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The goal of current research project is to implement regular observations of NEAs with rotating-drift-scan CCD (RDS CCD) technique at Shanghai Astronomical Observatory (ShAO) with particular attention to fast moving and newly discovered objects and to obtain additional high precision astrometric positions for them during discovery apparition. The IAU MPC observatory code was obtained for the Lishan Observing Station (National Time Service Center of Chinese Academy of Sciences, NTSC of CAS, China) in 2019 and regular observations were started. The specific astrometric reduction software was developed to obtain topocentric astrometric positions of the objects. The part of observations was obtained around time moment of minimal distance to the Earth during current CA when apparent motion substantially exceeds diurnal motion. Follow-up observations during discovery apparition allows to extend the time intervals of the observed orbital arc for refining the orbit and reducing the orbital uncertainty, so it will be possible to recover them in next apparitions.

The astrometric results of NEAs observations, including new discovered one, are presented and analyzed. The comparative analysis of astrometric and ephemeris positions was done regarding to JPL's HORIZONS system and NEODyS-2 service. The residual differences (O-C) often show high values for newly discovered NEAs during observation date as well as big differences between ephemerid positions of mentioned services. The data for such NEAs is presented.

DETERMINATION OF THE OPEN CLUSTERS 3D STRUCTURE FROM GAIA EDR3 CATALOG

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Catalogs with an unprecedented level of accuracy were obtained as a result of the Gaia space mission. The use of data from these catalogs for the open clusters research allows clarifying of their star population and obtaining more accurate estimates of their parameters. The software, developed by the MAO Research Institute, uses astrometric data (proper motions and parallaxes) to determine the size, mean parallaxes, and mean proper motions of the open clusters and their populations. The software can work with any modern catalogs which contain the necessary astrometric parameters. The ultimate goal of the software is to refine the population and study the 3D structure of open star clusters.

This report presents the results of processing of the selected 129 clusters from the open clusters catalog (Dias +, 2002, CDS VII / 229) with current updates according to the catalogs GAIA EDR3. Most of the selected clusters are at distances not exceeding 1 kPs. The algorithm for calculating and separating background and cluster stars in the selected sky areas is based on the assumption that the clusters stars have similar values of their proper motions and parallaxes. The calculation is performed by the method of confidence intervals by successive iterations. Comparison with the data of the catalog (Cantat-Gaudin +, 2020, J / A+A / 633 / A99) mostly showed good consistency in distances and proper motions, but the population differs significantly in some cases. For some clusters, distance has big differences to the same in the Dias catalog but similar to the Cantat-Gaudin catalog. The probable reasons for such discrepancies and a detailed analysis of the selected clusters are given.

OPPORTUNITIES AND EXAMPLES OF USING NEW SERVICES FOR SCIENCE AND EDUCATION FROM GÉANT - A PAN-EUROPEAN NETWORK FOR RESEARCH AND EDUCATION

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The presentation reveals what the pan-European GÉANT network is, who its members are, and what the National Research and Education Network (NREN) is. Why GÉANT unites all research and education institutions in Europe, what services it provides and how to get these services in Ukraine - and for whom they could be useful.

NEW DIGITAL RECEIVER-SPECTROANALYZER FOR RADIO TELESCOPES UTR-2 AND URAN

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This report presents the results of the development and testing of a prototype of a new digital receiver with Fourier analysis functions. The receiver is designed for UTR-2 and URAN decameter range radio telescopes.

The receiver consists of a digital conversion and input board and a computer equipped with Nvidia CUDA graphics processor running developed software.

Unlike previous ones, the new receiver has a frequency range of 0-40 MHz, number of frequency channels is over 524,000, frequency resolution is 0.076 kHz, and time resolution is 12.8 μs.

COOPERATION BETWEEN MYKOLAIV AND MAIN OBSERVATORIES FOR DEVELOPING AUTOMATIC ASTROMETRIC COMPLEXES

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In 1980 on the territory of Mykolaiv Astronomical Observatory the new experimental laboratory of Main Astronomical Observatory (Goloseevo) of NAS of Ukraine was founded to construct the astrometric complexes onto modern digital technologies. This happened because the administrations of Pulkovo, Goloseevo and Mykolaiv Observatories made decision to fast implementation of the new techniques and technologies in astronomical observations. The history of joint development and production of automatic complexes "PARSEC" and "AMC" will be discussed, as well as the astronomical results of this cooperation.

A NEW PLATE DIGITIZER WITH AIR BEARING PLATFORM

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A new plate digitizer with air bearing platform has been developed during 2019-2021 in Shanghai Astronomical Observatory. Main parameters will be given and results of test digitization will be shown.

HISTORY OF MYKOLAIV ASTRONOMICAL OBSERVATORIES IN TELESCOPES

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The Mykolaiv Astronomical Observatory had three stages in the history: 1821 - 1912 (92 years), Marine Observatory (Russian empire, Maritime Department); 1913 - 1991 (78 years), Nikolaev branch of the Main (Pulkovo) Astronomical Observatory, (Russian empire and the USSR, Academy of Sciences); since 1992 (30 years), (Mykolaiv Astronomical Observatory (status of research institute since 2002), (Ukraine, Ministry of Education and Science of Ukraine).

The observatory used actual optical telescopes for positional observations at each stage of their history.

Some telescopes were used for visual observations at the first stage: Reichenbach-Ertel meridian circle (with a mercury horizon), Utzschneider passage instrument, a nine-inch Fraunhofer-Merz refractor and portable vertical Repsold circle.

At the second stage for visual and photoelectric observations: Freiberg-Kondratiev passage instrument, Repsold vertical circle, six-inch Repsold-Merz refractor, Repsold meridian circle, Zone astrograph with Ascorecord measuring machine and PARSEC measuring complex, time service passage instruments: Bamberg - 6353, APM - 10, Askania – Verke.

At the third stage some automatic and robotic telescopes with CCD cameras were created in MAO: Axial meridian circle, High-speed automatic complex, modernized AFU-75 camera, MOBITEL mobile complex (kinoteodolite (KT-50), MEZON telescope, television telescope), complex of 8 meteor telescopes for baseline observations.

Time service was carried out by the clocks: Norton since 1826, Hohwu №24 since 1875, Riefler №12 since 1894, Riefler №519 since 1894, Short №35 since 1931, Rode&Schwarz quartz clock since 1958, Hewlett-Packard rubidium standard since 1980, GPS-time since 2000.

OBSERVATIONS OF WEAK GALACTIC OH MASERS IN 1.6GHZ FREQUENCY BAND USING IRBENE RT32 RADIO TELESCOPE

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Ventspils International Radio Astronomy Centre (Ventspils University of Applied Sciences) is implementing the scientific project "Complex investigations of the small bodies in the Solar system" (lzp-2018/1-0401) related to the research of the small bodies in the Solar system (mainly, focusing on asteroids and comets) using methods of radio astronomy and signal processing. One of the research activities is weak hydroxyl (OH) radical observation in the radio range - single antenna observations using Irbene RT-32 radio telescope. To detect weak (0.1 Jy) OH masers of astronomical objects using radio methods, a research group in Ventspils adapted the Irbene RT-32 radio telescope working at 1665.402 and 1667.359 MHz frequencies. Novel data processing methods were used to acquire weak signals. Spectral analysis using Fourier transform and continuous wavelet transform were applied to radio astronomical data from multiple observations related to weak OH maser detection. Multiple observation sessions of OH maser objects (R Lmi, RU Ari, IRAS 00428+6854,OH 138.0+7.2, etc) were carried out in 2020-2021.

SIX YEARS (2015 -2020) OF CONTINIOUS RADIAL VELOCITY OBSERVATIONS OF POLARIS (α UMI) SYSTEM

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265 spectra of the Polaris system obtained during 2015 - 2020 six observational years at the 0.81m telescope of the Three College Observatory (TCO, North Carolina, USA) were used to determine the radial velocities (RV) and effective temperature of the Cepheid Polaris Aa. These new data have been added to the entire Polaris system RV data collection (over 2,500 measurements) to compute a new orbit of the Polaris Aa companion. Furthermore we have used our eight observational datasets taken in 2015–2020 and eight datasets taken in 2011–2018 by Anderson (2019) to check for possible influence of the orbital motion of Polaris Ab on the Polaris Aa pulsational activity. It was found that the mean pulsational period in 2015–2020 was quite stable (3.976±0.012 days), while the pulsational amplitude showed evident changes: a growth before HJD 2457350 with a following decrease. This fact could be due to the Polaris Ab passing through the periastron.

RADIAL VELOCITIES INVESTIGATIONS OF TWO OBJECTS IN COLLINDER 394 GALACTIC OPEN CLUSTER: HD 174403 AND BB SGR

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We present the results of the spectroscopic observations of two remarkable objects in the open cluster Collinder 394: post-MSTO object HD 174403 that is an eclipsing binary V4088 Sgr, and Cepheid BB Sgr. More than twenty spectra of HD 174403 during June-September of 2021 and 16 ones for BB Sgr during 2019-2020 summer seasons have been obtained at the 0.81m telescope of the Three College Observatory (TCO, North Carolina, USA). These spectra were used to determine the radial velocities (for HD 174403 and BB Sgr) and effective temperature (for BB Sgr). For the HD 174403 we were able to establish for the first time the exact orbital period of eclipsing binary near 26 days. The mean effective temperature of 5677 K have been determined for the BB Sgr. Moreover, according to radial velocity measurements, BB Sgr shows an spectroscopic companion's presence.

CIRCULAR VELOCITY CURVE OF RED GIANTS AND SUB-GIANTS FROM THE GAIA EDR3 DATA

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In our study, we determine the circular velocity of rotation of red giants and sub-giants around the Galactic center for stellar systems with radii 0.5 and 1.0 kpc, located along the direction the Galactic center - the Sun - the Galactic anticenter within the range of Galactocentric distances *R* 0-8-16 kpc. We know that the Solar velocity $V_{\odot}$ relative to the centroids is the difference between the vectors of the Solar velocity and the circular velocity of the centroids relative to the Galactic center. On the other hand, we know that the components of the Solar velocity vector relative to the center of the Galaxy are constant values. Consequently, the behavior of the components $X_{\odot}$, $Y_{\odot}$ and $Z_{\odot}$ is a reflection of the behavior of the circular velocity of centroids relative to the center of the Galaxy. The value of the circular velocity in the Solar vicinity is equal to 227.36±0.11 km/s, that is in good agreement with those given in numerous papers.

OBSERVATIONS AND INVESTIGATIONS OF ARTIFICIAL OBJECTS IN LVIV

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Space debris is an increasing threat to space services including satellite communication; allocation of new satellites; navigation and timing applications; even Earth observation itself is affected. As the use of Earth orbit grows more congested, the need to track space objects and provide information about activities in space becomes increasingly critical for a number of reasons, such as helping to prevent collision or debris-caused damage.

Among the methods of tracking the artificial objects are optical ones, which can give information about position of the selected object (positional observations), distance to the object (laser ranging), behavior of the object on the orbit and the shape of the satellite (photometric observations).

The Astronomical observatory (AO) is equipped with special complex of hardware and software for receiving data about: position of LEO object one could get making observations with the "Jupiter-9" on automated mounting of the Meade DS-2130 which was upgraded by AO staff and equipped with modern light-sensitive cameras; position, behavior and the shape of the satellite in GEO region—from observation made with the telescopes AZT-14 or/and GLD-250, which are equipped with modern Starlight Xpress astrocameras and photometric filters Astrodon.

During the time of working the AO has accumulated very many observations of artificial objects which should be collected somewhere. That's why there arose a need to create some Repository (data warehouse) of satellite observation data. Now it is currently being filled.

CLASSIFICATION OF GALAXY CLUSTERS. REALIZATION OF THE ALGORITHMS OF CLASSIFICATIONS AND CAPABILITIES OF THE CLUSTER CARTOGRAPHY SET

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For detail classification of galaxy clusters taking into account numerical criteria we create the cluster Cartography (CC) tool. For detecting various kinds of regular substructures in this objects new algorithms were developed. The input data are the Catalogue of Galaxy Clusters and Groups, E. Panko & P. Flin (2006), and list of galaxies of Munster Red Sky Survey (MRSS), R. Ungruhe, W. C. Seitter, and H. W. Duerbeck (2003). At the first step the MRSS information of galaxies is transformed to CC format. Equatorial coordinates are recalculated into 2D standard rectangular tangent coordinates in *arcseconds* by usual way. Real sizes of galaxies mainly so small for size of cluster field so, the size of galaxies in the CC map corresponds to galaxy' magnitude (calculated by a special equation). The shape of each symbol corresponds to the galaxy in best-fit ellipse appreciation.

CC allows one to determine the standard morphological types of cluster (the level of concentration to the center or/and straight line automatically – comparing the weighted densities in corresponding areas. The cross-type peculiarities we detect using a rotating pencil-beam area. CC also demonstrates corresponding histograms for visual control.

The possibilities of CC tools are demonstrated and discussed.

ANALYSIS OF GEOS PHOTOMETRIC SIGNATURE CLASSIFICATIONS BASED ON OBSERVATIONS OF FOCUSGEO TELESCOPE

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Ground-based optical-electrical observation is the main approach to obtain the Geostationary earth orbit (GEO) targets' optical characteristics. Light curve classification was studied based on the photometry observations of FocusGEO telescope at Lijiang Station from Dec, 2017 to June, 2019. A new classification system was introduced based on the statistical analysis of GEO satellite light curve features. Moreover, for those satellite signatures with an identifiable peak in brightness, the satellites' solar panel pointing offsets was also examined. And the correlation between light curve classification and satellites' bus type was analyzed. Results shows that photometric signatures of 197 GEO satellites can be divided into six classes and each class can be qualitatively explained by the actual satellite structure. Approximately 90% of these satellites appear to belong to three of six different classes. The distribution of offsets ranges from -15° to +15° and is mostly concentrated between -5° and 5°, with a slight positive bias. However, light curve classification has no significant correlation to satellites' bus types, but for the satellites with the same or similar bus types in each class, the light curves resemble each other. The classification system can aid to identify cluster GEO targets and provide basis for anomaly detection and physical characteristics research.

INTRODUCTION TO THE OBSERVATIONS OF THE GLOBAL ELECTRO-OPTICAL OBSERVATION NETWORK

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In recent years, with the rapid development of aerospace activities, the number of GEO targets (including artificial satellites, space debris, rocket wreckage, etc.) has increased year by year. In order to grasp the situation of GEO or HEO/MEO, Shanghai Astronomical Observatory is building a global observation network. This presentation aims to make an introduction to the observations of the network.

THE PROGRAMS FOR SEARCHING GAMMA-RAY BURSTS IN THE UKRVO DATABASE

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The results of continuous GRB monitoring are being published in GCN Circulars regularly for further observations of their afterglows as well as for investigation of any objects in the sky areas around the GRB. The last task can be performed using data of digitized photographic and CCD observational archives.

The overview of the scientific works on compiling a list of stars for identifying the sources of gamma-ray bursts on the UkrVO astronegatives, made in 2004-2016, is presented in the context of renewation of this UkrVO program.

THE COORDINATES ESTIMATION OF THE GALACTIC VERTEX BY MEAN OF KINEMATIC ANALYSIS OF THE RED GIANTS AND SUBGIANTS VELOCITY FIELD CONTAINING IN THE GAIA EDR3 CATALOGUE

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In this work we present the results of estimation coordinates XG and YG of the rotation center of the Milky Way galaxy (vertex) in a Cartesian galactic coordinate system and the Galactocentric distance to the Sun R0. Using method determination of the deviations from vertex by stellar velocity fields of some samples in the Galaxy plane the rotation center coordinates were estimated. The kinematic analysis of the spatial velocities of more than 3.8 million red giants and subgiants contained in the Gaia EDR3 catalogue was carried out. The rays emanating from the analyzed stellar samples and have directions to the vertex are intersecting at a certain geometrical place that probably is the center of the Galaxy rotation. In the current work, we used classical distances to stars based on trigonometric parallax (as $1/\pi$) and the distances estimated by Bayesian method (photogeometric). Using the different distances leads to a difference of estimations of stellar kinematics parameters of the Galaxy, as a consequence, give a difference of the coordinates of the center of Galaxy rotation.

OBSERVATION FACILITIES OF THE JOINT COMPLEX IN LISNYKY

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We use the joint complex of two telescopes under same slide roof in Lisnyky Observatory. They was assembled thanks a grant of STCU of Ukraine in 2008. We developed Kyiv Internet Telescope (KIT) on base of Celestron 14-inch telescope and pavilion of Lisnyky Observatory was prepared for its operation.

After testing of telescope at the MAO NAS of Ukraine it was set at Lisnyky observatory in May, 2012. AO KNU was upgraded telescope with mount WS-240 in 2013. During these years the KIT was used for observations of different space objects: exoplanet transits, eclipses of double stars, asteroids, chromosphere-active stars, distant comets, GEO satellites and occultation of stars by asteroids.

The Celestron Satellite Telescope (CST) was developed by cooperation with Mykolaiv Astronomical Observatory at 2015. It was mounted under same sliding roof with KIT. CST targets are LEO artificial space objects.

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